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Transforming agriculture – between policy, science and the consumer

Proceedings – Volume 1

Warsaw University of Life Sciences – SGGW

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I.

PEER REVIEWED PAPERS

AGRICULTURAL POLICIES AND THE EGYPTIAN FARMER: MODIFICATIONS IN FAVOR OF AGRICULTURAL DEVELOPMENT

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Abstract

The study emphasized the need for treatment of problems emerged with economic liberalization within the agricultural sector. Emphasis has been focused upon farm management as revealing the negative impacts upon crop rotations, efficient use of production requisites, marketing performance and agricultural infrastructure. Under privatization, the agricultural policies realization was short of acts of motivation. Certain specific actions were suggested, based upon restoring governmental intervention without violation of the established principles of economic performance and free market, and basically relying upon incentives vs. taxes.

Keywords: agricultural policies, central-planning, open-door economy, economic liberalization, privatization

1. Introduction

Since 1952, the Egyptian regime started to strongly interfere in agribusiness in order to achieve certain socioeconomic goals. In this respect, central planning of economic sectors became dominant. However, an entirely different strategy took place in 1975 with adoption of the Open-Door Economic Policy, gradually liberating all economic sectors from governmental intervention, almost accomplished during the 1990s.

Considering the agricultural sector, both those contradictive strategies had their advantages and disadvantages which influenced the agricultural development process. However, the currently dominant liberalized agriculture is experiencing serious problems which fiercely impede agricultural development, and hence call for intervening treatment. In this respect, treatment suggestions for such problems represent the main interest of this study.

2. Objectives

The study tends to monitor the public agricultural policies adopted by Egypt's subsequent governments, revealing their major developments and their causality. Emphasis is set upon both advantages and disadvantages of the adopted policies, especially focusing upon agricultural production development via producers responses. As such, the major objective is suggestion of empirical solutions for the main problems facing small producers, constituting the majority of the Egyptian farmers, and obstructing efficient management of their farms. Such solutions may call for governmental intervention with no violation of the principles of liberal economic behavior.

3. Methodology

Along with descriptive analysis, the study shall assess impacts of the adopted agricultural policies upon small farmers' management decision-making, using assessment tools and criteria most proper according to both case under scope and nature of data.

4. Results

4.1. Development of public agricultural policies in Egypt

To reach its goal of agricultural sector development in favor of both production and producers, the Egyptian regime after 1952 established a heavy interference program strongly accelerated during the 1960s. The central planning of agricultural production was implemented through programs of price-subsidized distributed production requisites, mandatory deliveries of specific quotas of the produce, and governmental marketing of strategic crops. The main direct target was production of specific volumes of strategic crops such as to satisfy as far as possible either domestic markets or exports needs. After the 1973 war, the regime tendency to change its politics strategy with stronger relations with the West, i.e. free economic world, exerted dramatic changes under the umbrella of the open-door economic policy. The government began a serial of actions toward withdrawal from the economic activities and providing a principal role to the private sector. Within the agricultural sector, subsidization of the production requisites' prices was gradually uplifted, and private marketing was given more room. With the fall of the Soviet Union at the beginning of the 1990s, capitalism concepts became dominant and most centrally planning countries adopted policies of economic privatization. In this respect, programs of privatization which were earlier initiated in Egypt became subject to haste acceleration. The government abolished mandatory deliveries, and hence the farmers became free in decision making with respect to both production and marketing, in addition to liberation of land rent. However, the government still sets up to date guaranteed prices for voluntary deliveries of specific crops, which are wheat and sugar cane, such as to maximize covering domestic consumption of subsidized price both bread and sugar, respectively. That in addition to temporal intervention in fertilizers marketing whenever marketing supply heavily drops.

4.2. Implications and impacts of variant economic policies:

A. Phase of Centrally-planned economy

The state's plan with respect to the agricultural sector focused on production promotion of certain exportable crops, while maintaining the reached levels of production for other strategic crops. The first group included cotton, rice and onions while the second represented by wheat, sugarcane and specific kinds of vegetables. Maize production was also increased as a major feedstuff. As example, area of rice increased from about 144.4 to almost 336.4, sugarcane from 24.8 to 53.2, onions from 10.6 to 23.1 and garlic from 3.5 to 7.6, in thousands ha during the period (1952-60). The widest leap occurred for maize which expanded in area from only 12 thousands to almost 400 thousands ha through (1952-66). Additionally, nearly 60 thousand ha were reclaimed in six years (1960-66). As such, the cropped area increased by almost 0.48 million ha during the period (1952-66) (El-Sanhouty, S.M., 2003). Such expansion was mainly attained by completion of the High Dam project in 1959.

Beside agricultural promotion, the welfare of small farmers was targeted through laws of land reform, including redistribution of agricultural land in excess of a maximum set limit for land possession of large landholders among landless farmers, limiting land rent at seven times land taxes and subsidizing prices of production requisites.

As outcomes of the agricultural policies of (1952-66), the value of agricultural production rose in real term from L.E. 388 million to nearly LE. 627 million, and value of livestock production almost doubled (Abdou, A. I., 1983). In a period of five years; (1961/64) to (1965/69), exports of rice increased from about 468 to 739 thousands mt/year and sugar production from 454 to 601 thousands mt/year, as shown in table 1.

Nevertheless, caused by the war of 1967, agricultural development almost stagnated and even recessed along with the whole Egyptian economy, and all land reclamation plans came to a halt.

Table 1. Acreage of some major crops in Egypt (1000 ha)

Crop	1952	1966	1994	2002	2010
Wheat	564.8	504	844	980	989.6
Maize	11.6	421.2	696	736	790.8
Rice	144.8	336.4	550.8	602.8	547.6
Cotton	786.8	743.6	288.4	214	113.6
Onions	11.8	23.1	10.0	21.6	50.0
Sugarcane	25.0	53.2	120.4	130.8	112.0

Source: calculated from data of several bulletins of: Ministry of Agriculture, Agricultural Economics Institute, “Agricultural Economics Bulletin”, Ameria Press

B. Phase of Open-Economy and privatization

The political diversion toward the capitalistic world started in 1974 with adoption of so-called Open-door economic policy. Such conversion was strongly encouraged by foreign fund donations and facilities of credit and imports payments. Such actions exerted a certain tendency toward favoring importation over domestic production for several major crops, especially wheat. Accordingly, the state lost interest in development of agricultural production. As such, the share of agriculture in GNP dropped from 28 to 22 and further to 14% (Siam, G. & H. M. Abd El-Radi., 2012). Consequently, wheat imports increased from about 2 million mt/year in average for (1965/66), to 3.9 million and 6.4 million mt/year as averages for (1975/79) and (1983/86), respectively. For the same periods, maize imports increased from 148 thousands mt/year to 538 thousands from L.E. 150 million in 1960 to almost L.E. 2 billion in 1979 (El-Sanhouty, S. M., 2003).

Considering costs of production, as shown in table 2, their absolute values increased over 20-30 folds during the period (1965-94) and by 80-90 folds by 2009-2010. Removal of production requisites’ price subsidies, labor wage leaps and liberation of land rent were the major causes of such increases.

Despite the mentioned above negative impacts, the open-door policies activated technology transfer through scientific cooperation with western and international institutions. As favorable outcomes, remarkable yields improvement occurred. As examples, shown in table 3, the average yield of wheat increased from about 2.9 mt/ha in 1965-66 to almost 5.3 mt/ha in 1994, for maize from about 4.4 to 7.0 mt/ha, and for rice from 5.3 to 8.3 mt/ha in same period. A further delayed leap occurred for yield of onions, as increasing from about 24.5 to 46.3 within the period (1994-2004), though suffering a retreat to almost 34.5 mt/ha in 2009-10 (El-Sanhouty, S. M., 2003).

The neglect of agricultural development during the early phase of the open-door economy caused dramatic increases in imports cost, while exports were hardly

Table 2. Total production costs for some major crops in Egypt (LE/ha)

Crop	1965-66	1994	1999-2001	2009-10
Wheat	95	2453	3805	9200
Maize	88	2513	4550	9258
Rice	110	2490	4273	9445
Cotton	170	3500	7005	9995
Onions	143	5585	5855	6193

Source: Ibid

Table 3. Yields of some major crops in Egypt (mt/ha)

Crop	1965-66	1993-94	2003-04	2009-10
Wheat	2.85	5.30	6.88	5.98
Maize	4.35	7.03	8.58	8.55
Rice	5.25	8.30	10.25	10.10
Cotton	1.73	2.36	2.81	2.48
Onions	20.50	24.50	46.25	34.50

Source: Ibid

promoted, and were even subject to decline as converted, toward the free market world of severe competition. As such, the leaping deficit of the balance of trade and foreign debt became an intolerable burden on the Egyptian economy. Accordingly, the state started to review its policies with respect to the strategic crops, especially wheat, corn and sugarcane. In this respect, the government resumed, in the last 1980s, intervention in production and marketing of the said crops. The main tool was ensuring guaranteed floor-prices for voluntary deliveries of wheat, maize and sugarcane in close levels to international prices. As a result, the area of wheat which dropped from an average of 0.67 million ha (1980-82) to almost 0.48 million (1984-86) increased to 0.79 and 1.0 million ha in 1994 and 2010 (El-Sanhouty, S. M., 2003), respectively. Subsequently, the 50% self-sufficiency rate of the early 1970s was re-attained. Another tool was to temporally intervene in domestic trade of chemical fertilizers whenever prices were beyond reach of most farmers, through provision of price-subsidized supplies. On the other hand, despite implementation of certain infrastructure improvement projects, such as tile drainage, problems still prevail, causing quality deterioration for certain crops such as cotton and onions whose ratios of non-exportable produce approached one-half their total production (Abdou, A.I., 1983).

To sum up the present situation of agricultural production and its implications with respect to farming practices, light should be shed upon certain major issues:

1. For both phases of centrally-planned economy and privatization, the government prepared plans for agricultural development. However, while the government took responsibility for execution of the plans' programs in the first phase, this task was assumed by the private sector in the second. Accordingly, as the plans of the second phase were short with respect to effective measures for building up the private sector's will and enthusiasm to fully adopt such programs, only 10-40% of the stated targets were reached. Under such conditions, neither producers nor the government have been fully committed to their expected obligation.
2. Farm-gate prices have increased by a great extent. However, costs of production dramatically increased. Hence, the small farmers' standard of living and livelihood slightly improved.
3. Despite the remarkable yields improvement, it was in quantity and not quality. That is mostly due to adoption of high-yield but not better quality varieties. That in addition to the unsolved problems of infrastructure, especially regarding both the irrigation and drainage systems. Such problems afflicted potentials of exports promotion.
4. The constantly weak agricultural extension has worsened despite its growing necessity under procurement of production requisites from the private sector. One of the main causes is non-replacement of promoted extension agents. Likewise, excessive use of both agricultural chemicals and irrigation water had its negative impacts upon both produce quality and agricultural ecology.
5. Despite return of agricultural labor from Arab oil countries, the problem of short labor supply still prevails. This may be due to an emerging general concept undermining farming as a profession. In addition to wide spread of education for farmers' descendants driving them to seeking jobs out of rural areas.
6. In addition to poor agricultural extension with respect to farming practices, the conditions are severer considering marketing. The small farmer faces lack of marketing information beside oligopsony of middlemen and their acts of speculation. Such conditions strongly disturb farmers' planning of cropping structures.
7. Enduring market increasing prices and labor wages, small farmers also face diminishing credit facilities. The Bank of Development and Agricultural Credit which has been supporting

small farmers since the 1930s was converted during the 1990s to a semi-commercial bank directing more than 80% of its credit services to non-agricultural investments. As such, most small farmers are forced to either borrow their financial needs at commercial interest rates or resort to middlemen for loans conditioned by selling their produce to those middlemen at less than fair market prices.

5. Suggested agricultural policies' adjustments

In view of the stated above conditions, the study tends to suggest policy modifications focusing upon agricultural production, principally targeting small farmers. Most of the present agricultural policies aim at favorable targets but lack applicable implementation measures. Accordingly, the suggested adjustments embed specific arrangements that should be taken such as to enable actual fulfillment.

1. **Government-producers contract agreements:** To ensure specific bulks of strategic crops' production, maximizing satisfaction of domestic needs, contracts prior to production may be issued between the government and the producers. Such contracts ensure deliveries of certain quotas of the produce at specific non-changeable prices. A price balance fund may be established to fill in the gap between the agreed upon price and the import price at time of delivery. Such system may be put in action in cases of wheat, maize, sugarcane, sugar beet and oil crops such as sunflower and soybeans.
2. **Monitoring and follow-up of production requisites marketing:** A specific authority should keep a close look on market performance and conditions. Permits to dealers should be given only after thorough inspection of the kind and quality of their merchandise. Satisfaction of hygienic, environmental and quality specifications must be strict conditions for permits of trade. Even in absence of complaints, periodic inspection procedures must be undertaken. Forecasting trends of short supply must be conducted, calling for governmental temporal intervention to fill in the market gap.
3. **Expansion and promotion of extension services:** The Ministry of Agriculture, of which its principal mission is agricultural extension, should reconstruct its extension program such as to improve performance. Its mission should rely on effectively playing the liaison role between research institutions and producers. A specific marketing extension body should be established, such as to provide farmers with reliable information with respect to market conditions and price trends, as a vital requirement for farmers' production and marketing planning.
4. **Cooperation activation:** The agricultural cooperation system has mostly been, since 1952, governmentally initiated and operated system. That is in exception of very few specialized and privately established cooperatives, such as the Potatoes Producers, the Horticultural Producers and the Dairy Producers cooperatives. Farmers should be encouraged to combine their efforts and resources within forms of cooperation in both areas of production and marketing. Awareness enhancement, training and organizational aid may be the most feasible measures to fulfill such target.
5. **Financial facilities:** According to its president's verbal announcement, The Bank of Development and Agricultural Credit is currently (2012) trying to re-attain its original mission of supporting farmers who suffer limited financial resources. It has been suggested to offer loans to small land holders at ascending interest rates according to landholding size. As such, the poorest farmer may be provided with loans at interest rates of 1-2, reaching 6-7% for big landholders. Such action, if put to effect, would be of great help to small producers in particular. Another suggested arrangement is to couple the loan offer with adoption of new

proper technologies which would generate higher yields allowing loans payback. At any case, the forthcoming production can be considered as collateral instead of the land owned by the producer, enabling inclusion of land tenants who represent a great proportion of Agricultural producers in Egypt.

6. **Activation of fiscal policy tools:** incentives and taxes may be effective tools to direct farmers toward production patterns in favor of the country's economy. While bonuses may be offered to producers of crops such as wheat and oil crops of which imports represent a burden on the economy, taxes may be imposed on production of competing crops of less national importance.

To avoid discrepancies, overlap and contradictive actions, a specific authority should assume responsibility for organization, coordination and liaison actions with respect to all procedures and actions required in course of the adjusted policies realization. The Ministry of agriculture (MOA) is the most proper to play this role. Fig. 1. presents a flowchart of the suggested plan of action for the Ministry of Agriculture.

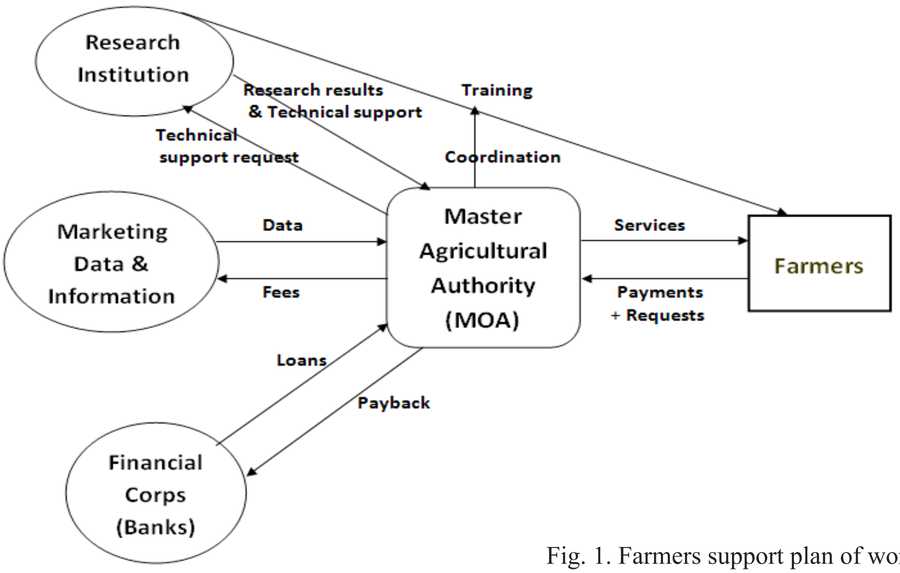

Fig. 1. Farmers support plan of work

5. Conclusions

The study's suggested modifications of the present agricultural policies relies on reviving the government intervention role in both production and marketing, in addition to sustaining, as far as possible, establishing of cooperation bodies among small farmers. The government withdrawal, due to privatization, seems hasty and inconsiderate of small farmers' conditions. Public agricultural investments, sharing no more than 3% of gross public investments, are far below percents recommended by relevant international bodies, mounting up to 10%.

As the net impact of privatization appears negative with respect to both development and small farmers' conditions, intervention should target interests of both the state and farmers. Contracts should be issued between the government and farmers to be fully respected by both parts. The government must not go back on its stated commitments under any condition. Likewise, the farmers, in return, must fulfill their obligation, especially with respect to delivered quotas and cultivated areas. The usual waving of fines on violation, due to political reasons, should be seized.

6. References

Abdou, A. I., 1983. “Impact of open-door economic policy upon food consumption patterns and rationalization potentials”. Econ. Working paper no. 199, ADS project, Egypt Ministry of Agriculture / University of California. Cairo, 1983.

Abdou, A. I., 2005. “Institutional support for farmers of developing countries: suggested forms and plan of action”. IFMC 15, 14-19 August 2005, Campinas, Brazil. Pp.13-18.

El-Sanhouty, S. M., 2003. Rural development finance: challenges and Ambitions” 11th Egyptian Agricultural Economics Conference, 24-25 September 2003, Cairo. pp 187-205.

Ministry of Agriculture/ Agricultural Economics Inst. “Bulletin of Agricultural Economics”. variant vols. For 1968-2011., Ameria press, Giza, Egypt.

Nassar, S., 1993. “The economic impact of reform programs in the agricultural sector in Egypt”. Symposium on: Implications of Economic Reform for Food and Agricultural Development in Egypt”. 28-29 November 1993. IFPRI / MOA, Cairo.

Osman, Y. M., 2003. “The effect of economic liberalization policy on the agricultural wages in Egypt”. 11th Egyptian Agricultural Economics Conference, 24-25 September 2003, Cairo. pp 369-385.

Siam, G. & H. M. Abd El-Radi., 2012. “Proposed set of reform policies to confront in the Egyptian agriculture”. 20th Egyptian Agricultural Economics Conference, 16-17 October 2012, Cairo. pp 1-18.

PRELIMINARY ASSESSMENT OF THE COMMUNICATION MECHANISMS USED IN THE VIRTUAL ACADEMY OF THE SEMI-ARID TROPICS (VASAT) PROJECT

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Abstract

Information and Communication Technologies for Development (ICT4D) have shared pre-occupation developing specific mechanisms and tools, considering their applicability, outcome, and impact. An analysis of an eight-year extension project in 21 villages in India suggests that the development of a multimedia approach to knowledge sharing to include extension education, considering both the local farmers´ organization and the context, brings about good results. Such outcomes are related not only to the technological frame, but also to economic, social, and ecological issues. A qualitative research taking into account farmers and local peoples´ opinions using a theoretical approach of Reflective Appraisal of Programs (RAP) presents some of the implications and lessons learned that can be adopted in the ICT4D projects.

Keywords: agriculture, multimedia, information and communication technologies for development (ICT4D), extension, knowledge sharing and innovation

1. Introduction

The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) is one of the 14 institutions of the Consultative Group on International Agricultural Research (CGIAR) continuously working on new and effective linkages between research and extension subsystems in the agricultural knowledge system to improve information access. Economic, social and political life in the 21st century will be increasingly using digital devices and those without Information and Communication Technologies (ICT) will be excluded (Heeks, 2008:26).

According to Balaji *et al.* (2007) and Rudgard *et al.* (2011), the Information and Communication Technologies (ICT) for Development (ICT4D) is an umbrella that includes computer hardware and software, digital broadcast, telecommunications technologies, social networks, interfaces for sharing information through the Internet, TV, radio, mobile phones, cloud computing facilities, geographic information system (GIS). It also includes the policies and laws that govern their widespread use. That digital technology domain intersects with development goals in search of a delivery mechanism (Heeks, 2008:27).

A "triple helix model" conceptual framework was used at ICRISAT to emphasize three strands to be observed as a unique chain[1]. First, there is a necessity for useful knowledge. Second, the ICT4D model is emphasized. Third, an open-distance paradigm is required in an effort to personalize learning for masses. This also takes into cognizance the future with distances being shortened by technology access.

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[1] For more information about the "triple helix model": http://vasat.icrisat.org/?q=node/96

Acknowledgments: The authors wish to acknowledge the VASAT Project team and its leader, especially mentioned, Dr. Balaji. Our profound gratitude to the people of Addakal and AMS Center for sharing their time, allowing us to carry out the interviews and meetings in the field.

ICRISAT, in collaboration with other institutions and aligned with the CGIAR policies, initiated the Virtual Academy for the Semi-Arid Tropics (VASAT) Project. The objective was to develop opportunities to exchange knowledge among researchers, extension workers and farmers, focusing on the community preparedness to cope with drought (Dileepkumar et al., 2006). The project involves a platform for communication, considering that preparedness is better than relief and that the communication systems would necessarily combine top-down and bottom-up approaches, with the paradigm of open and distance learning , and ICTs applied to rural development (Balaji et al., 2007:3).

Climate change is one scenario that affects farmers, and resource-poor farm households continuously rely on technologies for creating or improving their incomes and livelihoods (Heeks, 2008:29). This paper explored to assess the mechanisms and tools used in the VASAT project, a research for extension development initiative of ICRISAT, to identify recommendation domains for improving the system and draw upon the insights and experiences in the project for sharing these to various interest groups working on ICT4D.

2. Objectives

The research focuses on a preliminary assessment of the mechanisms used in the VASAT project, taking into account the framework of ICT4D in agricultural information. It describes the experiences and analyzes VASAT activities, mechanisms and results.

2.2. Specific objectives

- Describe the different tools and mechanisms used.
- Assess the tools and mechanisms from the perception of rural farm households.
- Suggest areas for crafting an innovative extension education system.

3. Background

3.1. The place and the people

Addakal is a “Mandal” (country subdivision) in Andra Pradesh, one of the poorest regions in India. It covers 196 km2 and consists of 21 villages whose economy is concerned with agriculture and livestock (Sreedhar et al., 2009: 28).

The region has a population of 46 380, of which 23596 is male and 22784 is female. It faces frequent droughts, and migration increased during last 10-12 years. People look for work out of their farms during summer time, searching for better income (Sreedhar et al., 2009:28). Institutional presence through development or extension organizations is weak. However, the strongest bonds to exchange information can be observed among farmers, and between vendors and farmers (Balaji et al., 2007:5).

In 2002, ICRISAT was involved in a governmental development program in Addakal, providing seeds and extension services. A federation of female self-help microcredit groups called Adarsha Mahila Samaikya (AMS) was a strong actor with 8000 members from 21 villages. Since 2004, ICRISAT and AMS have worked together in the VASAT Project using methodologies related to the ICT approach to foster drought preparedness. A hub-and-spoke model was designed, using local language (Telugu) (Sreedhar et al., 2010:3). At the beginning, basic ICT infrastructure facilities were used: a PC-based computer network with low cost Internet access in the Village Knowledge Centers

(VKCs). Later, video and audio conferencing, and mobile phone for two-way communication to ensure local knowledge acquisition. Starting a pilot experience with three villages during 2004, it extended to eight in 2008, covering farmers in the 21 villages in Addakal (Sreedhar et al., 2009:30).

3.2. VASAT Project: Communication tools and mechanisms

The VASAT project worked with drought preparedness based on an integrated approach for improving capacity in rural communities. An interface of ICT and distance-learning methods in a short period of time is used (Lavanya et al., 2010:2). The content was defined on a farmers´ demand basis and delivered in local language[2].

Since 2004, the project has been developing access to ICT tools through the eight VKC with PCs and the AMS building with video conferencing infrastructure. ICRISAT provides technical information and financial support for data collection, and AMS provides the facilitators who convert local terminology into a scientific one and vice-versa, serving as a bridge connecting ICRISAT, AMS and farmers (Dileepkumar et al., 2005). The role is being performed by eight Village Network Assistants (VNAs) trained by ICRISAT in ICT management.

The VKCs were designed based on the hub-and-spoke dynamics. Based on demand, the session schedules are prepared and provided in advance (Lavanya et al., 2010:5). The farmers´ queries are answered; if possible with the ICRISAT expert during the video conferencing session, or referred to a senior expert and the answers communicated to the VNAs. The facilitators translate the content into the local language. After every videoconference, the content is validated in order to build repositories at the VKCs and queries are uploaded to the Internet “aAqua” Forum[3] (Sreedhar et al., 2010:3). We need to point out here that as the ICT initiatives progressed, the VNAs evolved as knowledge intermediaries.

Since 2009, a field investigator has been helping interaction between VNAs and farmers, answering questions about agricultural problems.

The project developed colored maps using water budgeting, based on rainfall information collected and measured by a group of local farmers, and GIS tools provided by technical assistants of ICRISAT. Combined together allowed the drought preparedness of the communities of the project site (Patwar et al., 2009; Rudgard et al., 2011). According to Sreedhar *et al*.(2009:29), the message of the maps are easily understood by rural people because they are able to relate the corresponding meaning of the colors in terms

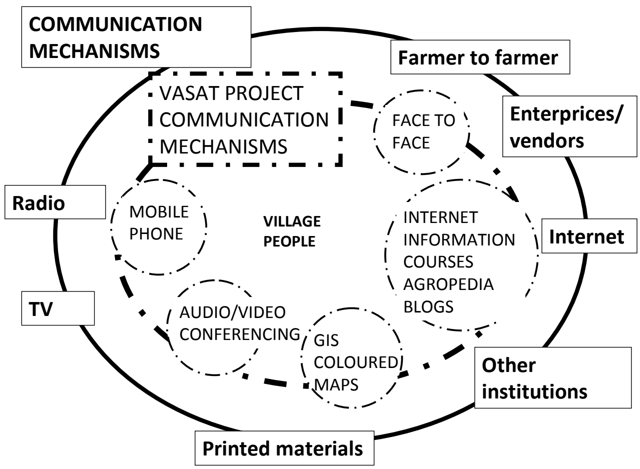

Figure 1. ICT4D mechanisms and tools used in the VASAT Project

[2] More information about the VASAT Project: http://www.icrisat.org/vasat
[3] More information about the Forum: http://www.aaqua.org

of what is the available moisture (or water) in their soil. Farmers are then assisted for their drought-related decision making by this kind of information.

Recently ICRISAT has also explored on an experimental web-mobile phone communication platform. As video conferencing requires volunteers to move to the AMS Center, the project set up audio conferencing facilities in the villages, enabling several people to interact with the experts (Lavanya *et al.,* 2010:4).

The mechanisms used in the Project are shown in Figure 1. The Internet provides access to Agropedia, VASAT´s blog, wiki, courses and activities related to the project (Kaur *et al.*, 2009:2). The Internet connection was also utilized by the rural people for other purposes such as weather, market information and education.

4. Methodology

A preliminary assessment of the VASAT Project through qualitative research is presented. The research elicited actors perception and knowledge gained during the project. Analysis and systematization of secondary data, direct observation, semi-structured interviews and group meetings were combined to obtain more reliable assessment.

Evaluation is a management tool where the analysis of activities and their corresponding effects allows for reaching conclusions considering the objectives (de Hegedüs, 1995; OIT, 1997). It is also a process to determine relevance, efficiency, effectiveness and impact of the project (Villarraga, 1998). The theoretical approach of Reflective Appraisal of Programs (RAP) (Bennett, 1992) was efficiently used in the evaluation of technology transfer projects (Albicette *et al.,* 1999; de Hegedüs *et al.,* 2000; Guerra, and Zocco, 2006), using different ICT tools. According to that model and from Bennett's hierarchy (Bennett and Rockwell, 2000) there are seven levels of evaluation; 1) inputs; 2) activities; 3) participation; 4) reactions; 5) knowledge, skills and attitudes; 6) behavior change and adoption; and 7) impact. The study was geared to the first five levels, focusing on five villages and the AMS Center (Table 1). Ninety interviews were carried out to know about relevant issues (Taylor, and Bogdan, 1986).

Table 1: Addakal Mandal: Interviews and meetings

Village	VNA	Activity	Nº Female	Nº Male
Nijalapur	Ms. Ramayswaramma	SSI & GM	5	3
AMS Center		GM	21	5
Komireddypalli	Ms. Chandrakala	SSI & GM	16	-
Janampet	Ms. Vemmalmma	SSI & GM	11	1
Vemula	Ms. Narmadamma	SSI & GM	15	11
Kandur	Ms. Lalithamma	SSI	2	-

SSI: Semi-structured interviews; GM: group meeting

The respondents were farmers, VNAs, and AMS members attending the meetings and farmers interviewed in the field (Table 1). Interview dates were fixed in advance and conducted personally with simultaneous translation from Telugu language. Meetings and interviews lasted approximately two hours. Notes and photos were taken and direct observation data were written in a booklet (Taylor and Steele, 1996).

An interview guide was used during individual interviews and focus group discussions. Questions were mostly open-ended to allow respondents' openness on the issue being explored. For more reliable conclusions, the interviews and notes were again validated not only with the local communities but even with other stakeholders like the ICRISAT staff involved in the project and even with scientists who were providing technical assistance.

Table 2 - VASAT project results in 5 villages and AMS Center - (K&U: known and used)

Components	Nijalapur Village	Komireddypalli Village	Janampet Village	Vemula Village	Kandur Village	AMS Center
Technological						
Video/Audio Conferencing	K&U	K&U	K&U	K&U.	K&U	Infrastructure
Internet	K&U.	K&U	K&U.	K&U.	K&U.	K&U.
Colored Maps	K&U. Fixed on the walls		Fixed on the walls	Fixed on the walls	On the walls	K&U
Cell Phones	K&U	For the future	For the future		K&U	K&U
Social						
Field Investigator	K&U. Good relation with farmers	K&U	K&U. Good relation with farmers	K&U		K&U
VNAs	K&U	K&U	K&U	K&U	K&U	K&U
Relationships	Farmer-to-farmer		Farmer-to-farmer			Farmer-to-farmer
	Farmer-vendors		Farmer-vendors	Farmer-vendors		Learned to negotiate
Gender issues	No gender differences			Some gender issues arose		No gender differences (Female 50%, Male 50%).
Labor		New jobs	New jobs		Men look for work	Rural employment grantee
Education and health		Internet for educational purposes				Programs: Livelihood, physical handicap, old pensioners, health insurance
Acquired knowledge	Learned a lot	Learned a lot		Learned a lot		Learned a lot
Economic						
	Aware of seed quality	Micro-financial groups	Micro-financial groups			Dairy cooperative, handloom, restaurant
	Better yields		Costs reduced			Costs reduced. Incomes increased.
Institutional						
	No extension		No extension	No extension		Focus of rural development. Relation with Bank.
Ecological						
Topics for further research	Drought, Pests Management		Water management	Nutritional crops deficiencies		Non pesticide management.

5. Results

A matrix summarizing people and AMS members´ opinions is presented in Table 2. Likewise, the overview of outcomes under technological, economic, social and institutional components, regarding the different tools and mechanisms used in the VASAT Project is also shown. The empty cells in the matrix mean that there were no comments about that item.

6. Conclusions and lessons learned

The preliminary assessment shows that the project has achieved good results as some outstanding outputs can be gleaned from the result of the interview. Responses like (1) '"We have more agricultural information especially those that relate with technical issues that results in better management of the technologies", (2) "We have learned to minimize the use of agricultural inputs and still have better yields; (3) "We have learned more knowledge due to internet connectivity, mobile phones, colored maps and other tools; (4) "We have learned to negotiate with vendors; and (5) "Because of capacity building provided by the project, some of our household members have landed in better jobs".

6.1. Tools and mechanisms used

The mechanisms and tools used for communication during the Project, which people were really acquainted with, were as follows: video/audio conferences, colored maps, Knowledge Centers with PC's, VNAs, field investigators, capacity building, and mobile phones. Our preliminary assessment shows impact of these tools, however, it is suggested that there should be more detailed assessment to determine impact not only of the tool but also of the entire project.

In line with what was expressed above, farmers used colored maps for decision- making in relation to drought preparedness. The advice given by the field investigator or the VNAs people sent through the hub-and-spoke mechanism resulted in quick response to agricultural problems.

As observed, farmers have internalized the knowledge acquired from the various tools. It would be of interest to have an in-depth study on the decision-making process of farm households.

6.2. Economic outputs

The farmers learned technical issues, which allowed them to have better farm management. To date, they have become critical to seed quality, water availability and management. Better decisions were taken like which crop to grow based on science. They are concerned about reducing their costs, so they are instructed on the benefits of precision agriculture like inputs utilization to save money without sacrificing productivity. Farm households also use the Internet for other agricultural support like accessing market and prices information and educational purposes. As a result of being better informed, farmers were in good position to deal with vendors and save resources.

6.3. Social issues

People in general learned to improve their negotiation skills. This contributed to upgrade their abilities as a result of the various capacity building activities included in the project. The Knowledge Centers also opened doors to the young members of the farm household to have better access to information and educational issues.

As a result of the implementation of the Project, women were empowered to face new challenges. We verified that VNAs learned about technological issues or got new jobs.

In very few of the villages, some gender issues emerged, leading to the question: Are there differences between women and men using agricultural information? A recommendation to this is to understand the reasons how AMS being a women's organization has been successful in a cultural domain of a patriarchal society.

6.4. Roles among the people participating in the project

It was clear that the VNAs are happy and proud of the job they are doing. It would be of interest for a future project to know about farmers' opinions about VNAs performance.

The KCs are already installed and can generate interactive information among farmers, promoting innovation. Consequently, capacity building to enable the VNAs as facilitators for development, upgrading knowledge, attitudes and aptitudes is required.

Farmers have no time to attend meetings and courses, so new ICT tools for easy access to information, as well as effective methodology to be applied by the field investigators are also needed.

A deep relationship among AMS members, VNAs, field investigators, farmers, and ICRISAT researchers was observed. In extension projects, leadership, good attitude and empathy toward local people are important. Institutions have to be aware of the importance of these, highly value them, and take into account that extension workers are part of the success of projects. A strong mechanism of coordination among actors by developing a network for faster information access is necessary.

6.5. Horizontal and vertical linkages

Dialogue and discussion at horizontal and vertical levels are important for facilitating community knowledge. ICRISAT needs to know first-hand about the farmers´ problems for a better reach of the technological information proposed.

The vertical linkages were enhanced through various capacity building activities. AMS members called ICRISAT to work together on the VASAT Project, and during the implementation, new mechanisms of communication emerged. It can be remarked/should be noted here that impact can be greater with better horizontal interactions and new ICT tools. Participatory research could be useful with pilot groups, considering the traditional farmer-to-farmer exchange of information.

7. Other recommendations

7.1. Institutional

There was no evidence of a strong linkage between farmers and institutions. Thus, it seems apparent that extension support is needed.

The VASAT Project should be continued and expanded as an example of how scientists test the relevance of their research with farmers. Special value can be added looking for a coordinated platform to develop ICT tools for extension and research. The organization of the villages with private participation can improve production and explore new markets. Financial logistics, trained professionals, innovative learning methods and materials will be required to interact with farmers.

7.2. Project advocacy

The project and its results should be known by ICRISAT and other research institutions looking for a closer relationship with small farmers. The advocacy is strongly recommended with multimedia approach: TV, radio, printed material, conferences and newsletters. Institutional policies regarding the use of mass media and communication devices would be useful to standardize strategies and activities.

7.3. For final assessment and other projects

A more comprehensive assessment considering qualitative and quantitative methods can deeply assess activities, participation and reactions, evaluating knowledge, behaviors and impact using the seven levels proposed by Bennett (1982) and Bennett and Rockwell (2000).

The ICT4D framework can be applied in an effective way, using several mechanisms and tools with small farmers, especially considering countries where extension services count on few resources. Using ICT4D new interrelations among farmers, researches, institutions, local facilitators are generated and can possibly be viewed as a model to be adapted by research and extension institutions.

8. References

Albicette M. M., Brasesco R., de Hegedüs P., 1999. *Evaluación de impacto de un proyecto de difusión y transferencia de tecnología*. Young. Instituto Plan Agropecuario. Uruguay. 83 p.

Balaji V., Meera S., Sreenath D., 2007. *ICT-enable knowledge sharing in support of extension: addressing the agrarian of the development world threatened by climate change, with a case study from India*. SAT eJournal: ejournal.icrisat.org 4 (1): p 18.

Bennett C., 1982. *Reflective appraisal of programs (RAP): An approach to studying clientele-perceived results of cooperative extension programs*. New York, Media Services. Cornell University. p 19.

Bennett C.F., Rockwell C., 2000. *Targeting outcomes of program (TOP)*. [Online], Available: http://www.citnews.unl.edu/TOP/english/. [20 Dec 2012].

de Hegedüs P., Vassallo M., Gravina V., Rodríguez N., 2000. *Evaluación de las actividades realizadas por el Instituto Plan Agropecuario (1996-2000).* Montevideo, Instituto Plan Agropecuario. Uruguay. p 28.

de Hegedüs P., 1995. *Evaluación: Aspectos conceptuales y relación con la investigación*. In: Educación de adultos y desarrollo 44. Bonn, Institut für Internationale Zusammenarbeit. Germany. pp. 69-88.

Dileepkumar G., Dixit S., Balaji V., 2005. *Agricultural extension with information and communication technology (ICT) mediated open distance learning (ODL) methods: A case study from rural South India.* Educomm Asia, 10 (4) pp8-11

Dileepkumar G., Dixit S., Balaji V. 2006. *Rural Knowledge Centers as Facilitators of New Learning Opportunities for the Rural Families: a case study*. [Online], Available: http://www.iasri.res.in/icsi2006/theme3/balaji.pdf. [20 Dec 2012].

Guerra A., Zocco J., 2006. *Informe de adopción e impacto. Proyecto producción artesanal de semilla de variedades mejoradas de maíz.* San Javier, FAO-DANAC. p 22.

Heeks R., 2008. *ICT4D 2.0: The Next Phase of Applying ICT for International Development.* University of Manchester. IEEE Computer, 41(6), 26–33.

Kaur P., Patwar S., Gerard Sylvester A., Balaji V., 2009. *Use of semantic Wiki tool to build a repository of reusable information objects in agricultural education and extension: results from a preliminary study*. [Online], Available: http://vasat.icrisat.org/images/New%20Folder/Web%202%20for%20Dev.pdf . [20 Dec 2012].

Lavanya N., Ramnaresh Kumar V., Sreedhar G., Gerard Sylvester A., Balaji V., 2010. *Fostering community preparedness to cope with drought: new initiatives and results from a study involving ODL and ICT from South Central India*. [Online], Available: http://wikieducator.org/images/9/99/SJ_Lavanya.pdf. [20 Dec 2012].

OIT, 1997. *Pautas para la preparación de evaluaciones independientes de programas y proyectos de la OIT*. Oficina de programación y gestión. [Online], Available: http://preval.org/documentos/00452.pdf. [20 Dec 2012].

Patwar S., Kaur P., Gerard Sylvester A., Balaji V., 2009. *Towards a novel content organization in agriculture using semantic technologies: a study with topic maps as a tool.* [Online], Available: http://vasat.icrisat.org/images/New%20Folder/IJSMO.pdf. [20 Dec 2012].

Sreedhar G., Nagarajan R., Ramnaresh Kumar V., Lavanya N., Gerard Sylvester A., Balaji V., 2010. *Disaster Preparedness using IT Tools: Case studies on the use of ICT and GIS derived tools for micro-level drought preparedness*. [Online], Available: http://vasat.icrisat.org/images/New%20Folder/Disaster%20Preparedness%20using%20IT%20tools%20FINAL.pdf. [20 Dec 2012].

Sreedhar G., Ramnaresh Kumar V., Nagarajan R., Balaji V., 2009. *Improving Micro-level Drought Preparedness Using GIS. Case study of Adakkal Mandal, AP.* The first monthly magazine on ICT4D, climate change, special information for development (I4D). Vol. VII No. 3. pp 27-30.

Taylor S.J., Bogdan R., 1986. *Introducción a los métodos cualitativos de investigación. La búsqueda de significados.* Buenos Aires, Paidos. p 342

Taylor Powell E., Steele S., 1996. *Collecting data evaluation: Direct observation.* Program development and evaluation. University of Wisconsin. USA. [Online], Available: http://learningstore.uwex.edu/assets/pdfs/G3658-4.pdf .[20 Dec 2012].

Villarraga J., 1998. *Sistema de evaluación de impacto del proyecto de apoyo al desarrollo de la microempresa rural.* Colombia, PADEMER. FIDA nº 426. p 16

Rudgard S., Ballantyne P., Del Castello R., Edge P., Hani M., Maru A., Morras E., Nichterlein K., Porcari E., Treinen S., Balaji V., Balasubramanian K., 2011. *ICTs as Enablers of Agricultural Innovation Systems. In:World Bank. ICT in agriculture: Connecting Smallholders to Knowledge, Networks, and Institutions.* Report number 64605. E-sourcebook. pp 113-147.

INVESTMENT DECISION SUPPORT SYSTEM FOR HIGH QUALITY CONTROL POSTS IN EU

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Abstract

In 2010 an EU subsidy program started to create high quality control posts in Europe. Control posts are companies offering facilities for animals to rest and eat during long distance transport. They also offer facilities for trucks, drivers and competent authorities. A decision support program has been developed to support owners of control posts with their investment plan. The aim of this computer program is to calculate what increase in truckloads or in price per truckload is needed to justify the investment plans. The program was tested at two control posts participating in the EU project in Poland[1]. Both owners appreciated the added value of the program and suggested some improvements.

Keywords: control post, investment, BEP, mathematical model

1. Introduction

The proportions of the regional production of animals in Europe are different from the respective regional consumption. As a result, animals and meat are transported all over this area. In the period 2005-2009 the number of cross-border truckloads of live animals within EU increased from 315,000 to almost 400,000 (excluding poultry). About two thirds of this transport is shorter than 8 hours, however, 16,000 to 24,000 truckloads so called “long distance transport” last more than 24 or 28 hours (Baltussen et al, 2011). About 40% of these are cattle truckloads, about 40% are horses for slaughter truckloads, about 20% are pigs and about 5% are sheep and goats truckloads. Figure 1 shows the main long distance transports routes of cattle in 2009 in EU. The tendency was that during the period 2005-2009 the total number of consignments was increasing while the number of long distance transport has been decreasing since 2007.

The main routes of animals transported within EU have remained the same for a long time. The long distance transport has to stop at so called control posts, and has to unload the animals, feed them and let them rest for 24 hours. At the beginning of 2010 there were 157 control posts on the official EU list (approved by the EU). However, only 113 out of 157 investigated control posts were still in operation. Data shows that 5 of them where suspended and 39 were closed down because of the lack of customers. The majority of the control posts in operation also report low occupancy. This tendency concerns all control posts on all routes no matter which species they deal with. Only four control posts reported the use of more than 60% of the full capacity during the whole year (Gebrensbet et al, 2010).

Transport of live animals including stops at control posts is regulated by Directive 1/2005/EC. This regulation was evaluated in 2011 (Baltussen et al, 2011). The main conclusions are that the introduction of that regulation slightly improved the animal welfare during transport especially during long distance transport and at the same time increased the transport costs for live animals.

[1] The authors want to thank the control posts owners for their cooperation.

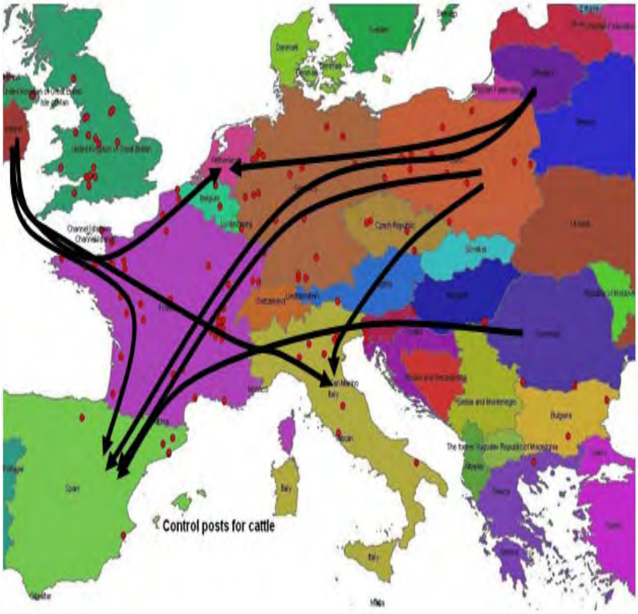

Figure 1. The main routes of long distance cattle transport in 2009 and location of the control posts for cattle Source: Gebrensbet et al, 2010

There are still differences in the implementation, enforcement and penalties for infringements of the Directive by individual Member States which undermine the level playing field for transport companies. This means that transport companies working according to the rules can hardly, or not at all, compete with transport companies who violate the rules.

It can be expected that in the coming years the EU will not change the regulation but will try to enforce it equally in all Member States. One of the effects will be that the number of stops at control posts will increase. The research carried out by Baltussen et al. in 2011 showed that for example about 50% of all horse transport lasting 20 to 24 hours should have stopped at a control post, but it didn't.

Based on a feasibility study (Gebrensbet et al, 2010) the EU stimulated the improvement of the quality of control posts by two subsidy programs (SANCO D5/10753/2010; SANCO 10834/2011). As a result, 11 control posts joined the high quality project in 2011 and additionally 5 control posts joined the high quality program in 2012. The goal of the first subsidy program is to develop a certification scheme for control posts to reach high quality standards with respect to animal welfare, bio-security and facilities for drivers and competent authorities and services for trucks (see Gebrensbet et al, 2010; SANCO D5/10753/2010; SANCO 10834/2011). In the second subsidy program also transport companies are invited to develop a high quality scheme.

Most of the existing control posts have to be rebuilt or renovated to reach the high quality standards. For owners of control posts it is hard to decide if and in what facilities they should invest. It's difficult to predict the number of trucks stopping at their control posts, the willingness to pay for certain services (e.g. truck facilities, drivers facilities, animals facilities). Therefore, within this high quality program a computerized decision support system has been developed to support owners of control posts in their investment decisions. In this article this decision support system is described and two investment plans of control post are given as examples.

2. Description of the model

A certain number of trucks with animals visit a control post a year. Each visit generates variable costs e.g. costs of fodder, costs of water, costs of electricity. The fixed costs grow if additional investments in equipment, buildings and new facilities are needed to enhance the quality of the control post. The costs of the adjustments need to be calculated to justify investment decisions. The additional revenues from the control post need to outweigh the additional costs.

To support an owner of a control post in managerial decision making, an economic model has been developed. The model supports owners in evaluating potential investment projects in two ways. Firstly, it helps the control post owners to decide whether they want to implement a particular investment project. Secondly, it will also help the control post owners to determine the optimal size of the investment. The tool is a deterministic mathematical program that calculates the break-even point for the number of truckloads at varying prices or varying occupancy rates. By "playing around" with various "what-if" situations, the owner of the control post gains knowledge about feasibility of the investment. The model offers the possibility to change the "price per load" (daily allowance per truck load) and to see the economic impact of the change. Thus owners are supported in making justified decisions in order to reach the desired standards.

The model consists of three different sheets for data input, a calculation module (i.e. the mathematical-/economic model) and the main sheet with the output of the calculation. The model is available online, free of charge and requires only Excel 97-2003 or later. It is available in 5 languages: English, German, Spanish, Polish and French. When the user chooses a language, all texts of the model (including buttons) are replaced by texts of the selected language (will be available: http://www.controlpost.eu/joomla/index.php/project-1/2011-05-30-09-54/prototype-break-even-analyses).

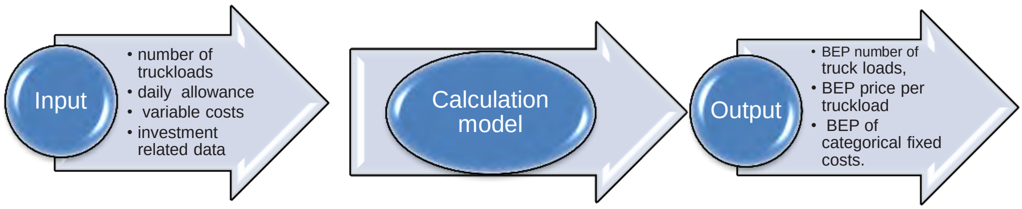

Figure 1. The decision support program for control post investment

2.1. Input

The data input requires information about a specific animal category. In the model eight animal categories are distinguished for the four species: cattle, horses, sheep and pigs. The user has to introduce the figures concerning the current (before-investment) and the future (after-investment) situation (e.g. value of the investment, maintenance). For each investment there is a separate input sheet, to calculate the annual costs. The program provides specific default values for some items, so the investor does not need to estimate them (e.g. 'useful life' or 'rest value' of the investment). The system enables to select the options from the list or enter your own figures.

Some investment costs (i.e. buildings and equipment) are divided into per-animal category and the rest are general investment costs not categorized (i.e. services for trucks, facilities for truck drivers, facilities for competent authorities).

2.2. Calculation module

When the needed inputs are provided, the mathematical model starts to distribute the total amount of occurring costs to the individual animal categories. It is based upon the calculated gross margins of the animal categories. The larger gross margin the animal category produces the bigger the amount of general fixed costs is assigned to the animal category.

The main focus of the model is the break-even analysis. The model calculates three Break-Even Points (BEP) to cover all additional costs (Figure 1). The three BEP are: the number of truckloads at a given price (allowance per day), the minimum price at a given expectation of occupancy and the combination of number of trucks and changing prices (daily allowance). Higher prices, more truckloads or lower value of planned investment will result in a higher level of project justification. Variations in additional costs or prices result in different break-even points. Break-even points for price, for number of truckloads, and for categorized fixed costs are calculated for each relevant animal category A separately:

$\text{BreakEvenPrice}_A = ((\text{YearlyCosts}_A + \text{AllocationFixed}_A + \text{TruckLoads\_IST}_A * \text{GM\_IST}_A) / \text{TruckLoads\_SOLL}_A) + \text{VariableCosts}_A + \text{ExtraVariableCosts}_A$

$\text{BreakEvenTrucks}_A = (\text{YearlyCosts}_A + \text{AllocationFixed}_A + \text{TruckLoads\_IST}_A * \text{GM\_IST}_A) / \text{GM\_SOLL}_A$

$\text{BreakEvenCatFixed}_A = \text{TruckLoads\_SOLL}_A * \text{GM\_SOLL}_A - \text{TruckLoads\_IST}_A * \text{GM\_IST}_A - \text{AllocationFixed}_A$

where:

$\text{AllocationFixed}_A = \text{AllocationPct}_A * \text{GeneralFixedInvestmentCosts}$

$\text{AllocationPct}_A = \text{GM\_SOLL}_A / \Sigma_A (\text{GM\_SOLL}_A)$; GM is abbreviation for Gross Margin

$\text{GM\_IST}_A = \text{Price\_IST}_A - \text{VariableCosts}_A$

$\text{GM\_SOLL}_A = \text{Price\_SOLL}_A - \text{VariableCosts}_A - \text{ExtraVariableCosts}_A$

The surplus (i.e. returns minus additional costs) is calculated for each relevant animal category separately from the returns, fixed costs and number of expected truckloads. These surpluses are summed up to yield the total surplus for the after-investment situation. The outcome can be compared with the returns from the before-investment situation.

2.3. Output

Annual costs of the investments for the animal categories as well as general investment items are presented on the main screen of the model. Investments, other costs and allowances are summarized as the difference between IST- and SOLL outcome. The break-even analysis results in three outcome values: break-even number of truckloads, break-even price per truckload and break-even of categorized fixed costs.

2.4. Two examples

The model has been tested on two control posts in Poland participating in the EU project for high quality control posts. Both control posts have been visited in the last 4 years, by 453 and 377 truckloads of animals a year on average. Both control posts can host pigs and cattle. From table 1 it can be concluded that the number of visits vary considerably from one year to another. Control post 1 was shut for half a year during 2012 because of renovation. Both control posts depend strongly on the transport of pigs from Denmark, Germany and the Netherlands to Ukraine, Belarus, Russia and Kazakhstan and on cattle transported the opposite direction from Lithuania and Poland to Spain and Italy. The transport of pigs is highly uncertain because of import breakdowns for safety or political reasons (e.g. to Russia).

The owner of control post 1, considered the investment in stables for pigs and cattle in order to create a high quality control post. He planned double of the existing capacity of stables while the owner of control post 2 considered the investment in a facility for truck wash (see table 2). The total investment for control post 1 and 2 was to 300.000 and 393.000 euro respectively.

The main question for owner of the control post 1 was if the investment in stables for cattle would be justified. The main question for the owners of control post 2 was if the investment in additional facilities for trucks and drivers could be justified by an increased number of expected visits and/or a higher price per visit because of better quality facilities. For control post 1, its owner expects to host between 877 and 1162 truckloads of animals after the renovation. The first one being a pessimistic view and the second a more optimistic one. As a result of investment in control post 1 there was an increase in fixed costs by 44,257 euro. To achieve a break-even point without changing the daily allowance and without using EU funds, 781 truckloads are needed to compensate for the cost increase. In case of participation in the EU project, a subsidy of 69% is given for all the investment (except for land purchase). With the EU subsidy, the break-even point declined to 544 truckloads (table 3). The number of truckloads needed for both break even points is smaller than the number predicted by the owner. They make respectively 47 and 62% of the expected consignments. Therefore, there is high probability that the investment will increase the income of the owner of control post 1.

As a result of investment in control post 2 there was an increase in fixed costs by 50,170 euro. For control post 2 the owner expects annually between 500 and 900 truckloads of animals after the renovation. To reach the break-even point without EU funding and without changing prices for services, 400 truckloads are needed. With the EU subsidies only 236 truckloads are needed to break-even. This makes 26 to 47% of the expected truckloads estimated by the owner (table 3).

Table 1. Number of truckloads visiting two control posts in Poland during the period 2009-2012

Year	Control post 1		Control posts 2	
	Pigs	Cattle	Pigs	Cattle
2009	395	0	284	275
2010	790	8	327	104
2011	123	23	431	34
2012	51	87	468	89
Average	453	39	377	125

Source: control post documentation

Table 2. Investments (in euro, excluding VAT) per control post to reach high quality

Type of investment	Control post 1	Control post 2
Stables	208,180	-
Truck wash	11,500	150,000
Access road and parking space	22,820	80,000
Tractor	45,000	-
Manure storage & fencing	12,500	85,000
Facilities for drivers	-	40,000
Charger	-	38,000
Total investment	300,000	393,000

Source: control posts documentation

Table 3. Break-even analysis CP 1 and CP 2

Specifications	Self financing option		EU funds contribution option	
	Pigs	Cattle	Pigs	Cattle
Control post 1				
Number of truck loads /year before the investment	790	2	790	2
Number of truck loads /year after the investment	790	87	790	87
General fixed costs	44,257		44,257	
BEP (Number of truck loads)	725	56	529	15
BEP (Price per truck loads) [€]	341	247	312	175
Surplus [€]	12,094		40,881	
Control post 2				
Number of truck loads /year before the investment	377	125	377	125
Number of truck loads /year after the investment	377	125	377	125
General fixed costs	50,170		50,170	
BEP (Number of truck loads)	277	125	194	42
BEP (Price per truck loads) [€]	341	300	310	201
Surplus [€]	14,575		38,980	

Source: own calculation

3. Discussion and conclusions

The developed decision support model has proven its value at least for the owners of the control posts where it was tested. By "playing around" with expected numbers of truckloads and with prices per truckload they were able to get insight into the sensitivity of their investments. For both cases, the probability of net profits from these investments is quite high.

The testing of the model resulted also in some suggestions from the users for improvement of the model:

1. Make it more user-friendly. For example, by introducing separate "help-icons" for instructions. For the present model data descriptions and explanations are put in a Manual.
2. Introduce more flexibility. In the model, the stables can be used by one category of animals. In reality stables are used for different species. This complicates the calculations because also investments in stables have to be divided over the species.
3. For the calculation of the profits the number of truckloads is multiplied by the price per truckload. However, the owners of control post use different methods of pricing. Therefore, they suggested adding the possibility of choosing the way of data input-giving either a number of truckloads or a number of animals.

4. References

Baltussen W.H.M., Gebrensbet G., de Roest K., 2011. Study on the impact of regulation (ec) no 1/2005 on the protecTion of animals during transport [wageningen etc.] : wageningen ur [etc.], p. 117.

Gebresenbet G., Baltussen W., Sterrenburg P, de Roest K., Engstrøm Nielsen K., 2010. evaluation of the feasibility of a certification scheme for high quality control posts sanco/d5/2005/si2.548887 final report, may 2010. p. 122.

http://ec.europa.eu/food/animal/welfare/financing/index_en.htm: sanco d5/10753/2010 sanco d5/10834/2011.

ECONOMIC COSTS OF SOIL NUTRIENT MINING AND BENEFITS FROM PLANT NUTRIENT RECYCLING: THE CASE OF SWITCHGRASS PRODUCED FOR BIOENERGY FEEDSTOCK

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Abstract

Few attempts have been made to account for the potential costs associated with soil nutrient mining or the potential benefits associated with nutrient remobilization in switchgrass pastures established and managed as a dedicated bioenergy feedstock crop. Continuous soil nutrient mining could result in declining yields and profitability in the long-run and ultimately final exit out of switchgrass production. The objective of this study was to determine the cost associated with nutrient mining and the potential benefits associated with nutrient remobilization associated with one and two-cut switchgrass harvest systems in the southern Great Plain, USA. Data collected from a four-year, two-location agronomic field trial that evaluated two harvest systems, five N rates, and fixed rates of P and K applications were used for analysis. A standard forage analysis was used to determine the concentrations of N, P and K nutrients in the feedstock harvested. Cost of mining (or benefit of recycling) was estimated by comparing two separate economic models. Model 1 follows the conventional economic approach of utilizing yield response to treatments levels of N, P and K. Model 2 follows an approach that accounts for the costs and benefits associated with the N, P and K concentrations removed by the plants at harvest. Results from the convention economic approach indicate that producers should harvest twice per year, lending the system to mine significant quantities of N, P and K. When the benefits and costs associated with total nutrient uptake from plants were accounted, assuming a \$110 Mg^{-1} for feedstock, the results indicate a producer would be better off harvesting twice (once in the summer and again in the winter), and the non-market economic tradeoff between nutrient mining and long-run soil sustainability was \$8.70 Mg^{-1}.

Keywords: Switchgrass, bioenergy, economic sustainability, cellulosic feedstock, nitrogen, harvest system

1. Introduction

Switchgrass (*Panicum vigatum* L.) has been identified by crop scientists and public policy makers as a leading source of cellulosic feedstock for conversion into bioenergy products in the southern Great Plains—a region in the USA that has a comparative advantage in growing native perennial grasses for conservation programs, wildlife habitat, and livestock enterprises. Published reports (Kazi et al. 2010; Wu, Sperow, and Wang 2010; Haque and Epplin, 2012) indicate that a large-scale biorefinery ($\geq$ 189 x 10^6 L yr^{-1} production capacity) will require between \$100 x 10^6 and \$500 x 10^6 in initial investment capital, depending on the conversion technology utilized (e.g., enzymatic hydrolysis, thermochemical pyrolysis, gasification, etc.). Rational investors would be reluctant to invest in a large-scale biorefinery unless they are certain they can procure a steady, long-term and locally produced supply of feedstock in each year of the expected life of the capital investment in the plant [Haque et al. 2012]. Furthermore, it is important for farmers to have reliable information about the actual fertilizer requirements of the plants in order for them to maintain productive levels of nutrient in their already fragile soil-base in order for them to produce a long-term, economically sustainable and steady supply of feedstock to biorefineries.

Data collected from multi-location, multi-year agronomic field trials in south-central Oklahoma show that significant quantities of nutrients (i.e., N, P and K) in excess of levels supplied via controlled treatments were removed (i.e., mined) from the soil by switchgrass plants that were harvested at the time of plant physiological maturity (prior to plant senescence) in July (Guretzky et al. 2011). Conversely, data from the same trials showed that significant levels of N, P and K nutrients supplied to switchgrass plants were remobilized back to the root zone (and to some extent, back to the soil) of plants harvested in the winter after a hard freeze, after plant senescence. This indicates that if harvest activity can be delayed until after plant senescence, some of the N, P and K will remobilize back into the root system and will minimize the need for their replacement. To date, conventional economic methods commonly used to determine the most economical harvest time and corresponding rates of fertilizer (Lemus et al., 2008; Haque et al., 2009; Boyer et al., 2013) do not consider the potential agronomic problems associated with soil nutrient mining nor the potential benefits associated with nutrient remobilization that are associated with producing switchgrass for bioenergy feedstock.

The objectives of this study were to determine the cost of mining and the potential benefits associated with recycling N, P and K nutrients in one and two-cut switchgrass harvest systems in the southern Great Plains, and to determine the non-market price for which producers would be indifferent between short- and long-run profitability of growing, harvesting and storing switchgrass feedstock on their farms.

2. Theoretical framework

Barber [1984] reported that a balance of sufficient quantities of vital nutrients is required to maintain proper plant growth throughout the growing cycle of the plants. The nutrient balance in the soil is measured by taking the difference between nutrient inflow and outflow [FAO 2004]. A positive balance occurs if nutrient additions (inflow) to the soil are greater than those removed (outflow), and a negative balance occurs if more nutrients are removed the quantity of nutrients added [Gruhn, 2000; Rijpma and Islam 2003; FAO 2004]. Negative balances are directly related to soil nutrient depletion that may lead to soil degradation [Rijpma and Islam 2003; FAO 2004], and soil nutrient depletion is a process by which nutrient are reduced through natural processes, such as soil erosion and leaching, and by human-induced processes, such as continuous nutrient mining through harvested plant biomass without adequate replenishments of nutrients [Drechsel and Gyiele 1999]. Continuous soil nutrient mining affects soil quality adversely and has been shown to reduce crop yields, providing for an unsustainable cropping system over the long term [Hopkins et al. 2001; Tan 2005; Henao and Baanante 2006].

For switchgrass produced for a bioenergy crop, the extent of soil nutrient mining depends heavily on the time of the growing season that it is harvested. If switchgrass is harvested in mid-season (summer harvest) nutrient levels in harvested biomass are relatively high [Guretzky et al. 2011]. On the other hand, if harvest is delayed until after the first hard freeze (after plant senescence), the plants will have recycled some of the nutrients in the plant back to the root zone, providing for a positive nutrient balance for that growing season [Vogel et al. 2002; Mooney et al, 2010;

Guretzky et al. 2011]. Guretzky et al. (2011) reports that the difference between the quantities of N, P and K fertilizer treatments applied to experimental plots and quantities of the same nutrients removed by the plants in a two-cut harvest system was negative, representing nutrient mining. In the same study, a positive difference (reflecting the quantities of nutrients that were remobilized back to the root zone) was found to be the case with the one-cut system.

The conventional economic approach for determining the economically optimal levels of N, P and K nutrients to apply to agricultural crops follow a producer expected profitability optimization framework where yield response to N, P and K nutrient application functions are econometrically estimated using yields actually measured in agronomic experiments from varying quantities of fertilizer treatments (Tembo et al., 2008; Biermacher et al., 2009; and Boyer et al., 2013). Response functions along with expected prices of crop and fertilizers are then used to analytically determine the economically optimal levels of N, P and K. However, this method does not consider the consequences associated with what the plants actually remove from the fixed soil nutrient base.

In this paper, we use the expected profit maximization framework that is commonplace. In addition, we develop a second model that utilizes data representing N, P and K concentrations that were actually removed from the plants at harvest. Using the results from both models, we determine the cost of nutrient mining or benefits from nutrient recycling, depending on the harvest system. Mathematically the cost of nutrient mining can be expressed as follows:

$$C = \mathrm{E}(NR^C) - \mathrm{E}(NR^S), \tag{1}$$

where C refers to the cost of nutrient mining, NR^C is the net return obtained using the conventional economic modeling approach that uses the yields associated with the actual nutrient treatments applied in the agronomic experiment, NR^S is the net return obtained by accounting for the benefits and costs associated with the data representing nutrient concentrations taken from the plants. A positive value of C is defined as the cost of nutrient mining and a negative value for C reflects a benefit associated with nutrient remobilization. At present, the marketplace does not place any value on the cost of excess nutrients that are removed from the soil (or surplus nutrients that are translocated back to the root zone) in excess of the quantities applied by the farmer; that is, farmers tend to consider only those cash costs associated with the quantities of N, P and K that they are actually purchase and applying to their crops.

3. Data

Data were collected in four production seasons (2008-2011) from two agronomic field experiments conducted on established stands of switchgrass (var. ‘Alamo’). The first site was near the community of Frederick in Tillman County, OK (34º23´ N, 98º85´ W) and the second located near the community of Burneyville in Love County, OK (33º89´ N, 97º29´ W). The experimental design was a randomized complete block with four replications. The two harvest systems included (1) a single-cut harvest system in the winter after a hard freeze, after plant senescence (WNTR); and (2) a two-cut system that included a summer cut in July at the time of plant maturity, followed by a second cutting of the regrowth in the winter (December) after a hard freeze, after plant senescence (SMWNTR). Each study site and harvest system received 0, 45, 90, 135, 179 and 224 kg ha^{-1} yr^{-1} of N in the form of urea (46-0-0), 67 kg ha^{-1} yr^{-1} of phosphorus in the form of P_2O_5 (0-46-0), and 135 kg ha^{-1} yr^{-1} of potassium in the form of K_2O (0-0-60).

Sub-samples of the harvested switchgrass were collected to calculate dry matter yield and nutrient concentration measures for crude protein (CP), P and K. Following drying at 60°C, samples were ground to pass a < 1 mm screen using a Wiley Mill (Thomas Scientific, Swedesboro, NJ). Ground material was analyzed for CP, P and K using the Foss 6500 near infra-red reflectance spectroscopy (NIRS) instrument. The samples were scanned using Foss ISI Scan software and prediction equations developed by the NIRS Forage and Feed Testing Consortium (Hillsboro, WI). The CP concentration mean, standard error of validation, and r^2 for the equation used were: 19.9 g kg^{-1}, 1.3 g kg^{-1} and 0.98, respectively. The P mean, standard error of validation, and r^2 for the equation used were: 1.9 g kg^{-1}, 0.4 g kg^{-1} and 0.73, respectively. The K mean, standard error of validation, and r^2 for the equation used were: 16 g kg^{-1}, 2.8 g kg^{-1} and 0.85, respectively. These equations were then used to predict CP, P, and K for all samples. Concentrations of N removed by the plants were then calculated from CP by dividing each observation of CP by 6.25. Amounts of P and K removed by biomass were converted to P_2O_5 and K_2O kg ha^{-1} equivalents. Comprehensive details regarding the growing conditions and agronomic relationships between feedstock yield response to N, P and K nutrients and concentrations for the alternative harvest systems for each location and year are reported in Guretzky et al. (2011).

4. Economic methods

We assume that a rational farmer wants to know when to manage the timing of harvesting activities (i.e., when to cut, rake, bale and store feedstock) and how best to manage N, P and K nutrients for that system in order to obtain maximum profit on each acre on his farm. Therefore, risk-neutral farmer's objective function can be expressed mathematically as:

$$\max_{H^*,N^*|\bar{P},\bar{K}} E(NR^C) = \max\{\rho_b E[Y(H,N,\bar{P},\bar{K})] - r^N N - r^p \bar{P} - r^k \bar{K} - r^a - r^h - r^b Y(H,N,\bar{P},\bar{K}) - \mathrm{r}^x X - FC\},$$

Subject to:

$$Y \geq Y(H,N,\bar{P},\bar{K});$$

$$H \in \{1 = WNTR, 2 = SMWNTR\};$$

$$N,\bar{P},\bar{K},X,FC \geq 0;$$

$$r^N, r^N, r^K, r^a, r^h, r^b, r^x \geq 0 \tag{2}$$

where E(NR^c) refers to the expected net returns (\$ ha^{-1} yr^{-1}) from conventional economic approach; P_b is the price of switchgrass feedstock (\$ Mg^{-1}); *Y(H,N,P,K)* is feedstock yield (Mg ha^{-1} yr^{-1}) and is a twice differentiable continuous function of the levels nitrogen (*N*) for fixed rates of *P* and *K* fertilizers (kg ha^{-1} yr^{-1}) for a given harvest system *H* (either a winter only system (WNTR) or a summer and winter (SMWNTR) system); r^N, r^P and r^K are the price of *N*, *P* and *K*, respectively; r^a is the custom application rate for applying *N*, *P* and *K* fertilizers (\$ ha^{-1}); r^h is a vector of custom rates for mowing, raking, and staging feedstock (\$ ha^{-1}); r^b is the custom rate for baling switchgrass feedstock (\$ Mg^{-1}); r^x is a vector of prices that corresponds to the vector *X* containing non-fertilizer, non-harvest activity inputs, such as pesticide, pesticide application and interest on operating capital; and *FC* represents fixed cost associated with the annual prorated cost of switchgrass establishment and a land rental rate.

A similar framework is utilized for the sustainable economic approach (model 2) to determine the most economical harvest system. The primary difference is that the costs and benefits of nutrients (N, P and K) were determined by using the levels of N, P and K that were actually removed from the soil by the switchgrass plants. The concentration levels vary between N rate treatments assigned randomly in the RCBD. In this case, a twice differentiable yield response to nutrients concentrations equation could not be estimated; that is, the yield responded to nutrient concentration levels linearly. Therefore, the objective function for the sustainable economic approach is expressed mathematically as:

$$\max_{H,N^S P^S K^S} E(NR^S) = \max\{\rho_b E[Y(H,N,\bar{P},\bar{K})] - r^N N^S - r^p P^S - r^k K^S - r^a - r^h - r^b Y(H,N,\bar{P},\bar{K}) - r^x X - FC\},$$

Subject to:

$$Y \geq Y(H,N,\bar{P},\bar{K});$$

$$H \in \{1 = WNTR, 2 = SMWNTR\};$$

$$N,\bar{P},\bar{K},X,FC \geq 0;$$

$$r^N, r^N, r^K, r^a, r^h, r^b, r^x \geq 0, \quad (3)$$

where E(NR^s) refers to the expected net return (\$ ha^{-1} yr^{-1}) represented by the sustainable economic approach; N^S, P^S and K^S are the nutrient concentrations levels for N, P and K actually removed from the plants at the time of harvest and for analytical purposes were converted to N, P_2O_5 and K_2O (kg ha^{-1}) equivalents. It is important to note that these data provide insight about how the plants consumed nutrient they had available to them either from the nutrient treatments applied in the study or by surplus sources already available in the soil. Substituting equation (2) and equation (3) in to equation (1) and simplifying yields:

$$C = -r^N N - r^p \bar{P} - r^k \bar{K} - (r^N N^S + r^p P^S + r^k K^S). \quad (4)$$

Full detailed enterprise budgets (AAEA 2000) were developed to determine an estimate for all production cost components in equations (2) and (3), except the cost of owner's labor, management and overhead. These costs were not considered because they tend to differ substantially, depending on farm size and location within the region. The budgets included the prorated annual establishment costs as well as the costs associated with annual stand maintenance and harvesting activities.

Under the conventional economic approach (Eq. 2), only the cost of N, P and K that was purchased from the market and applied on the plots was accounted in the analysis. For the sustainable economic approach (Eq. 3), nutrient cost adjustments were made by calculating the difference between the fertilizer treatments applied and nutrient removal rates. These differences are presented in Table 1.

If the difference is negative, the cost of the nutrients applied to the plots, plus the cost associated with the additional quantity of nutrients removed from the soil by the plants was accounted in the analysis. A positive value indicates the cost of nutrients applied minus the value of the additional quantity of nutrients translocated to the root zone.

Table 1. Levels of N, P and K treatments, removed, and nutrients mined or recycled, and feedstock yield by harvest systems

Nutrient treatment rates (kg ha^{-1} yr^{-1})			Nutrients removed* (kg ha^{-1} yr^{-1})			Nutrients levels mined/recycled** (kg ha^{-1} yr^{-1})			Feedstock yield (Mg ha^{-1})
N	P	K	N	P	K	N	P	K	
WNTR system									
0	67	135	33 (33)§	16 (10)	31 (37)	-33	52	103	10.3 (4.9)
45	67	135	55 (41)	20 (11)	39 (38)	-10	47	95	12.4 (4.8)
90	67	135	68 (50)	25 (13)	44 (47)	21	43	91	14.1 (5.2)
135	67	135	84 (58)	28 (18)	50 (48)	50	39	84	15.0 (6.5)
179	67	135	101 (57)	29 (16)	43 (43)	78	38	92	15.0 (6.5)
224	67	135	105 (60)	30 (17)	48 (48)	119	37	86	14.7 (6.1)
SMWNTR system									
0	67	135	73 (54)	30 (17)	120 (79)	-73	37	15	9.5 (5.5)
45	67	135	106 (65)	41 (20)	170 (91)	-62	26	-36	12.8 (6.5)
90	67	135	154 (77)	56 (27)	236 (120)	-64	11	-102	16.4 (8.1)
135	67	135	185 (86)	61 (32)	256 (135)	-50	7	-121	17.0 (8.5)
179	67	135	220 (107)	71 (37)	309 (163)	-40	-3	-175	20.4 (10.2)
224	67	135	229 (105)	69 (36)	286 (145)	-4	-2	-151	19.3 (9.8)

* Nutrient removal levels are given by a standard forage (NIRS) analysis. These represent levels of nutrients N, P and K (in the form of N, P_2O_5 and K_2O) that were removed from the soil by switchgrass plants.
** Calculated as the difference between nutrient applied and nutrient removal level. A negative value implies the nutrient was mined and a positive value implies the nutrient was remobilized to the root zone of the plant.
*** Numbers in parentheses are standard deviations

5. Results and discussion

The net cost of nutrient mining or net benefits of nutrient recycling, the non-market price adjustment necessary to encourage long-run economic sustainability and the economically sustainable feedstock price by yield and various assumed market prices for feedstock are reported in Table 2. For the base-case price scenario that assumed a feedstock price of \$83 Mg^{-1} and a price of N of \$1.19 kg^{-1}, the expected net return estimated under the conventional economic approach was obtained with the SMWNTR harvest system and was \$388 ha^{-1}. Conversely, the greatest expected net return using the sustainable economic approach was \$392 ha^{-1} and obtained with the one-cut WNTR system. The difference in these two net returns was \$4 ha^{-1} (\$392 - \$388) and reflects the net benefits associated with nutrients that were recycled back to the root zones of the plants harvested in the WNTR system after plant senescence. The benefit of recycling in the two-cut system (SMWNTR) was also accounted, but the costs associated with the nutrients (primarily N and K) that were mined by the plants from the soil with the summer cutting more than exceeded the benefits of recycled nutrients in the winter cut. Further analysis reveals that for the base-case scenario, a producer would actually require \$0.30 less for each metric ton produced on his farm in order to maintain economic sustainability. That is, instead of receiving \$83 Mg^{-1}, he would only require \$82.7 Mg^{-1}.

When a price of \$110 Mg^{-1} of feedstock was assumed in the analysis, the greatest net return using the conventional economic approach was obtained with the two-cut (SMWNTR) system, realizing a net return of \$937 ha^{-1}. The greatest net return found using the sustainable economic approach was the one-cut (WNTR) system, realizing \$806 ha^{-1}. For this feedstock price scenario, our analysis shows that there was a \$131 net cost associated with nutrient mining. In this case, a farmer would need an additional \$8 for each metric ton of feedstock produced in order to encourage her to choose the economically sustainable one-cut (WNTR) system. That is, instead of \$110 Mg^{-1}, she would require \$118.7 Mg^{-1} to compensate her for choosing the more sustainable system (WNTR) that produces 5 Mg ha^{-1} less switchgrass than is produced with the SMWNTR system found using the conventional economic approach. This system had more short-run profit, but is likely unsustainable in the long-run.

The results were most sensitive to the expected price of feedstock and assumptions about the percentage of nutrients that is remobilized back to the root-zone and made available to growing plants in the following year. The results show that the net cost of nutrient mining in the two-cut SMWNTR system increases substantially as the assumptions about the total percentage of the nutrients that is recycled for later use are relaxed and reduced down from the 100% assumed in the base-case.

6. Conclusions

Conventional methods for determining the economical harvest timing and optimal rates of nutrients to apply to a dedicated cellulosic bioenergy feedstock crop do not consider the costs of nutrient mining associated with harvests prior to plant senescence nor the benefits from nutrient recycling with harvests after plant senescence. It is noteworthy to point out that price adjustments necessary to encourage harvest systems that are economically sustainable during the life of the investment into expensive, large-scale biorefineries are not currently valued in the marketplace. Therefore, it is believed that substantial mining of the nutrients in the fixed, already fragile nutrient-base of the soils in the region will be the result, placing additional risk and uncertainty on the economic potential of a large-scale, expensive cellulosic biorefinery.

Table 2. Net cost of nutrient mining or net benefit of nutrient recycling, price adjustment necessary to encourage soil sustainability and the economically sustainable feedstock price by various assumed feedstock prices

Assumed feedstock price (\$ Mg^{-1})	Model 1 Conventional approach			Model 2 Sustainable approach		
	feedstock yield (Mg ha^{-1})	harvest system	net return (\$ ha^{-1})	feedstock yield (Mg ha^{-1})	harvest system	net return (\$ ha^{-1})
55	20.0	SMWNTR	-163	10.3	WNTR	-33
83	20.0	SMWNTR	388	15.0	WNTR	392
110	20.0	SMWNTR	937	15.0	WNTR	806

Net cost of mining/ net benefits of recycling* (\$ ha^{-1})	Price adjustment necessary to encourage sustainability (\$ Mg^{-1})	Economically sustainable feedstock price (\$ Mg^{-1})
130	-12.6	42.4
4	-0.3	82.7
-131	8.7	118.7

* Calculated as the difference in net returns between the sustainable and conventional economic approaches. A negative value implies the net cost of nutrient mining and a positive value implies a net benefit of nutrient recycling

7. References

American Agricultural Economics Association, AAEA, 2000. Commodity costs and returns estimation handbook. A report of the AAEA task force on commodity costs and returns. Ames, Iowa, USA.

Barber S.A., 1984. Nutrient balance and nitrogen use. In: Roland D. Hauck (ed.). Nitrogen in Crop Production, Madison, WA: ASA-CSSA-SSSA, p.87-95.

Biermacher J.T., Brorsen B.W., Epplin F.M., Solie J.B., Raun W.R., 2009. The economic potential of precision nitrogen application with wheat based on plant sensing. Agric Econ 40:397–407.

Boyer C.N., Tyler D.D., Roberts R.K., English B.C., Larson J.A., 2012. Switchgrass yield response functions and profit-maximizing nitrogen rates on four landscapes in Tennessee. Agron J 104:1579-1588.

Drechsel P., Gyiele L., 1999. The economic assessment of soil nutrient depletion: Analytical issues for framework development. IHSRAMISWNM. Issues in Sustainable Land Management 7, IBSRAM Barigkok, 80 pp.

Food and Agriculture Organization of the United Nations, 2004. Scaling soil nutrient balance. FAO Fertilizer and Plant Nutrition Bulletin. Available from: http://www.fao.org/docrep/008/y5749e/y5749e00.htm [accessed 11.01.12].

Gruhn P., Goletti F., Yudelman M., 2000. Integrated nutrient management, soil fertility, and sustainable agriculture: current issues and future challenges. Food, Agriculture, and the Environment Discussion Paper 32.International Food Policy Research Institute, Washington, D.C. 20006 U.S.A.

Guretzky J., Biermacher J.T., Cook B., Kering M., Mosali J., 2011. Switchgrass for forage and bioenergy: harvest and nitrogen rate effects on biomass yields and nutrient composition. Plant & Soil 339(1-2):69-81.

Haque M., Epplin F.M., Taliaferro C.M., 2009. Nitrogen and harvest frequency effect on yield and cost of four perennial grasses. Agron J 10:1463-9.

Haque M., Epplin F.M., 2012. Cost to produce switchgrass and cost to produce ethanol from switchgrass for several levels of biorefinery investment cost and biomass to ethanol conversion rates. Biomass and Bioenergy 46:517-530.

Henao J., Baanante C., May 2006. Agricultural production and soil nutrient mining in Africa: Implications for natural resource conservation and policy development. IFDC, An International Center for Soil Fertility and Agricultural Development.

Hopkins J.W., Lal R., Wiebe K.D., Tweeten L.G., 2001. Dynamic economic management of soil erosion, nutrient depletion, and productivity in the north central USA. Land degrade. Develop. 12:305-318.

Kazi F., Joshua K., Fortman A., Anex R.P., Hsu D.D., Aden A., et al., 2010. Techno-economic comparison of process technologies for biochemical ethanol production from corn stover. Fuel 89:S20–S28.

Lawrence J., Cherney J., Barney P., Ketterings Q., 2006. Establishment and management of switchgrass. Cornell University Cooperative Extension. Fact sheet 20. Available from: http://www.grassbioenergy.org/resources/documents/Switchgrassfactsheet20.pdf (accessed June, 2010).

Lemus R., Brumme E.C., Burras C.L., Moore K.J., Barker M.F., Molstad N.E., 2008. Effects of nitrogen fertilization on biomass yield and quality in large fields of established switchgrass in southern Iowa, USA. Biomass Bioenergy 32:1187-1194.

Mooney D.F., Roberts R.K., English B.C., Tyler D.D., Larson J.A., 2010. Is switchgrass yield response to nitrogen fertilizer dynamic? Implications for profitability and sustainability at the farm level. Southern Agricultural Economics Association Annual Meetings, Orlando, Florida, February 6-9.

Rijpma J., Islam M.F., 2003. Nutrient mining and its effect on crop production and environment in Bangladesh. Paper presented at seminar on "Soil Health Management"; DAE-SFFP Experience, Bangladesh.

Tan Z.X., Lal R., Wiebe K.D., 2005. Global soil nutrient depletion and yield reduction, J. Sustain. Agr. 26(1):123-146.

Tembo G., Brorsen B.W., Epplin F.M., 2008. Crop input response functions with stochastic plateaus. Am J Agric Econ 90(2):424-434.

Vogel K.P., Brejda J.J., Walters D.T., Buxton D.R., 2002. Switchgrass biomass production in the Midwest USA: harvest and nitrogen management. Agron J 94:413–420.

Wu J., Sperow M., Wang J., 2010. Economic feasibility of a woody biomass-based ethanol plant in central Appalachia. J Agric Res Econ 35:522-544.

THE DRAKENSBERGER AS COMPETITIVE BREED OF CATTLE IN THE SOUTH AFRICAN BEEF INDUSTRY

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Abstract

This paper focuses on the Drakensberger as competitive beef breed of cattle. The Drakensberger is a medium-framed black cattle breed, indigenous to South Africa. The breed fares well in key requirements for successful cattle farming, and although the breed has much to offer, it does not enjoy a large market share in the country. Resultantly, this low market share raises questions as to why an indigenous, quality cattle breed has a low market share. The primary objective was to determine the South African farmer's perception on Drakensberger as cattle breed in the market. This was achieved by the secondary objectives that identify and describe the competitive South African cattle breeds, identify the characteristics a South African farmer looks for a cattle breed, measure the Drakensberger's performance against these identified characteristics, and to clarify the low market share. The literature study reviewed the background of the South African cattle industry, identified the competitors in the cattle market, and also assessed the Drakensberger breed's potential. From the literature it was evident that the breed has no fatal flaws. It outperforms certain other more popular cattle breeds, and the Drakensberger is also exceptionally well adapted for the diverse South African conditions, performing well on even low quality sour grass veld conditions. The empirical research employed qualitative research to determine the characteristics important to South African cattle farmers. Additionally, quantitative research, using a structured questionnaire, was employed to determine cattle breeders' perceptions of the Drakensberger and competitive cattle breed. The data showed a high reliability coefficient of 0.83 (as calculated by the Cronbach Alpha). The results showed that farmers prefer cattle breeds possessing hardiness, high fertility, high weaning weight and, surprisingly, the colour of the breed. The colour preference negatively impacts on the Drakensberger as South African farmer prefer red and not black cattle breeds (such as the Drakensberger). However, farmers farming with the Drakensberger are very satisfied with the breed's performance, even more so that the farmers of other cattle breeds are with their breeds.

Keywords: Drakensberger cattle; marketing of cattle; potential of cattle; marketing perceptions; characteristics of cattle; black beef cattle

1. History of the Drakensberger

The Drakensberger breed of cattle is indigenous to South Africa. It developed over the past 150 years to become one of few true indigenous cattle breed. However, tracing history back to 1497, the breed was originally discovered by the Portuguese when the explorer Vasco da Gama rounded the Cape of Good Hope in 1497. He met with local natives and acquires a black ox, incidentally trading it for three copper bracelets. Da Gama was impressed with the excellent quality of its meat (a characteristic of the breed that stood the test of time) (The Cattle Site, 2010). The Drakensberger gained popularity as breed, and by the time of the Great Trek (1834), the Drakensberger was part and parcel of the migration to the north when these families left the Cape. These cattle were then called *Vaderland cattle* (Home country cattle).

A large number of these migrating farmers halted against the fertile slopes of the Drakensberg mountain range (located today in the midlands of the KwaZulu-Natal province of South Africa), and the cattle became known as the "Drakensberger" (Pentz, 2009:1). Drakensberger Cattle Breeders Society of South Africa was founded in 1947, and the name "Drakensberger" eventually gained official status.

The Drakensberger breed of cattle enjoys widespread recognition for its ability to thrive on a variety of grazing types, even the sour veld to be found in the Drakensberg region. They even strive in the mountainous and arid Karoo region as well as in Namibia. Recent research showed that the breed does even better on sweet grazing and has the ability to round off on the farm without requiring feedlots or excessive conditioning supplementary feeds (Smit, 2010). This is an exceptional advantage where premium priced free-range beef is in high demand. Furthermore, an additional benefit of the breed is embedded in its history. Being part of the demanding migration in the 19th century, only the most hardy, illness resistant and best adapted cattle survived, making a case for natural selection where the best genetic material remained to as breeding material for the Drakensberger breed of cattle for the future (Roos, 2007:1). This means that these cattle are very suitable for the "natural" beef markets because they require little medication and antibiotics, and its beef could fetch premium prices on the market. It is relatively inexpensive when compared to other breeds and it competes well in important cattle characteristics like fertility, feed conversion ratio, hardiness and weight gain. It is reasonably to very resilient against illness and pests such as ticks (Drakensberger, 2013).

Today the Drakensberger can be found all over South Africa, but its main concentration remains the Mpumalanga and KwaZulu-Natal regions where it originated as registered breed. The Drakensberger is dispersed mainly in Southern Africa, and roughly 14 000 purebred Drakensberger cows and 5 300 bulls are registered. Annually an average of another 2 700 cows and 2 800 heifers are added as to the registrations roll (Drakensberger, 2013). The Drakensberger Cattle Breeding Association adopted the well-respected mantra: "*The profit breed*" in the late 1980s (Foster *et al.*, 2008).

2. The South African beef- and beef cattle market

Cattle farming form an integral part of the South African economy and culture of South Africans. Agriculture contributes nearly 2.2% to the South African GDP. Cattle and calves contribute 12% to the agricultural GDP (Thato, 2009), which in turn contributes around R100 billion to the total SA GDP of R2 000 billion per annum (Anon., 2009a). South Africa produces 85% of the domestic demand while the remaining 15% are imported from Namibië, Botswana, Swaziland, Australia, New Zealand and the United Kingdom. Brazil is competing fiercely to gain entrance in the South African beef market (Gallardo, 2012). The red meat industry is a valuable contributor to the gross domestic product of the South African national economy, and also has an important multiplier effect through creation of employment throughout the value chain; from the farm to the table. The livestock sector in South Africa produces on average 900 000 tons red meat per annum.

In the South African cattle industry, farmers are spoilt for choice among different breeds, having to choose between indigenous or imported breeds and having to choose a breed in these categories. No single breed dominates the market. (The popularity of breeds is shown in Table 4).

Despite the various positive attributes associated with the indigenous Drakensbergerit does not enjoy a dominant market share. There are areas where the Drakensberger is a prevalent breed (see Figure 1), but there are large areas where other breeds totally dominate. The areas where relatively strong presences of the Drakensberger are observed are the following:

- Eastern regions of Mpumalanga, with the Drakensberger Cattle Breeders Organisation based in Volksrust;
- Certain parts of the Northern Free State; and
- Small pockets in the Northern and Eastern Cape.

One of the most prominent cattle producing areas in South Africa is the North West Province, but the Drakensberger is not popular in this area (Morgenthal et al., 2004; Fourie, 2011).

Figure 1. Area of Drakensberger concentration
Source: Anon (2009b)

3. Research objectives

The primary objective was to determine the South African farmer's perception on Drakensberger as cattle breed in the market. This was achieved by the following secondary objectives, namely to:
1. Identify and describe the competitive South African cattle breeds;
2. Identify the characteristics a South African farmer looks for in his or her cattle breed;
3. Measure the Drakensberger's performance against these identified characteristics; and to
4. Clarify the low market share based on the research findings.

4. Research methodology

4.1. Research orientation

The results are based on the perceptions of the farmer(s) pertaining to their respective cattle breeds. The perceptions pertaining different breeds of cattle is directly comparable seeing as they reflect how each farmer feels about his or her breed of cattle and its performance. Therefore, should "Cattle breed A" perform better than "Cattle breed B", it means that farmers who farm with "Breed A", are more impressed with the breed than farmers who farm with "Breed B". Each farmer is thus the judge of his own cattle and their performance.

4.2. Research schedule

The schedule consisted of five phases. These phases are explained below.

Phase 1: Discussions and conceptualisation of the research area with delegates from the Drakensberger Breeders' Association.

Phase 2: Consultation with different large stock authorities and experts pertaining to the chosen characteristics of beef cattle and the production of wieners.

Phase 3: Consultation with a joint interest group where, according to the Meta technique, cattle characteristics were identified and prioritised in order to finalise the questionnaire for the empirical research.

Phase 4: Data collection and processing. In total, 158 questionnaires were received. Of these, seven were received after the cut-off date and were not processed in the quantitative calculations. Furthermore, eight questionnaires were incomplete, and were therefore only partially processed. Another five questionnaires were not processed due to incorrect completion thereof. This means that 138 complete questionnaires were received and could be fully processed.

Phase 5: Reporting based on the empirical survey.

The research made use of qualitative as well as quantitative data collection. Phases 1, 2 and 3 employed qualitative research to gather data by means of focus group discussions. The aim of these discussions was to identify the characteristics a beef farmer is looking for in his or her preferred breed of cattle. It was also important to determine a ranking of the characteristics. The results obtained from the discussions led to the compilation of the structured interval-scaled questionnaire. In total 29 dedicated beef cattle farmers participated in three focus group meetings.

After the questionnaire was compiled, the research made use of quantitative data collection. The Drakensberger breeders' association assisted to ensure that all their members received a questionnaire with a special request to complete. A total of 158 questionnaires were received back.

5. Results

5.1. Objectives 1. Identify competitive cattle breeds

Contrary to a large producer of beef such as Brazil where a major market share in beef cattle is held by the adapted South African cattle breed, the Bonsmara (Bisschoff, 2007), the South African beef cattle farmers are spoilt for choice when it comes to the number of breeds available. Farmers can select their breed of choice according to distinguishing features such as:

- Characteristics of the different cattle breeds in relation to grazing;
- The South African farming environment;
- Personal preference;
- Climate; and
- Other cattle breed characteristics.

In this regard, the Drakensberger as cattle breed has a formidable offering to a prospective cattle farmer. The Drakensberger is a medium frame breed with a long and deep body. It has a smooth black coat. The mature bulls weigh between 820kg to 1100kg. Cows weigh between 550kg and 720kg. The breed has a relative low birth weight of 35 kg at birth. In addition, the cows calve easily, have high fertility, display excellent mothers' instincts and can remain productive for up to 20 years. The breed as motherline breed, cross-breeds very well with most other breeds (The Cattle Site, 2010). Regarding specific offerings as a breed, the Drakensberger fares well on the following characteristics:

- Ability to adapt to all conditions,
- Good milk production – 240 kg weaning weight (205 days) is common in stud,
- Fertility – 90%, ICP to 353 days/92 cows,
- Low mortality – in official tests 49% lower than most breeds from birth to wean,
- Impressive weight reached by wiener calves - heifers 210 kg and bull calves 240 kg, on average 25 kg more in sweetveld,
- Even temperament, easy handling,
- Outstanding mothering ability,
- Long productive life of 14 years and more,
- Tender and succulent meat.

Some of the popular competitors to the Drakensberger are the following beef cattle breeds available in South African: Bonsmara, Hereford, Simmentaler, Limousin, Sussex, Aberdeen Angus and Beefmaster. The Bonsmara, bred specifically for South African conditions by the renowned professor Jan Bonsma, is the only other competitive indigenous cattle breed. The cattle breeds are introduced in the table below.

Table 1. Competitive cattle breeds

Bonsmara – market share 15.9% (Anon, 2009c) The Bonsmara breed was developed through cross-breeding by the late professor Jan Bonsma. It is the only cattle breed in the world to have been developed through objectively recording performance data. The breed was mainly developed in response to the British breeds not being able to handle the sub-tropic climate and relatively high temperatures in South Africa. It is the market leader in South Africa.	
Hereford – market share 12.7% (Anon, 2009d) The Hereford originated in the United Kingdom in 1742 near Herefordshire as an answer to fulfil the expanding need for beef following the Industrial Revolution. The Hereford distinguished itself with high beef yield and production efficiency, which is still a breed attribute today. Considering its rich history and excellent features, the Hereford earned its strong place in the South African cattle market and should be a strong contender for years to come.	
Simmentaler – market share 12.3% (Anon, 2009e) The first Simmentalers were introduced to South Africa when President Steyn of the Free State established a stud in 1905. The breed did not occupy a strong position in the South African market until the 1960s when tests revealed its excellent attributes. The breed fares well in aspects like the reproduction index, weaning weight, yearling weight of heifers and feedlot growth. One possible challenge with Simmentaler animals is their relative heat sensitivity when judging rectal temperatures in high ambient heat.	
Limousin – 8.9% market share (Anon, 2009f) The Limousin is a breed with a long history, originating in the south of France in the 1800s. The animals fare well in rocky and harsh conditions and were often used as drought animals prior to fattening them up for slaughter. They were imported to South Africa in 1974. The Limousin is a medium-framed animal that calves easily and fares very well in hybrids or cross breeding. They can feed efficiently on the veld and has a high feed conversion ratio, which should suit commercial farmers and feedlots. They are, however, more suitable to the Highveld regions of South Africa, which might hamper a countrywide growth strategy.	
SA Aberdeen Angus – 8.2% market share (Anon, 2009g) The Angus originated in the cold Scottish highlands and is currently numerically the largest breed in the world. It is quite popular in South Africa, especially in the Free State, Western Cape and KwaZulu-Natal. The breed can withstand the extreme cold of some parts of South Africa well and therefore is a popular choice in cold areas and areas with winter rainfall. (Contrary to black being the colour of choice uin the United States of America, the South African farmers opt for the red Aberdeen Angus).	

Beefmaster – 6.0% market share (Anon, 2009b) The Beefmaster originated in Texas in 1908 when a breeder crossed a Brahman, Hereford and Shorthorn. The primary focus of the Beefmaster during development was the production of beef, and other attributes were not pursued strongly.	
Sussex – 4.5% market share (Anon, 2009h) The Sussex is one of the oldest and purest cattle breeds. The breed has been recorded as early as 1066 in England. The breed was imported to South Africa for the first time in the early 1900s by Mr Alec Holm of the Potchefstroom Agricultural College. The breed has many winning characteristics, but its strong features are mainly its: size (medium-sized); hardiness; and milk abundance.	
Charolais – 4.2% market share (Anon, 2009x) The exact origins of the breed is not known, but is suspected to have originated in France in the 800s to 900s. It is a large breed with a thick, matted coat. Whether it can be attributed to its coat or not, the breed was found to be more prone to heat sensitivity than other breeds tested. Also suffers from excessive teeth wear in sandy regions	

Source: Pentz, 2009; Wiese, 2012

The South African beef cattle market share is shown in table 2.

The table clearly shows the superiority of the Bonsmara, enjoying three times the market share of the Drakensberger (5.3%) at 15.9%, followed by the British Hereford and the Simmintaler (both at 12%)

Table 2. Market share per cattle breed (CARCASSES)

Position	Cattle breed	% of total
1	Bonsmara	15.9
2	Hereford	12.7
3	Simmentaler	12.3
4	Limousin	8.9
5	SA Angus	8.2
6	Beefmaster	6.0
7	Drakensberger	5.3
8	Sussex	4.5
9	Charolais	4.2
10	Holstein	4.1
11	Afrikaner	3.8
12	Santas Gertrudis	3.4
13	Brahman/Simbra/Brangus	5.3
14	Other breeds	5.4

Source: Pentz (2009)

5.2. Objectives 2 and 3. Identify characteristics and measure perceptions of cattle breeds

Objective 2 was reached per se from analysing and ordering the qualitative research in the process of compiling the questionnaire. The characteristics of beef cattle breeds was identified and formalised in the questionnaire. The data was collected as described above to achieve objective 3, and the results are discussed below.

Processing of data

The data were processed by the statistical software Statistical Package for Social Sciences (SPSS version 18). Reliability coefficients and descriptive statistics were used.

- Regarding the reliability and internal stability, the data show a very satisfying Cronbach Alpha coefficient of 0.83, exceeding the required 0.70 with ease (Field, 2005:668).
- Descriptive statistics were employed to perform the comparative analysis, and the mean values were calculated. Standard deviations were also scrutinised, but no significant deviations were identified, hence these figures were omitted from the results.

Market perceptions

The questionnaire makes comparisons between the expected performances of the Drakensberger as breed of cattle on the cattle breed characteristics versus the expected performance by other breeds of cattle. The interval measurement scale varies from -3 (much poorer) to +3 (much

Table 3. Perceptions of expected performance of different breeds in comparison to the Drakensberger

No	Characteristic	Drakens-berger	Brah-man	Bons-mara	Charo-laise	Angus	Santa	Afri-kaner	Simmen-taler	Beef-master	Sim-bra
1	Temperament	2.00	1.70	1.08	1.00	1.00	1.50	1.67	0.75	1.75	0.71
2	Mothering characteristics	2.46	1.40	1.19	1.50	1.43	1.00	1.00	0.50	1.50	1.14
3	Fertility (Cows)	1.96	1.56	1.04	1.00	0.86	0.50	1.00	0.50	1.50	0.43
4	Growth rate	1.38	0.80	0.42	0.50	0.86	0.50	0.67	0.75	0.25	-0.43
5	Hardiness	2.48	1.00	0.76	1.50	1.86	2.25	0.00	0.75	0.75	0.86
6	Adaptability	2.43	1.30	0.50	1.00	1.71	1.75	1.00	1.25	0.75	0.00
7	Quality of meat	1.91	1.30	0.88	1.00	0.71	1.00	0.33	0.50	0.50	-0.29
8	Productive life span	2.21	0.90	0.84	1.00	1.71	1.00	0.67	0.33	1.25	0.57
9	Recovery ability (E.g. after a cold winter or drought)	2.29	1.20	0.35	1.00	1.14	1.50	0.67	1.50	0.00	-0.29
10	Feed conversion ratio (FCR.)	1.54	0.90	0.15	0.00	0.86	0.25	1.33	0.50	0.50	-0.43
11	Walking ability	2.25	0.70	0.88	1.50	1.57	1.50	1.00	0.00	0.50	1.14
12	Serving ability (Bulls)	2.04	1.10	0.73	1.00	1.29	1.25	0.33	0.50	0.50	1.00
13	Easy calving	2.17	1.00	1.08	2.00	1.71	1.25	0.67	0.25	1.50	1.43
14	Prepotency (heredity of characteristics)	1.63	0.70	0.85	1.50	0.71	0.75	0.00	0.67	1.25	1.00
15	Heat sensitivity	1.38	0.20	0.12	0.50	0.57	0.75	-0.67	0.25	0.75	0.57

Source: Bisschoff & Lotriet (2009)

better). An average performance of a cattle breed should yield a mean value of zero while a better than average expected performance by the cattle should yield a positive value (the inverse is true for negative values). The results appear in table 3.

It is clear from the table that the Drakensberger farmers are very satisfied with their breed, even more so than the farmers of the competitive breeds with their own cattle breed. Especially characteristic 5, 6 and 9 (respectively *Hardiness*, *Adaptability* and *Recovery ability*) are experienced as very positive by the Drakensberger farmers. Furthermore, it is also important to take note of the characteristics that other breeds evaluated below 1, namely 4, 10 and 15 (*Growth rate*, *FCR* and *Heat sensitivity*), seeing as they lean towards negative perceptions about the Drakensberger as breed.

5.3. Most important cattle breed characteristics

From the questionnaires, farmers were also required to indicate the three most important characteristics required for the cattle breed they farm with. The results appear in the table 4. Interesting is, however, that there is a deviation at Bonsmaras, namely that a core characteristic of the breed is *Popularity of the breed*, and that this stimulates the sales of the bulls. Because of this, the market shows that a significant premium on the price of Bonsmaras can be levied if breeding material is purchased.

Table 4. Most important characteristics of cattle per breed

Breed	Characteristic 1	Characteristic 2	Characteristic 3
Drakensberger *	Adaptability	Hardiness	Temperament
Brahman	Hardiness	Is not stolen	Mothering characteristics
Bonsmara **	Bulls marketability	Fertility	Mothering characteristics
Aberdeen Angus	Fertility	Field finishing	Temperament
Other breeds (mixed)	Udder weight	Mothering characteristics	Hardiness
Santa Gertrudis	Fertility	Udder weight & FCR	Hardiness & calves easily
Afrikaners *	Mothering characteristics	Hardiness	Low maintenance
Simmentaler	Udder weight	Meat quality	***
Beefmaster	Udder weight	Adaptability	***
Simbra	Fertility	Udder weight	***
Drakensberger X	Adaptability	Hardiness	Fertility & Mothering characteristics
Brahman X	Hardiness	Adaptability	Mothering characteristics
Bonsmara X	Hardiness	Udder weight	***
Other X	Mothering characteristics	Udder weight	Hardiness

* Indiginous, ** SA developed cattle breed
Source: Bisschoff & Lotriet (2009)

5.4. Objective 4. Market share

Both the literature as well as the empirical research clearly showed that the Drakensberger as cattle breed is not flawed. From the literature review it is clear that the breed is hardy, has excellent farming qualities and is well adapted to a variety of veld conditions. It even fares well under poor veld (such as sour veld) conditions. The literature also showed that the breed has a number of distinctive and very competitive qualities such as its hardiness and resilience to illness and pests. Add to that the ability to be able to gain the required carcass condition for market-readiness, and the Drakensberger is clearly well positioned to enter into the premium beef markets of *free range, health* and *natural beef*. Strangely, in contrast to farmers in the United States of America, Scotland and other countries, colour seem to be an issue with the South African farmer who believes that a black cattle breed is not able to perform well in harsh African sun. However, this misnomer is clearly reputed by Foster, *et al.* (2008), Fourie (2011) and Jordaan (2012) who explain that animal heat tolerance is not determined by colour of skin, but by the thickness of the skin (as isolator) as well as the density of sweat glands on the skin (as cooling mechanism). The Drakensberger breed is exceptionally well equipped in both instances, and has a high tolerance for heat (scientifically possessing higher heat tolerance levels than some of the popular European cattle breeds in South Africa). From the literature there is no explanation why the Drakensberger does not enjoy a significant market share, as it should, in South Africa.

The empirical research shows clearly that the Drakensberger performs excellently in South Africa. Also here not even one failure in performance could be identified. More mysterious is the fact that, although a black coloured animal seems to be dismissed outright, the empirical research have shown that none of the required characteristics (as identified by farmers) identified the colour of beef cattle to be a characteristic of choice!

A marketing-focussed managerial analysis reveals that, in the event of poor market performance with a seemingly well-performing product, a *market* and *marketing mix* analysis should be performed (Kotler and Armstrong, 2011). In this regard, it is evident that the beef cattle market is above suspicion, and can be ruled out. The marketing mix on the other hand showed that the:

- *Product* (Drakensberger) is acceptable,
- *Price* offering is fine,
- *Distribution* and the availability of the breed is satisfactory, but that
- *Promotion* as marketing mix element fails catastrophically.

The breed per se is not promoted properly (if at all) and its qualities are not known to prospective farmers. The conservative marketing approach in this regard by the Drakensberger Breeders Association adds to the poor knowledge of the breed. In addition, the association also does not attempt to address any misnomers of the breed, such as the correlation between heat tolerance and black colour. The failure of the marketing mix (via promotion) is, therefore, the reason for the poor market performance. Tragically, this is essentially and easy failure to correct in the marketing mix, and the window of market opportunity that currently exists is fast being closed by the successful marketing of the Bonsmara (SA adapted and excellent cross-bred bulls), the Angus (premium beef qualities), and even some feeding lots with a specialised beef branding focus. Other cattle breeds are also starting to brand themselves, and the Drakensberger continues to lose market share, despite being an excellent cattle breed.

6. Conclusions

The results of this empirical survey indicate that the Drakensberger as breed of cattle, pertaining to the 15 identified beef cattle characteristics, fares well in certain categories, but that there are areas of concern. The success of a cattle breed rests on its ability to provide good quality meat, adapt to the environment and be an economically viable asset based on its breed characteristics. However, unfortunately this is not enough to ensure a success for a cattle breed. Economic and market influences also plays a role because the market requires bulls as breeding material, and cattle breeds, as supplier of good quality bulls to the meat-producing market, can charge a premium for a bull from a cattle breed that is more well-known or has a superior image.

The marketing failure on the part of the Drakensberger is a managerial issue, and sadly breeders and the breeders' association focus on improving the breed rather than properly marketing the breed and developing the market. It is still possible to utilise the marketing window of opportunity and to promote the Drakensberger as one of the top breeds within a premium market niche. It, however, remains to be seen if the role-players would recognise this opportunity and timeously refocus also on the first part of their mission statement (and not only on the second part thereof to continuously to improving the cattle breed):

"The declared mission of Drakensberger farmers is to propagate the traditional black animals carrying a maximum amount of high quality beef without sacrifice of the breed's inherent qualities"

7. References

Anon., 2008. Livestock Farming. SAinfo reporter. [Web:] http://www.southafrica.info/business.html Date of access: 23 Sep. 2010.

Anon., 2009a. Estimate of National Revenue. . [Web:] www.treasury.gov.za. Accessed 12 June 2009.

Anon., 2009b. Studbook. [Web:] http://studbook.co.za/Society/drakensberger. Accessed 12 June 2009.

Anon., 2009c. Embryoplus. [Web:] http://www.embryoplus.co.za. Accessed: 12 June 2009.

Anon., 2009d. Hereford Cattle Breeders' Association. [Web:] http://www.herefordcattle.org/. Accessed 12 June 2009.

Anon., 2009e. Simmentaler Cattle Breeders' Association. www.simmentaler.org. Accessed 12 June 2009.

Anon., 2009f. Limousin Cattle Breeders' Association. [Web:] www.limousinsa.co.za. Accessed 12 June 2009.

Anon., 2009g. Angus Cattle Breeders' Association. www.angus.org.za. . [Web:] Accessed 12 June 2009.

Anon., 2009h. Sussex Cattle Breeders' Association. [Web:] www.sussex.co.za. Accessed 14 June 2009.

Anon., 2009x. Charolais Cattle Breeders' Association. [Web:] http://www.charolais.co.za. Accessed 10 August 2009.

Bisschoff C.A., 2007. IFMA 16: Farm visit to Bonsmara stud. Campinas, Brazil.

Bisschoff C.A., Lotriet R. 2009. Market perceptions of the Drakensberger breed of cattle. (Original title: *Markpersepsies van die Drakensberger beesras*). *Allere Flammam*, 1(2009):16-22.

Department Forestry, Agriculture & Fisheries, 2010. National livestock statistics (February). www.nda.agric.za/docs/statsinfo/newsLivstokFeb2010.pdf Date of access: 20 Augustus 2010.

Field A., 2005. Discovering statistics using SPSS. London: Sage.

Fourie J., 2011. Chairman of the Drakensberger Breeders Association and Medical practitioner. Interview: June 2011.

Foster L.A., Fourie P.J., Neser F.W.C., Fair M.D., 2008. Effect of heat stress on six breeds in the Zastron district: the significance of breed, coat colour and coat type. University of the Free State. Bloemfontein, South Africa.

Gallardo A., 2012. Brazil says South Africa is restricting beef imports over mad cow doubts. Times Live. http://www.timeslive.co.za/world/2012/12/13/brazil-says-south-africa-restricts-beef-imports-over-mad-cow-doubts Date of access: 10 Jan. 2013.

Jordaan M., 2012. Practising veterinarian: Bult Animal Clinic. Interview: November 2012.

Kotler P., Armstrong, 2011. Principles of Marketing. 12th ed. New York, NY: Prentice Hall.

Morgenthal T.L., Newby T., Smith H.J.C., Pretorius D.J., 2004. Developing and refinement of a grazing capacity map for South Africa using NOAA (AVHRR) satellite- derived data. *Report GW/A/2004/66*. ARC-ISCW. Pretoria.

Pentz E., 2009. Marketing perceptions of the Drakensberger breed of cattle. MBA dissertation. Potchefstroom: North-West University.

Roos J., 2007. The Drakensberger. Supplement to the Landbouweekblad. *Landbouweekblad:* 2. 5 Mei.

Smit M.E., 2010. Marketing of the Drakensberger as cattle breed in South Africa (Original title: *Bemarking van die Drakensberger as beesras in Suid-Afrika*). MBA dissertation. Potchefstroom: North-West University.

Thato P., 2009. Pocket guide to South Africa 2008/2009. *Agriculture, Forestry and Land:* 135.

The Cattle Site, 2010. The Drakensberger. [Web:] http://www.thecattlesite.com/breeds/beef/79/drakensberger/overview Date of access: 12 June 2009.

Van Zyl J., 2004. New recipe is working. *Finance week*: 44, 3 Nov.

Wiese S., 2012. The Drakensberger as competitive breed. MBA presentation. Potchefstroom Business School, North-West University, Potchefstroom.

POLISH CONSUMERS' REACTION TO CHANGES IN PRICES OF FOOD PRODUCTS DURING THE FINANCIAL CRISIS

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Abstract

The issue of consumers's reaction to changes in prices of food products is particularly important at the time of the global financial crisis. The research aimed at surveying the opinions of selected consumers and their reactions to changes in prices of food products during the financial crisis. The literature study reviewed the determinants of the financial crisis, identified its causes and effects, and also assessed changes in prices of food product in Poland over 2007-2012. From the literature it was evident that the global financial crisis was a result of many factors both microeconomic and macroeconomic, i.e. shortcomings of regulatory systems and the rapid growth of the consumption of households financed mainly by debt and the long-term persistence of (real) interest rates at a low level, which led to a rapid growth of credit and an increase in prices of many assets.

The questionnaire was conducted among 250 consumers comprising students of two selected universities in Poland and their families. 47% filled-in questionnaires were returned.Results of the analysis showed that during the financial crisis, the prices of most of food products have increased. In the opinion of the surveyed, in the previous 5 years the prices of the following food products increased the most: bread, meat, cold meat, sugar, fruit, and fish. On the other hand, the prices of the following food products dropped the most: water, potatoes and other vegetables.

Key words: consumers, prices of food products, financial crisis

1. Introduction

According to literature, a financial crisis is a situation, in which there are serious disruptions in the financial market manifested through a significant fall in prices of assets and the bankruptcy of numerous financial and non-financial institutions (Wague, 2009, p.82).

The global financial crisis started before 2008 and was a result of many factors. However, the biggest significance can be assigned to the problems in the real estate market and the mortgage market in the United States as well as the abuse of complicated financial instruments, whose risk was neither correctly estimated nor treated with appropriate attention. Possessing an increasing number of outstanding credits and low valuation of foreclosed real property resulted in huge losses for mortgage institutions, and in consequence, in their downfall.

Simultaneously, the effects of the financial crisis spread to the real economy. The lack of orders for construction companies led to lay-offs and bankruptcies of many enterprises. It should be noted that primarily, as a result of the global financial crisis, there was a rising tide of bank and company bankruptcies. In a situation of global relationships and economic connections, the occurring domino effect may be a threat not only to transnational entities.

2. Methodology of research

The paper consists of a theoretical and an empirical part. It contains an overview of literature on the influence of the crisis on the food industry and changes in food products prices. This study was supplemented with the authors' primary research based on an online questionnaire sent to 250 students of two selected universities in Poland and their families. The rationale for selecting these two universities was that two of the Authors of the paper are employed at these universities. It was rational to send questionnaire to present academic year's students and theirs families. The Authors had a lecture for these students. One hundred and seventeen completed questionnaires have been returned. It constituted 47% of the total surveyed.

The research aimed at surveying the opinions of selected consumers and their reactions to changes in prices of food products during the financial crisis.

3. Causes and effects of the financial crisis

The outbreak of the financial and economic crisis in 2008 was preceded by a long period of prosperity, not only in the United States, but also in most of the countries of the European Union. The rise in work productivity and the import of cheap products stopped price increases, which in turn helped to keep inflation at a low level. Unemployment rates were also modest. The cause of the current financial and economic crisis was fluctuations in global financial markets and their spread to real economies. Minsky (2008) claims that these problems were caused by microeconomic factors (i.e. shortcomings of regulatory systems, inadequate corporate governance structures, errors in measurement techniques and in the valuation of risk and risk management) and macroeconomic factors (i.e. the boom in real property markets and the financial market, the rapid growth of the consumption of households financed mainly by debt and the long-term persistence of (real) interest rates at a low level, which led to a rapid growth of credit and an increase in prices of assets – shares, real property and certain minerals). It can be assumed, in line with Schumpeter (1954) that the fluctuating variable economic situation is a form of life of capitalism, and the only ultimate cause of every crisis and depression is prosperity and an implementation of innovations. A crisis is a process of adjusting the economy and societies to the results of development and quick transformations. According to Schumpeter (1954), it is "a normal process of absorption and liquidation". Globalisation, the digital revolution, deregulation, privatisation, the weakening of the role of the state – these are the main innovations, as understood by Schumpeter, of our times. The current crisis is a period when the unsettled balance of the global economy is restored, which in turn will create conditions for a new phase of development caused by the implementation of new innovations, which today we are still not yet able to imagine (Glapiński 2009, p.51-52).

4. Price as a basic economic category

Price is the basic information coming from the market which determines the preferences of the buyers and sellers. Price dictates how much of a product will be on the market and how much of the product the consumers will want to buy. The lower the price of a product (service), the more of it the consumers will buy, whereas the higher the price of a product, the more of it the producers will supply to the market. It is in the interest of the buyer to buy at cheaper prices, and in the interest of the seller to sell at higher prices. The market sets the price at which the sellers are willing to sell their goods and the customers are willing to buy (Adamowicz, Gregorczyk, Romanowska, Sopińska, Wachowiak 2003, p.15).

Prices influence economic processes and are of interest to all individuals because they determine the scale of production and consumption and they explain the actions of producers and consumers (Marciniak 2001, p. 132). Demand is a function of price and even a small change in price will impact demand significantly. Price is a specified volume of customer spending and revenues of the seller. It contains information on the value of the product (Wyrzykowski 2007, p. 82).

Each change in the price of products influences the actions of consumers. Consumers are sensitive to changes in prices of expensive products and products used extensively, and they attach less importance to an increase in prices of cheap products which have many substitutes or in the prices of products rarely purchased. A decrease in the price of a product made by a producer may be interpreted differently by the buyer.

1. The product is in the decline stage of its life cycle and will be shortly substituted with a new product.
2. The product has some flaws and is not selling well.
3. The producer has financial problems and needs a quick inflow of cash.
4. The product price may fall even further, it is worthwhile waiting.
5. The product quality has decreased (Michalski 2009, p. 414).
6. On the other hand, an increase in the price of a product may be understood by the buyers in the following ways:
7. The demand for the product is rising and the producer has difficulties in meeting the demand.
8. The product is of high quality.
9. The producer wants to make more profit (Michalski 2009, p. 414).

The price policy, based on the development of demand, refers to the results of research on consumer demand from the point of view of its reaction to changes in prices, or the estimated price elasticity of demand. There are some useful procedures for planning a company price policy, which involves assessing the elasticity of demand in relation to the so-called degrees of price elasticity of demand. The price elasticity of the demand ratio for a given product should be determined on the basis of the following formula (Altkorn 2004, p. 202):

Ep = M% : P%

which means that the elasticity ratio Ep determines the quotient of the difference between demand at a given price and demand after the change in price, expressed in percentages, and likewise, the expressed change in the price of a given product. The price elasticity of the demand ratio answers the question of how demand will change if price changes by a given amount (Altkorn 2004, p. 202).

5. The influence of the crisis on the food industry and changes in prices of food products

Lower household incomes and higher credit burdens contributed to a limitation of consumption during a crisis (Bartkowiak 2010). Investors started to sell shares of those entities, which no longer had investor trust, which affects the value of companies also from outside the sector. Investors who withdrew their funds from stock exchanges and the real property market invested them in derivatives based on natural resources and food products. It caused a rise in food prices and a rise, most severe for many sectors, in the price of crude oil in the world markets. The higher prices of crude oil contributed to the increase in costs of business activity and companies had to raise the prices of products and services to be able to cover the growing costs. In consequence, inflation rose in many countries (Bartkowiak 2010).

The food economy and the food industry in Poland are among the most important sectors of the national economy and branches of industry. In 2009, the food industry produced around 4% of the GDP, over 18% of production sold, and had around 16% of employees. Around 18,000 entities operated in this sector. It is also a significant producer of food and drinks on the European market (Chechelski, Judzińska 2011, p. 6).

According to Chechelski and Judzińska (2011, p. 8), the crisis in the financial market did not substantially contribute to changes in food production. There was a slow-down in the development of production and consumption in developed countries, which was compensated by an increase in the developing countries. The rising demand for food in developing countries may cause a rise in global prices, which may contribute to significant changes in the development of the global food economy, e.g. through the influence on the perspectives of the Common Agricultural Policy in the European Union, the imbalance arising between transnational corporations and other market participants.

Both in previous year, and during the crisis, many threats (Bartkowiak 2010) were seen in the global food economy. The main ones are the increase in protectionism and speculation. The increase in prices concerns all raw materials in the world. Price surges have also been reported in the agricultural raw materials market. There was a two-and-a-half fold increase in the price of cereals and rice, one-and-a-half fold rise in the price of meat, more than twofold in the price of sugar. According to Orłowski (2011, p. 105) 'the supply of raw materials did not keep pace with the rising demand'.

In the years 2007-2011, there was a tendency, observed from 2004, of relative rise in prices of food. In 2011, the rise in the retail price of food in comparison with 2008 amounted to 13% and was 2.2 percentage points higher than the inflation rate. There was a significant increase in the prices of, primarily: sugar (by 52.1%), beef (by 25.2%), fish and processed fish (by 19.5%), poultry meat (by 19.1%), cereal products (by 16.4%, including bakery products by 19.5%) (Świetlik 2012, p. 13). There was also a rise in the price of fats (by 15.6%, including butter by 21%), vegetables and fruit (by around 15%) and eggs (by 13%). The price of pork and dairy products rose less than the average food price ratio. The high average annual growth in food prices since 2007 stands at around 5%. In 2011, in comparison with 2003, the price of food and soft drinks rose by 36.9%, including food by 38.2%, compared with a rise in the average level of prices of consumption goods and services by 26.3%. This means a real increase in the price of food by 9.4%. In the post-accession period, in years 2004-2011 (2003 = 100), the price of the following products rose the most: potatoes (by 105.1%), beef (by 102.7%) and sugar (by 95.3%). Average prices of bakery and cereal products rose by 50.9%, including bakery products by around 60%. The price of edible fats increased by 47.6%, including butter by 61.6%. In 2011, consumers paid on average 46% more for fruit, including 82.5% more for apples, than in 2003. Meat, offal and processed meat prices rose by an average of 33.3%, including poultry meat by 32%, and pork by 27.1%. Egg prices rose by 32.5%, and prices of fish and processed fish by 31.7%. The products whose price rose the least were dairy products (by 28.1%), including drinking milk by 34.1%, yoghurts by 9.4% and vegetables (excluding potatoes) by 19.2%. In accordance with the methodology of the Eurostat, in 2011, in comparison with 2006, the rise in the prices of consumption goods and services in EU-27 amounted to an average of 12.9%, and in Poland 18.6%. In the periods under comparison, the prices of food and soft drinks in EU-27 increased on average by 16.3%, and in Poland by 24.9%. According to information provided by FAO, in 2011 global food prices were 79.5% higher than in 2006. In the years 2007-2011 (2006 = 100), global prices of oils and edible fats rose by 125%, cereal products by 102.5%, sugar by 75.7% and dairy products by 72.7%. Meat products rose the least – by 48.7% (Świetlik 2012, p. 15).

Table 1. Retail prices of selected dairy products (PLN)

Years/ months	Processed milk (1 l)		Full powder milk (350 g)	Extra butter packaged (200 g)	Kefir (150 g)	Fruit yoghurt (150 g)	18% cream (200 g)	Semi-fat cottage cheese (1 kg)	Ripened cheese
	in foil	UHT							
2007									
I	1,59	2,38	10,73	3,02	0,63	1,06	1,35	9,65	15,95
XII	1,97	2,71	11,36	4,11	0,66	1,07	1,52	11,42	22,06
2008									
I	2,00	2,77	11,70	4,07	0,68	1,08	1,56	11,66	21,85
XII	2,05	2,70	12,86	3,50	0,71	1,10	1,59	11,84	17,08
2009									
I	2,05	2,71	12,84	3,49	0,71	1,09	1,59	11,85	16,80
XII	2,04	2,66	12,71	4,07	0,70	1,11	1,56	11,86	16,90
2010									
I	2,05	2,65	12,84	4,11	0,69	1,10	1,56	11,87	17,18
XII	2,45	2,67	13,03	4,27	0,69	1,09	1,59	13,08	17,97
2011									
I	2,47	2,71	13,20	4,31	0,69	1,09	1,58	13,19	18,10
XII	2,59	2,78	13,70	4,63	0,71	1,18	1,63	13,59	19,25
2012									
I	2,60	2,80	13,83	4,64	0,71	1,19	1,64	13,59	19,59
XII	2,61	2,73	14,94	4,29	0,70	1,22	1,67	13,55	19,87

Source: own study based on Rynek rolny, Analizy, tendencje, oceny, Biuletyn miesięczny grudzień 2006 – maj 2013, Instytut Ekonomiki Rolnictwa i Gospodarki Żywnościowej PIB

Table 2. Retail prices of selected meat products (PLN)

Years/months	Beef on the bone	Pork		
		loin on the bone	cooked ham	Toruńska sausage
2007				
I	17,11	13,09	19,69	11,73
XII	17,68	13,69	20,15	12,20
2008		14,13	20,35	12,27
I	17,82	14,62	21,06	13,04
XII	18,42			
2009		14,94	21,11	13,13
I	18,61	14,24	22,05	14,11
XII	20,26			
2010	20,32	14,25	22,05	14,15
I	20,54	13,68	21,65	13,93
XII				
2011				
I	21,09	13,92	21,64	14,09
XII	23,96	15,34	22,95	15,16
2012				
I	24,24	15,51	22,94	15,35
XII	26,18	15,96	23,88	16,10

Source: own study based on Rynek rolny, Analizy, tendencje, oceny, Biuletyn miesięczny grudzień 2006 – maj 2013, Instytut Ekonomiki Rolnictwa i Gospodarki Żywnościowej PIB

In the years 2007-2012, the price of dairy products increased (processed milk in foil by 64.15%, and UHT milk by 14.70%, full powder milk by 39.23%, extra butter by 42.05%, milk kefir by 11.11%, fruit yoghurt by 15.09%, 18% cream by 23.70%, semi-fat cottage cheese by 40.41% and ripened cheese by 24.58%) (Table 1).

In the years 2007-2012, the price of beef on the bone rose by 53%. In the years 2007-2009 (I), there was an increase in the price of loin on the bone (by 14.13%), in December 2009 and in 2010, the price fell (from PLN 14.94 to PLN 13.68), and in the years 2011-2012, there was another rise in prices (by 14.65%). In the analysed period (apart from December 2010 and January 2011), the price of cooked ham and Toruńska sausage rose by 21.28 and 32.25%, respectively (Table 2).

6. Changes in prices of food products in the opinion of the consumers – results of the questionnaire

In May 2013, a questionnaire was conducted among 250 consumers comprising students of two intentionally selected universities in Poland and their families. It contained 19 closed questions and 3 open ones. 47% filled-in questionnaires were returned. Due to the lack of representative character of the research sample, the obtained results cannot be applied to the whole population. However, they may constitute source material of a cognitive nature. 74% of the survey participants were female, and only 26% male. The majority of the survey participants (71%) were between 19 and 30 years old. Consumers between 31 and 40 years old constituted 19% of the research sample. The majority of the survey participants had either a university degree (33%) or high school education (29%). The largest number of respondents lived in a city with more than 300 thousand inhabitants (35%) or in rural areas (28%).

In the case of 31% of the survey participants, the number of people living in the household was three, for 30% it was four. 23% of the respondents stated that the net monthly income per person in the household was between PLN 501 and PLN 1,000, and 22% – between PLN 1,501 and PLN 2,000. 19% pointed to a net monthly income per person of above PLN 2,500, and 5% – below PLN 500.

42% of the survey participants went shopping three or four times a week, and 27% of them daily. According to 28% of the respondents, the share of food expenditure in the household budget amounted to between 31 and 40%, according to 23% it amounted to between 41 and 50%. The majority of the survey participants (54%) indicated that in comparison with last year, the proportion of the household budget allocated to food expenditure increased, for 30% of them it remained unchanged. Should a decrease in food expenses be needed, 51% of the survey participants stated that they would look for a shop where they could buy products of the same quality but at a lower price, and 35% would curb food expenditure.

In the opinion of the survey participants, in the previous 5 years the prices of the following food products increased the most: bread, meat, cold meat, sugar, fruit, and fish. On the other hand, the prices of the following food products dropped the most: water, potatoes and other vegetables. According to 57% of the questioned, inadequate advertisement or a lack thereof may substantially contribute to bankruptcies of companies. The information of a potential bankruptcy has a deterring effect on 34% of the respondents, and an encouraging effect on 31% of the surveyed, primarily because consumers expect a sale of products. The vast majority of consumers (85%) stated that during the financial crisis, the prices of most of food products have increased and 58% of the survey participants have restricted the purchase of food products. The answers to the open questions appeared interesting. Among industries most prone to the financial crisis, the respondents indicated, among others: the fishing, confectionery and meat industry. It was stated that, above all, the small local shops are unable to compete with the big chain shops and mega stores. Small farms are also vulnerable to crisis phenomena. According to the research conducted, the sectors least prone to crisis are primarily the bakery and dairy sector. One of the respondents indicated that the producers may use information about the crisis as a pretext to increase prices at every stage of trade.

7. Summary and conclusions

Several summarising remarks and conclusions can be made on the basis of the analysis conducted in the article.

Factors of both microeconomic and macroeconomic nature were underlined among the causes of the financial crisis.

Prices determine the scale of production and consumption and they explain the actions of producers and consumers. A change in the price of products influences the actions of the consumers.

In the years 2007-2011, there was a tendency, observed from 2004, of a relative rise in food prices. In 2011, the rise in retail prices of food in comparison with 2008 amounted to 13% and was 2.2 percentage points higher than the inflation rate.

The results of the conducted questionnaire confirm the upward tendencies shown on the basis of statistical data. The vast majority of consumers stated that during the financial crisis, the prices of most of food products have increased. In the opinion of the surveyed, in the previous 5 years the prices of the following food products increased the most: bread, meat, cold meat, sugar, fruit, and fish. On the other hand, the prices of the following food products dropped the most: water, potatoes and other vegetables. Among the branches most prone to the financial crisis, the respondents indicated, among others: the fishing, confectionery and meat industry.

The majority of the survey participants indicated that in comparison with 2012, the proportion of the household budget allocated to food expenditure increased, for 30% of them it remained unchanged. Should a decrease in food expenses be needed, 51% of the survey participants stated that they would look for a shop where they could buy products of the same quality but at a lower price, and 35% would restrict food expenditure.

8. References

Adamowicz E., Gregorczyk S., Romanowska M., Sopińska A., Wachowiak P., 2003. *Ekonomia bez tajemnic*, Podręcznik Część I, WSiP, Warszawa.

Altkorn J., 2004. *Podstawy marketingu*, Instytut Marketingu, Kraków.

Bartkowiak M., 2010. *Kryzys finansowy 2008/2009, przyczyny, przebieg, zwalczanie,* http://artelis.pl/artykuly/19346/kryzys-finansowy-2008-2009-przyczyny-przebieg-zwalczanie (dostęp w dniu 15.05.2013).

Chechelski P., Judzińska A., 2011. *Wpływ kryzysu na polski przemysł spożywczy*. Komunikaty, Raporty, Ekspertyzy nr 552, IERiGŻ-PIB, Warszawa.

Glapiński A., 2009. *Obecny kryzys gospodarczy a nauka ekonomii,* Studia i Prace Kolegium Zarządzania i Finansów, Zeszyt Naukowy 94, SGH Warszawa.

Marciniak M., 2001. *Makro i mikroekonomia, Ekonomia, Podstawowe problemy*, Wydawnictwo Naukowe PWN, Warszawa.

Michalski E., 2009. *Marketing, Podręcznik akademicki*, Wydawnictwo Naukowe PWN, Warszawa.

Minsky H.P., 2008. *Stabilizing an Unstable Economy*, McGraw-Hill, New York.

Orłowski W.M., 2011. Świat do przeróbki. Spekulanci, bankruci, giganci i ich rywale. Agora S.A., Warszawa 2011.
Rynek rolny, Analizy, tendencje, oceny, Biuletyn miesięczny grudzień 2006 - maj 2013, Instytut Ekonomiki Rolnictwa i Gospodarki Żywnościowej PIB.
Schumpeter J.A., 1954. *The crisis of the tax state*, „International Economic Papers", No. 4, Londyn, New York.
Świetlik K, ARR, Biuletyn Informacyjny, nr 3/2012, www.arr.gov.pl
Wague M., 2009. *Międzynarodowe kryzysy gospodarcze i ich konsekwencje*.[w]: Zeszyty Naukowe Szkoły Głównej Gospodarstwa Wiejskiego w Warszawie, nr 78.
Wyrzykowski K., 2007. Marketing nie tylko dla małej firmy, Hobby&Education, Warszawa.

THE EXTENT OF THE STRUCTURAL CHANGE IN PRIMARY AGRICULTURE

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Abstract

The primary agriculture production industry in OECD countries has been going through rapid increases in the concentration of production, giving rise to concerns about the industry developing into a bimodal distribution of farms with many small lifestyle oriented farms, a growing number of large farms, where the bulk of the production takes place, and fewer middle sized farms. It is true that larger farm businesses produce most of the agricultural commodities and get most of the government payments although less than the percentage of commodities they produce. However increased profitability is not completely correlated with increased farm business size, in that some small and medium sized farms are profitable. Unfortunately, many farm businesses especially the smaller ones are reliant on government payments for their financial survival. This is particularly true for Europe. Finally, the structural change in agricultural production that has occurred in the past will continue into the future. Concentration of production will continue with fewer and larger farm businesses. Niche market farm businesses, part time farms with off-farm income and lifestyle farms will dominate the farm numbers but not farm production.

Keywords: farm financial structure, profitability, government payments

1. Introduction

This paper reviews the literature to document the extent of the structural change, that is, the distribution of enterprise size and type within a region or country, in the primary agricultural production industry in many countries of the Organization for Economic Co-operation and Development (OECD). How this structure has changed over time and what it may look like in the future are also discussed.

The primary agriculture production industry in OECD countries has been going through rapid increases in the concentration of production, giving rise to concerns about the industry developing into a bimodal distribution of farms with many small lifestyle oriented farms, a growing number of large farms, where the bulk of the production takes place, and fewer middle sized farms. Contributing to this concentration of production is the industrialization of many parts of production agriculture, especially in the livestock sectors. Technological advances have also contributed, especially in the crop sector with regards to larger and more technologically advanced machinery requiring increased amounts of land and thereby production to reduce the fixed costs per unit. Organizational changes in the form of industrialization and market coordination have also occurred. Industrialization refers to the control of natural production processes to the extent that uniform products are mass produced at a minimum per unit cost. It is obvious that only very large farm businesses can accomplish this industrialization and it has occurred extensively in the livestock industry and is occurring rapidly in crop production as well. Market coordination deals with the extent to which supply chains are coordinated through contracts and less use of open markets. This increased coordination comes at the costs of a loss of independence and increased uncertainty over the continuation of the contracts, but also reduces some of the risk associated with market variability (Harrington and Koenig 2000).

Economic opportunity results in off-farm income becoming more important to the point where net farm income is only 1/8 of the income of farm households across most sizes of farms in the U.S. (Harrington and Koenig 2000). In Saskatchewan, Canada in 2009, off-farm income represented 70.7% of total farm family income and was significantly higher in previous years (Saskatchewan Ministry of Agriculture 2012). Off-farm income affects farm structure by taking time away from the farm, reducing involvement in labour intensive enterprises and in many cases means the farm business is losing its position of primary importance.

Agricultural policies, such as price and income support, also influence structural change by giving more risk reduction benefits and larger direct payments to larger farms. This in turn allows them to take on more financial leverage and acquire the assets of smaller farms (Harrington and Koenig 2000). Macroeconomic policies with regard to inflation control and taxation also influence farm business structural change because farmland values increases have tended to equal or exceed inflation rates, especially in the recent past. The tax rate on the capital gain associated with farmland is lower than normal income in many countries and can be deferred almost indefinitely as long as the land stays in the immediate family (Canada Revenue Agency 2012). The combination of these two forces makes the ownership of farmland attractive.

The future of structural change in the farm sector, at least in the short term will include continued industrialization, consolidation, and greater coordination of production and distribution systems. The gains from this structural change; are needed to maintain or improve global competitiveness, increase productivity, lower consumer prices and respond to consumer demands for quality, variety, and accountability in food supplies. The potential losses include; the disappearance of traditional market channels, problematic price discovery due to thin or non-existent markets, and loss of producer bargaining power. Farm sizes will continue to grow and farm numbers will continue to decline in most developed countries.

2. The Canadian experience

The number of farms in Saskatchewan, a western province, and in Canada as a whole have been decreasing since 1941 while the average farm size has been increasing (Saskatchewan Ministry of Agriculture 2012). In 2006 Saskatchewan had 44,329 farms down from 138,713 in 1941, with an average size of 1450 acres as compared to 432. This represents a drop of 68% in farm numbers while average farm size increased by 336%. A similar situation occurred in Canada as a whole with 732,832 farms in 1941 with an average size of 237 acres and 229,373 farms in 2006 with an average size of 728 acres. Again, this represents a drop of 69% in farm numbers while average farm size increased by 307%.

The economics of crop farming on the Canadian prairies and especially in Saskatchewan is dependent on wheat and canola. In Saskatchewan, all wheat (spring, durum and winter) and canola account for more than 60% of the seeded acres and total cash receipts from crops (Saskatchewan Ministry of Agriculture 2012). Livestock are also an important part of the agricultural economy on the Canadian prairies. On the Canadian Prairies livestock account for between 20 and 50% of farm cash receipts, with cattle making up about 70% of the livestock receipts (Alberta Agriculture and Rural Development 2012) (Saskatchewan Ministry of Agriculture 2012).

The assets, debt and equity of an average farm in Saskatchewan have changed substantially between 1971 and 2010. The value of land usually represents between 65 – 80% of the average Saskatchewan farm's assets. The rise and fall of the price of farm land, thereby has a major effect on the value of the farm's equity. The inflation adjusted or real assets, debt and equity of an average farm in Saskatchewan

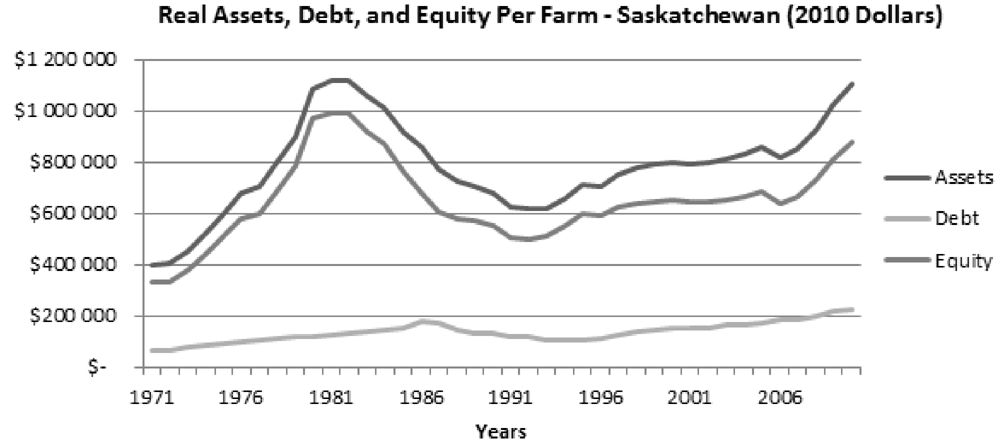

Figure 1. Real Assets, Debt, and Equity Per Farm – Saskatchewan (2010 Dollars)

have changed substantially between 1971 and 2010. Real assets and equity increased substantially in the 1970s and again since 2006 (Figure 1) (Saskatchewan Ministry of Agriculture 2012). However, the decline from the early 1980s to the mid 1990s was substantial in real terms where both assets and equity lost about 50 – 60% of their value. In fact real asset values did not regain their 1982 peak of about $1.1 million until 2010. Real equity values had still not regained their 1982 value of $1.0 million by 2010. Farm debt on the other hand has risen fairly consistently, although not a much, over the time period, with only a slight decline during the period from 1985 to 1995.

As can be seen in Figure 1 it takes quite a long time for equity value to regain from losses caused by land value decreases; in Saskatchewan, 38 years, 1982 to 2010 and still counting.

The Farm Income Issues Data Source Book last done is 2005 summarizes the changes that have occurred in the structure of Canadian agriculture (Strategic Research Policy and Planning Team 2005). In 1971 the largest 5% of farms produced about 37% of the farm production which grew to about 41% by 2001. In the same period, the largest 20% of farms increased their share of total production from 66 to 77%.

Bakshi and Culver analyzed and compared Canadian farm data from the 1986 and 2006 census and found that there are less farms generating less than $250,000 in annual sales and more farms generating more than $250,000 in annual sales in 2006 compared to 1986 (Bakshi 2010). These large farms are also getting a bigger share of annual sales, 27% in 1986 and 69.4% in 2006, and generally tend to be more profitable than the smaller farms (Bakshi 2010).

Another study was done to improve the understanding of the structure of farms according to income status in Canada (Mussell 2005). The results showed the following:

- There is a significant diversity in farm incomes that vary across region, farm type, and farm size.
- Off-farm income is critical in accurately reflecting the income status of farms.
- If $35,000 is held as a low income cut-off, many farms across provinces, farm types, and sizes are experiencing low incomes. Where this is occurring, income from other family members is needed to finance debt servicing, capital replacement and family living expenses.
- Farms were found below the low income cut-off irrespective of size.
- There was clearly more variability in net operating income plus operator off-farm income within a farm sales category than across categories.
- Most farms with greater than $250,000 in sales had assets valued at over $1 million (Mussell 2005).

Therefore one can conclude that in Canada and Saskatchewan at least, farms are getting larger and the largest farms are producing much of the output and making most of the profit. However, large farms are not guaranteed to make a profit.

2.1. Other areas of the world

The following analysis looks at agricultural structural change in the US, Australia and the European Union (EU). The Economic Research Service (ERS) of the United States Department of Agriculture (USDA) has developed a "Family Farm Classification System" that includes the following:

- Small family farms (sales less than $250,000)
- Retirement farms. Small farms whose operators report they are retired, although they continue to farm on a small scale.
- Residential/lifestyle farms. Small farms whose operators report a major occupation other than farming.
- Farming-occupation farms. Small farms whose operators report farming as their major occupation.
- Low-sales. Gross sales less than $100,000.
- Medium-sales. Gross sales between $100,000 and $249,999.
  Large-scale family farms (sales of $250,000 or more)
- Large family farms. Farms with gross sales between $250,000 and $499,999.
- Very large family farms. Farms with gross sales of $500,000 or more.
  Nonfamily farms
- Nonfamily farms. Any farm where the operator and persons related to the operator do not own a majority of the business" (Economic Research Service 2010).

The study found that between 45 and 75% of the farms in each small farm type had a negative operating profit margin in 2007, but other small farms were more profitable: between 17 and 32% had an operating profit margin of at least 20%. The ERS also pointed out that only 3% of U.S. farms are classified as vulnerable (negative net farm income and debt/asset ratio greater than 40%), and the majority (71%) of these farms are residential/lifestyle farms. Small farms make up most of the farm count and account for the bulk of farm assets, including farmland. Most farm production, however, occurs on large-scale and nonfamily farms. Small-farm households rely on off-farm work for most of their income. Twenty-eight percent of U.S. farms have a principal operator at least 65 years old. Most of these older operators, however, are on retirement or residential/lifestyle farms that produce only 2 percent of U.S. farm output (Economic Research Service 2010).

In 2007 small family farms made up 88% of U.S. farms and held about 64% of all farm assets, including 63% of the land. Also in 2007, large-scale family farms, plus nonfamily farms, made up only 12% of U.S. farms but accounted for 84% of the value of U.S. production. The average operating profit margin and rates of return on assets and equity for large farms and very large farms were all positive in 2007, and most of these farms had a positive operating profit margin. Average operating profit margin and rates of return on assets and equity were negative for most small-farm types. Nevertheless, some farms within each small-farm type had relatively high operating margins of at least 20%. Small-farm households typically receive substantial off-farm income and do not rely primarily on their farms for their livelihood. Median household income for retirement farms or low-sales farms were below the U.S. median in 2007 (Hoppe 2010).

Australian farms exhibit much the same concentration of production in all of its regions as do farms in Canada and the US (Australian Bureau of Agriculural and Resource Economics and Sciences 2011a,b,c,d,e). The data range from a low of approximately 5% of the farms realizing approximately 42% of the value of agricultural production in Tasmania to a high of 15% of the farms realizing approximately 53% of the value of agricultural production Western Australia.

Farm data from several European countries were analyzed and found to have quite different farm business strategies, capabilities to generate capital revenues, and segmented agricultural loan market regimes (Myyra 2011). In Denmark for example, farmers have adopted aggressive farm expansion strategies with average equity ratios in the 33-39% range with the lower end occupied by pig and poultry farms. Italian farms are the other extreme with equity ratios between 97-98%, although this may mean they do not have access to lenders. Obviously if interest rates rise substantially, Danish farms could experience major adjustments. Agricultural asset markets or the way the assets are valued also differ substantially among countries. Ireland and Denmark saw very large increases in asset values during 2004-2007, whereas France did not. This large variation in leverage positions means that farms in different countries will be affected differently by product and financial market changes.

The Farm Accountancy and Data Network (FADN) of the European Commission Directorate of Agriculture and Rural Development occasionally publishes an "EU Farm Economics Overview" describes the financial structure of farms in the EU (Farm Accountancy and Data Network 2010). The study found that the distribution of income among the farms in the EU25 from 2004-06 resulted in about 70% of income being realised by 20% of the farms (Table 1) (Farm Accountancy and Data Network 2010). The study also found that the profitability of the agricultural sector is dependent on direct payments because average total costs are higher than market revenue even on the largest farms (Table 1).

When examining the differences between farm types and size class, it can be seen that in the cases of field crops, milk, grazing livestock and mixed farms expenses exceed market revenue for even the largest farms (Table 2). However, in general the gap between costs and revenue diminishes with increasing size.

Table 1. Number of farms, share of income and share of input costs to income in the EU-25 by size class, average 2004-2006

	Farm Size in Economic Units (Economic Unit is a Gross Margin of 1,000 Euros)						
	<4.8	4.8-9.6	9.6-19.6	19.6-48	48-120	>120	Total
% of Farms	13.6%	27.8%	18.6%	20.1%	13.1%	6.8%	100%
Share of Total Income	2%	6%	7%	16%	25%	45%	100%
Income per Farm	e7,974	e12,932	e22,586	e48,771	e117,554	e404,377	e61,731
	as % of Income						
Gov't Payments	25%	21%	25%	25%	21%	13%	19%
Cash Costs as a	64.8%	52.9%	59.8%	67.4%	72.3%	78.0%	72.0%
Depreciation	21.7%	15.3%	16.7%	15.7%	14.9%	11.5%	13.8%
Imputed Own Labour Costs	69.8%	71.7%	52.6%	36.9%	22.4%	8.8%	24.4%
Imputed Own Land Costs	5.3%	7.4%	7.5%	7.0%	5.2%	4.0%	5.2%
Imputed Capital Costs	9.4%	4.5%	5.4%	4.6%	3.7%	3.0%	3.8%
Total Costs	170.9%	151.8%	142.0%	131.7%	118.5%	105.2%	119.1%

Source: DG AGRI EU-FADN

Table 2. Share of total costs to income by farm type and size class in the EU-25, average 2004-2006

	Farm Size in Economic Units (Economic Unit is a Gross Margin of 1,000 Euros)						
	<4.8	4.8-9.6	9.6-19.6	19.6-48	48-120	>120	Total
Field Crops	168.5%	162.7%	158.6%	144.7%	131.4%	118.8%	132.9%
Horticulture	106.6%	101.6%	103.7%	94.5%	95.0%	92.9%	94.2%
Wine	199.3%	166.7%	137.6%	113.3%	99.3%	87.8%	103.1%
Permanent Crops	187.5%	138.6%	124.1%	107.3%	95.5%	92.7%	112.4%
Milk		153.8%	137.7%	133.7%	121.1%	107.8%	118.3%
Grazing Livestock	287.8%	196.3%	171.0%	157.0%	136.1%	112.3%	147.2%
Granivores	98.3%	96.8%	105.2%	102.5%	96.2%	91.0%	93.7%
Mixed	181.1%	153.9%	133.5%	134.7%	122.1%	113.3%	123.3%
Total	170.9%	151.8%	142.0%	131.7%	118.5%	105.2%	119.1%

Source: DG AGRI EU-FADN

Table 3. Share of farms where total costs are covered by market revenue by farm type and size class in the EU-25, average 2004-2006

	Farm Size in Economic Units (Economic Unit is a Gross Margin of 1,000 Euros)						
	<4.8	4.8-9.6	9.6-19.6	19.6-48	48-120	>120	Total
Field Crops	9.2%	12.4%	14.7%	16.8%	17.8%	20.5%	14.4%
Horticulture	21.5%	37.3%	40.5%	49.4%	47.2%	50.9%	44.4%
Wine	10.2%	13.6%	18.7%	32.1%	42.9%	57.2%	27.1%
Permanent Crops	10.6%	23.1%	29.1%	40.4%	50.4%	53.6%	27.4%
Milk	6.2%	13.1%	21.6%	18.1%	16.0%	29.5%	18.4%
Grazing Livestock	3.1%	6.3%	14.7%	18.7%	18.0%	24.0%	13.6%
Pig and Poultry	29.5%	21.9%	22.6%	37.4%	49.7%	57.9%	39.5%
Mixed	3.5%	7.4%	16.4%	24.7%	19.1%	24.4%	12.6%
Total	7.6%	15.5%	20.1%	24.9%	24.8%	34.1%	19.7%

Source: DG AGRI EU-FADN

Table 4. Share of profitable farms by farm type and size in the EU-25, average 2004-2006

	Farm Size in Economic Units (Economic Unit is a Gross Margin of 1,000 Euros)						
	<4.8	4.8-9.6	9.6-19.6	19.6-48	48-120	>120	Total
Field Crops	19.2%	22.0%	29.2%	38.0%	48.6%	61.3%	32.0%
Horticulture	29.0%	39.1%	43.7%	51.3%	49.6%	53.4%	47.0%
Wine	15.9%	16.0%	23.9%	37.0%	50.0%	63.3%	31.8%
Permanent Crops	15.6%	33.0%	37.4%	51.1%	59.7%	64.4%	36.4%
Milk	21.3%	29.3%	38.4%	37.6%	45.4%	62.5%	42.1%
Grazing Livestock	12.6%	21.5%	34.3%	41.9%	49.8%	65.1%	34.7%
Pig and Poultry	31.8%	25.7%	34.5%	51.1%	60.7%	68.1%	49.1%
Mixed	8.6%	15.8%	35.1%	44.2%	47.7%	63.3%	27.4%
Total	14.9%	25.0%	33.7%	42.2%	49.5%	62.4%	34.5%

Source: DG AGRI EU-FADN

The share of farms in the EU-25 which are able to cover total costs based on market revenue alone without receiving government payments is only about 20% (Table 3). It is difficult for field crops, milk, grazing livestock and mixed farms to cover total costs based on market revenue. These farm type in turn are the ones receiving the largest amount of direct payments (Farm Accountancy and Data Network 2010).

The receipt of government payments significantly increases the profitability of farms where the share of all farms covering total costs increases from 19.7 to 34.5%, a 14.8% increase (Table 4). The amount of increase is much more pronounced as farm sixe increases with an increase of 7.3% for the smallest farms and an increase of 28.3% for the largest farms (Table 4). The biggest increase in the share of farms covering total costs is for milk at 23.7%, grazing livestock at 21.1%, and field crops at 17.6% (Farm Accountancy and Data Network 2010).

3. Conclusions

First, larger farm businesses produce most of the agricultural commodities and get most of the government payments although less than the percentage of commodities they produce. Second, farm businesses are getting larger but increased profitability is not completely correlated with increased farm business size, in that some small and medium sized farms are profitable. Thirdly, many farm businesses especially the smaller ones are reliant on government payments for their financial survival. This is particularly true for Europe. Finally, the structural change in agricultural production that has occurred in the past will continue into the future. Concentration of production will continue with fewer and larger farm businesses. Niche market farm businesses, part time farms with off-farm income and lifestyle farms will dominate the farm numbers but not farm production.

4. References

Australian Bureau of Agriculural and Resource Economics and Sciences, 2011a,b,c,d,e. *Commodity Outlook and Financial Performance of Key Agricultural Industries in the South Australia Greater South East Region.* Hahndorf: Government of Australia, 2011.

Australian Bureau of Agricultural and Resource Economics and Sciences, 2011b. *Commodity Outlook and Financial Performance of Key Agricultural Industries in the Fitzroy and Central Highlands region of Queensland.* Rockhampton: Government of Australia, 2011.

Australian Bureau of Agricultural and Resource Economics and Sciences, 2011c. *Commodity Outlook and Financial Performance of Key Agricultural Industries in southern Western Australia.* York: Government of Australia, 2011.

Australian Bureau of Agricultural and Resource Economics and Sciences, 2011d. *Commodity Outlook and Financial Performance of Key Agricultural Industries in Tasmania.* Launceston: Government of Australia, 2011.

Australian Bureau of Agricultural and Resource Economics and Sciences, 2011e. *Commodity Outlook and Financial Performance of Key Agricultural Industries and Fisheries in the northern Australia pastoral zone.* Darwin: Government of Australia, 2011.

Alberta Agriculture and Rural Development, 2012. Alberta Farm Cash Receipts by Detailed Type ($ Thousands), 2005-2010. Statistics Canada; Agriculture and Agri-Food Canada; and Alberta Agriculture and Rural Development, 2012.

Bakshi S., Culver D., 2010. *Structural Change in Canadian Agriculture and the Impacts on Canadian Farm Income and Farm Households.* Denver: Canadian Agricultural Economics Society Annual Meeting, July 25-27, 2010.

Bureau of Agricultural Economics, 1945. *Wartime Changes in the Financial Structure of Agriculture.* United States Department of Agriculture, 1945.

Canada Revenue Agency, 2012. “Capital Gains.” *Canada Revenue Agency.* 2012. http://www.cra-arc.gc.ca/E/pub/tg/t4037/t4037-12e.pdf (accessed Janaury 29, 2013).
Census of Agriculture, 2012. *Section 1 - A statistical portrait of agriculture, Canada and provinces: census years 1921 to 2006.* 2012. http://www.statcan.gc.ca/pub/95-632-x/2007000/t/4129740-eng.htm (accessed April 26, 2012).
Central Statistics Office, 2008. *Farm Structure Survey 2007.* Dublin: Stationary Office.
Economic Research Service, 2010. *America's Diverse Farmily Farms, 2010 Edition, Economic Information Bulletin No. 67.* Washington: United States Department of Agriculture.
Farm Accountancy and Data Network, 2010. *EU Farm Economics Overview FADN 2007.* Brussels: Eropean Commission- Agriculture and Rural Development.
FPD Savills, International Property Consultants, 2001. *Structural Change in Agriculture and the Implications for the Countryside.* Land Use Policy Groupt of the G B Statutory Conservation, Countryside and Environment Agencies.
Harrington D.H., Koenig S.R., 2000. *Structural Change: Farm and Financial Dimensions.* Economic Research Service, Paper Presented at Agricultural Outlook Forum, United States Department of Agriculture.
Hoppe R.A., Banker D.E., 2010. *Structure and Finances of U.S. Farms, Family Farm Report, 2010Edition.* Economic Information Bulletin Number 66, Washington: Economic Research Service, United States Department of Agriculture.
Lobley M., Errington A., McGeorge A., Millard N., Potter C., 2002. *Implications of Changes in the Structure of Agricultural Businesses.* University of Plymouth, 2002.
Mussell A., Moore T., McEwan K., Duffy R., 2005.. *Testing the Structure of Canadian Farm Incomes.* Ottawa: Canadian Agri-Food Policy Institute (CAPI), 2005.
Myyra S., Pietola K., Heikkila A., 2011. *Farm Level Capital: Capital Positions, Structures, the Dynamics of Farm Level Investments, Capital Accumulation, and Leverage Positions.* Factor Markets Working Paper No. 7, Brussels: Center for European Policy Studies (CEPS), 2011.
Saskatchewan Ministry of Agriculture, 2012. *Agricultural Statistics Database.* Saskatchewan Ministry of Agriculture, 2012.
Strategic Research Policy and Planning Team, 2005. *Farm Income Issues Data Source Book.* Ottawa: Agriculture and Agri-Food Canada, 2005.

FARM LEVEL FINANCIAL ANALYSIS OF THE WILDLIFE SECTOR IN SOUTH AFRICA

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Abstract

Despite recent statistics suggesting that the South African Wildlife industry is experiencing economic pressure coupled with a general financial upswing in the livestock sector; there is still an on-going switch from livestock to wildlife ranching making the wildlife sector the fastest growing agricultural sector in South Africa. Assuming that this switch is viewed as rational behaviour; can it be argued that the financial performance of the wildlife sector is still superior when compared with livestock? The study employs a profitability performance measurement in the form of Return on Investment to answer the research question. Primary data, collected by means of personal interviews among leading wildlife ranchers and farmers in the Northern Cape Province of South Africa was used for the required calculations. Results revealed that the economic pressure experienced by the industry is also visible in certain wildlife operations, specifically among wildlife harvesting and biltong hunting operations. Wildlife harvesting in particular yielded significant lower Returns on Investment compared to cattle farming. On the contrary, the financial performance of ranching operations such as a combination between biltong and trophy hunting as well as the breeding of plains and higher-value species for live sales proves to be superior when compared with cattle. Therefore, it is not reasonable to argue that despite economic pressure, the financial performance of wildlife is still superior to that of livestock. Moreover, it can be concluded that the continued switch from livestock to wildlife is only motivated by the financial performance of selected few wildlife operations in South Africa.

Key words: wildlife ranching; financial performance; return on investment

1. Introduction

Until 1991, wildlife in South Africa was seen as part of nature (NAMC, 2006). It had no monetary value and the accepted wisdom was that in order for modern agriculture to prosper, wildlife should be exterminated because: (i) transmittable wildlife diseases threaten the health of livestock and, (ii) it competes with domestic livestock for grazing (Joubert 1977). Ironically, today the accepted belief is that wildlife's disease tolerance and ability to adapt and to be more efficient users of local vegetation (Dlamini and Fraser, 2010) contributes towards its competitive edge compared to domestic livestock in South Africa. The realisation of these benefits and the need to tap into them from a sustainable agriculture point of view has contributed towards the growth in the industry (Dlamini and Fraser, 2010).

However, the real transition from livestock to wildlife started in the early 1990s with conditional ownership of wildlife that was granted to private landowners. This resulted in a monetary value for wildlife and coupled with fundamental developments such as improvements in the techniques of translocation, capture and immobilisation; developments surrounding information flows, resilient market for the sale of live animals, hunting and tourism, core leadership etc., enabled farmers to fully exploit the economic and ecological benefits associated with wildlife ranching. On the back of this, the wildlife ranching sector is the fastest growing agricultural sector in South

Africa, expanding at between 5 and 20% annually, whereas the real farm incomes have declined by approximately 5.3% (Eloff, 2002; Dry, 2010a, b; Jenkins, 2011).

A similar trend is observed in terms of the number of farmers/ranchers. The total number of commercial farmers in South Africa declined from 60 000 in 1994 to 37 000 today (Mcgroarty and Chaykowski, 2012) whereas the number of wildlife ranchers has increased from 9 000 to approximately 15 000; including those that combined wildlife with livestock (Cousins et al. 2010). In other words, approximately 40.5% of all commercial farming activities in South Africa involved wildlife. This resulted in more than 20 million hectares of marginal agricultural land being transformed into thriving wildlife land use options (Dry, 2010b); with an estimated 18.6 million head of game roaming the said land (Du Toit, 2007).

With these growth rates as the barometer, it seems that the industry is prospering although recent statistics suggest that some spheres of the wildlife industry are experiencing economic pressure. These include the stagnation of prices of plains wildlife on wildlife auctions, the negative impact of the strong exchange rate on trophy hunting operations, and the amount of negative publicity on unethical and exploitive wildlife practices which have a negative impact on eco-tourism (Cloete, 2012). The afore-mentioned factors, coupled with the large capital outlays required for converting from livestock to wildlife ranching, reveal that the switch from livestock to wildlife ranching is in most cases not lucrative (Cloete et al. 2007). Nonetheless, there is still an on-going switch from livestock to wildlife ranching, motivated by the breeding of exotic and higher- value species fetching exceptional prices on the back of extraordinary investor confidence (Cloete, 2012).

As a result, continued growth in the sector despite indicators suggesting that the industry is experiencing economic pressure coupled with a general financial upswing (mainly in terms of output prices) in the livestock sector raise questions with regard to the financial performance of the wildlife sector. Is it reasonable to argue that despite some spheres being under economic pressure, its financial performance is still superior to that of livestock?

In order to answer the research question, the Northern Cape Province (NCP) of South Africa will be used as a case study region. Most parts of the province are semi-arid to arid with wildlife and livestock farming being the major agricultural activities. The following section elaborates on the approach and data used, followed by the results, discussion and finally concluding remarks.

2. Approach and data used

The study employs a profitability measure to evaluate the performance of different wildlife and livestock activities. Return on investment (ROI) is arguably one of the most popular financial performance measurements (Andru and Botchkarev, 2011). Although ROI is widely considered a valid method to evaluate two or more investment opportunities against one another, it will be used in a slightly different context in this study, namely to gauge and compare the financial performance of different wildlife and livestock activities in order to determine whether wildlife is superior to livestock. Although different approaches to calculating ROI exist, the traditional ROI will be calculated. The difference between the traditional approach and others (i.e. extensions and virtualisation) is mainly the way in which profitability is calculated. For traditional ROI, profitability is calculated based on the actual income and cost of a specific investment (farming/ranching activity in this case) in a specific year, whereas the other forms make use of estimated income and costs (Andru and Botchkarev, 2011). In other words, the traditional ROI is much more accurate compared to the other two approaches. The traditional ROI can be calculated as follows:

$$\text{ROI [t]} = \frac{\sum_i FinRet(j) - \sum_j Cost(j)}{\sum_j Cost(j)} \ x \ 100 \qquad (1)$$

The approach requires that actual or precise accounting records (data) be used to calculate profitability of a specific enterprise. Therefore the data used in the study were obtained from leading wildlife ranchers in the NCP of South Africa. The data was gathered by means of personal interviews. Moreover, the ranching operations considered in the analysis comprise both consumptive and non-consumptive utilisation of wildlife with participants being selected based on their primary ranching/ farming focus. The participants include those that focused on game harvesting, biltong hunting, a combination of biltong- and trophy hunting as well as the breeding of wildlife (both plains and higher-value species) for live sales. Plains wildlife refer to species which are typically found in open plains or savannah habitats and include a great range of animals from the springbok to the very much larger kudu and eland (Wikipedia, 2012); whereas higher-value species refers to animals such as roan- and sable antelope as well as African savanna buffalo.

In order to compare the different ranching/ farming operations with each other, similar species compositions, capital outlays and land size were assumed. In other words, the data obtained from the leading wildlife ranchers was used to compile species-specific enterprise budgets for each respective ranching practice. For example, enterprise budgets for springbuck were compiled for utilisation by means of harvesting (meat), biltong, a combination between biltong and trophy hunting and the breeding for live sales. The data used for the compilation of species-specific enterprise budgets for each of the species included reflects the income and cost that prevailed in the market during the 2011/12 financial year. The profitability of the different practices was calculated by means of cash flow statements compiled from the species-specific enterprise budgets.

3. Results and discussion

3.1. Species composition and assumptions

As mentioned, a similar species-composition was assumed for the different ranching operations in order to compare financial performances with one another (see Table 1). The data portrayed in Table 1 reflect the information obtained from various leading wildlife ranchers in the NCP of South Africa.

The species composition is typical of a so-called plains wildlife composition that can be ranched with on 2000 ha in the NCP. In order to remain sustainable, a utilisation rate equal to the population growth rate for each species was assumed. For example, a game harvesting operation will cull between 25 and 30% per annum, depending on the respective species. The same applies with regard to a combined operation (biltong and trophy hunting); with trophy hunting accounting for 12% of the income with the remaining 13 to 18%, depending on the species, being hunted for biltong. The latter also provided additional income in the form of day fees. Based on the data gathered, 180 hunting days per annum were assumed i.e. 60 hunters with the average hunting safari that lasts 3 days. The average day fees charged by ranchers in the NCP range between R250 and R1 875 per day, depending on the safari and animals to be hunted i.e. day fees for dangerous game (buffalo, lion, hippo etc.) is much higher compared to plains game species.

In addition, literature also alludes to the fact that several farmers are motivated to enter the wildlife sector based on the exceptional prices fetched by scarce or higher-value species. Thus, in addition to the plains wildlife operations, the study will also investigate the financial performance

Table 1. Species composition and assumptions

Species	Number	Population growth (%)	Average weight (kg)	Average price		
				Meat	Biltong (per animal)	Trophy (1US$/ R 7.5
Springbuck	250	30	15	R 18/kg	R 450	R 2,625
Blesbuck	120	30	29		R 850	R 3,000
Impala	150	30	25		R 800	R 3,375
Gemsbuck	120	30	90		R 3,500	R 8,250
Blue Wildebeest	100	30	90		R 3,000	R 8,250
Kudu	60	25	81		R 2,500	R 11,250
Eland	20	25	225		R 4,500	R 16,500

of a wildlife ranching operation that focuses on the breeding and live sale of plains and higher-value wildlife. The main assumptions for this operation include:

- Based on the rate of recurrence of the various higher-value species among game ranchers in the NCP, only sable antelope will be considered part of the plains and higher-value species composition;
- Considering the required capital outlay and the average sable antelope breeding herd size; the number of animals will be restricted to 20% of the carrying capacity of the farm;
- A 80% weaning rate is assumed for sable antelope while the same population growth rate will account for the plains wildlife (see Table 1);
- 50/50 male- female offspring ratio for sable antelope with the entire offspring to be sold at the age of 18 months.

The livestock enterprise included in the analysis reflects a commercial weaner operation. With the average carrying capacity of 12 ha/LSU[1], which is similar to the grazing capacity used to determine the optimal wildlife composition; the total cattle herd consists of 165 animals. The main assumptions include an 85% weaning rate with an average selling weight of 220 kg.

The following sub-section provides a detailed discussion on the financial performance of the different practices, taking into consideration the afore-mentioned data and assumptions.

3.2. Financial performance

Table 2 shows the ROI of the respective operations for the period under review. From the table it is clear that the majority of the ‘plains wildlife ranching operations’ yielded lower returns than a commercial weaner production system. The results are slightly different from those of other studies in the 1990s. For instance, Jansen et al. (1992), as cited by Child et al. (2012), report that most wildlife operations “are much more profitable with only 5% of livestock operations generating a return on capital in excess of 10% when profits were calculated using market (financial) prices”. During this period, and even up to the mid-2000s, wildlife ranching yielded exceptional ROI on the back of continued output price increases with the demand for wildlife being driven by the restocking of farms previously used for conventional livestock farming. However, this trend peaked in 2004 after which new land for wildlife production became increasingly scarce. As the plains wildlife were by then fairly numerous, demand and subsequently prices started to

1 Large Stock Unit (LSU) equal to live weight of 450kg

decline, and established ranchers increasingly began to produce higher-value species (Bothma, 2010, personal communication).

The results from the Jansen et al. (1992) study do not only highlight the change in competitiveness between wildlife operations and livestock; it is also an indication that time has changed for agriculture in general, especially in South Africa. Today, a 10% ROI in the agricultural sector seemed a bit 'far-fetched'. This is mainly due to the significant increase in land values coupled with input inflation that continues to outstrip output inflation i.e. cost price squeeze/ lower profits.

Nevertheless, the gross margin per hectare for a wildlife harvesting operation amounts to a mere R104 per ha or R208 089 for the entire operation on 2 000 ha. Considering the initial investment of R15,3 million (i.e. R14 million for the land and an additional R1.3 million for the wildlife); the ROI of 1.36% is the lowest for all operations included in the analysis. This is almost a third of the returns yielded by a cattle operation in the same region. The same accounts for a biltong hunting operation with an estimated ROI of 3.05% compared to the 3.19% for cattle.

The exception in the case of plains wildlife operations is the combination between biltong and trophy hunting (see Table 2). The significant higher ROI can be attributed to the significant higher prices received for the 12% of the animals hunted for their trophies coupled with the additional day fees (see Table 1). When compared with cattle, the ROI (6.35%) of a biltong/ trophy hunting operation is almost double that of cattle (3.19%).

A similar situation accounts for the combination between plains and higher-value species (see Table 2 above). With an income per hectare of R1 668 that equates to a ROI of 15.5%, ranching with a combination of plains and higher-value species is probably the most profitable farming enterprise in South Africa at the moment. The exceptional ROI (15.5%) could be attributed to the average auction prices of sable antelope as well as fundamental developments in the intensive breeding of these animals. The average price for young Sable bulls ranges between R23 451 and R34 035 with the auction price for heifers ranging between R188 519 and R277 945 during 2011/12 (Cloete, 2012). Moreover, improvements in terms of the breeding, health control, management etc. contributed towards ranchers achieving weaning rates in excess of 80 to 85%.

Table 2. Financial performance of the various operations

Operation	Land (2000 ha)	Animals	Investment	Income	Income/ ha	ROI (%)
	R (ZAR)					
Cattle	10,000,000	1,000,000	11,000,000	351,936	176	3.19
Game harvest	14,000,000	1,329,000	15,329,000	208,089	104	1.36
Biltong hunting	14,000,000	1,329,000	15,329,000	467,100	234	3.05
Biltong/ Trophy hunting	14,000,000	1,329,000	15,329,000	972,859	486	6.35
Game/ 20% Sable Antelope	14,000,000	7,439,000	21,439,000	3,355,191	1668	15.56

However, concerns have been raised with regard to the end game strategy and subsequently the sustainability of higher-value species in South Africa. Maud (2012) states:

"*When you keep on blowing up a balloon it will eventually explode. Throughout history there have been investment opportunities that have caught the imagination of the public and which, through greed and ingenuity, have caused prices to rise way beyond reasonable expectations. It is also usually the people who get drawn into the situation long after it has started that are left holding the remnants* *of the balloon when it explodes. It is the insiders that get in early in the cycle who usually make the profits unless they, too, get carried away and greed takes over. This is a classical pyramid scheme".*

He elaborates by arguing that "a simple basic law of economics dictates that the supply of these high-priced wildlife is soon going to exceed the demand". This is especially true considering that the only well-established market for these animals is non-consumptive (live sales). Nevertheless, a combination of plains and higher-value species has yielded a far greater ROI compared to any other wildlife or livestock operation, at least for now.

4. Conclusions

The results from the study provide value information not only to new entrants (farmers) that wish to convert from livestock to wildlife but also for established ranchers that want to expand their practices or those who want/ need to diversify in order to remain financially sustainable in the current economic environment.

It can be concluded that the economic pressure in some spheres of the wildlife industry is also evident in the financial performances of operations with results that indicated that consumptive utilisation of plains wildlife, especially in terms of harvesting and biltong hunting, is not yielding the desired financial returns. It is therefore not reasonable to argue that despite economic pressure, the financial performance of wildlife in general, is still superior to livestock. Moreover, it is clear that the continued switch from livestock to wildlife in South Africa is motivated by the financial performance of a selected few wildlife operations.

5. References

Andru P., Botchkarev A., 2011. The Use of Return on Investment (ROI) in the Performance Measurement and Evaluation of Information Systems. http://www.academia.edu (accessed 20 November 2012).

Cloete P.C., Taljaard P.R., Grove B., 2007. A Comparative Economic Case Study of Switching from Cattle Farming to Game Ranching in the North Cape Province, South African Journal of Wildlife Research 37(1): 71-78 (April 2007).

Cloete P.C., 2012. Investment in Change- Wildlife versus Agric Development. Keynote address at the ABSA Annual Wildlife Conference 2012, Port Elizabeth, South Africa.

Cloete P.C., 2012. Wildlife Auction Trends. To be published in the Forthcoming Farmers Weekly

Cousins J.A., Sadler J.P., Evans, J., 2010. The Challenges of Regulating Private Wildlife Ranches for Conservation in South Africa. Ecology and Society XX(YY): ZZ [online]. http://www.ecologyandsociety.org/volXX/issYY/artZZ/

Du Toit J.G., 2007. Report: Role of the private sector in the wildlife industry. Wildlife Ranching SA/ Du Toit Wilddienste. Pretoria, South Africa.

Dlamini T.S., Fraser G., 2010. Economics of Meat Production from the Springbuck in the Eastern Cape Karoo, Paper presented at the joined 3rd African Association of Agricultural Economics (AAAE) and 48th Agricultural Economist Association of South Africa (AEASA) Conference, Cape Town, South Africa, September 19-23, 2010.

Dry G., 2010a. Why Game Ranching should be taken seriously. Farmers Weekly, 14 May 2010, Pretoria, South Africa.

Dry G., 2010b. Commercial wildlife ranching's contribution to the green economy. Green Economy Summit, South Africa.

Eloff T., 2002. The economic realities of the game industry in South Africa. In: H. Ebedes, B. Reilly, W. Van Hoven & B. Penzhorn (Eds), Sustainable utilisation– conservation in practice (pp. 78-86). South Africa Game Ranchers Organisation, Pretoria.

Jenkins H., 2011. Opening Address, 7th International Wildlife Ranching Symposium by Premier of the Northern Cape. Kimberley, South Africa. 7th International Wildlife Ranching Symposium.

Joubert D.M., 1977. Agricultural Research in South Africa: an historical overview. In Brown, A.C. (Ed). A History of Scientific Endeavour in South Africa. Cape Town, Royal Society of South Africa, pp. 265-282.
Maud K., 2012. Exotic Game- some questions. To be published in the Forthcoming Wildlife Ranching South Africa Journal.
Mcgroarty P., Chaykowski K., 2012. South Africa Reseeds Farm Debate. The Wall Street Journal, http://www.wsj.com (accessed 20 November 2012).
Musengezi J., 2010. Wildlife Utilization on Private Land: Understanding the Economics of Game Ranching in South Africa. Unpublished PhD thesis, University of Florida, USA.
The National Agricultural Marketing Council (NAMC), 2006. Report on the Investigation to Identify Problems for Sustainable Growth and Development in South African Wildlife Ranching. Report no. 2006-03, 8 August 2006, Pretoria, South Africa.
Wikipedia, 2012. The Free Encyclopaedia. http://www.wikipedia.org (accessed 21 November 2012).

THE ROLE OF SMALL FARMS IN MAINTAINING A BALANCE IN AGROECOSYSTEMS

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Abstract

Rural areas in Poland which offer biological and landscape diversity are of the most abundant in Europe. Small ecological farms, especially in southern and south-eastern Poland, still host rare weed species named in red lists of many European states. The diversity of animal and plant species in these areas is significantly higher than in the remaining parts of Poland. Consequently, the balance of agroecosystems is far more stable. The presence of rare weed species in the fields does not equal lower crop but contributes to maintaining of the considerable diversity of insects or birds. Preserving the mosaic structure of crop fields and traditional rural landscape is only possible on small farms and hence the importance of their further existence.

Keywords: weeds, preservation, small farms, agroecosystems, diversity

1. Introduction

Throughout ages the pressure of a man onto the environment has grown enormously. Shifting from hunting and gathering to farming caused replacement of the mosaic system of habitats by a growing number of single species cultivations. By simplifying the complex ecosystems and eliminating the ‘unwanted’ species, the man made his diet poorer and changed the habitats of wild flora and fauna completely. At the end of the 20th century there were 4.5 billion people and as little as 180 species of plants consumed of which 6 species provided more/less 90% of food of plant origin (FAO, 1996). In Polish registers there are 140 varieties of cultivated plants of several dozens of species (details of 2011, Research Centre for Cultivar Testing – COBORU).

Modern agriculture should put considerable emphasis on maintaining biological diversity. The purpose of original and modern agriculture is to produce food. The difference is that primitive farming uses mainly the work of men and animals and simple tools while modern farming is based on advanced technology of cultivation, which is characterised by very intense nature, and the entire production is meant for sale. There is no place to maintain diversity in agricultural ecosystems. Large scale monocultures, excessive chemisation and heavy machinery destroyed the balance of agroecosystems. Genetic erosion of crop plants is observed; also accompanying plants species as well as microorganisms and animals directly related to them die. Surviving of small farms agriculture is the only method of maintaining diversity and balance in agricultural agroecosystems.

2. Materials and methods

The research area is situated in the Nadnidziański natural landscape park and partly within the ‘Natura 2000’ network (Ponidzie area). This area has been settled for a very long time. The oldest traces of settlement date back to the neolith times. The Ponidzie was examined in detail, among others thanks to funding by the State Committee for Scientific Research of a supervisor research grant ‘Diversity of field weeds of the Nadnidziański Natural Landscape Park, its determinants and preservation' (Dostatny, 2000) and by a grant of the Ekofundusz Foundation as well as the **Plant Breeding and Acclimatization Institute** (2007-2009). A detailed survey of weed species was performed that enables comparison of changes occurring in segetal communities and further monitoring thereof. Places of occurrence of vanishing weed species, in particular among cereal crops cultivated on small farms of the region were identified. Research was carried out in close cooperation with local farmers that were very helpful with providing information on traditional cultivations in of the area. Favourable inclination towards the idea of maintaining of biodiversity and relevant activities was observed.

Occurrence of weed species in cultivations of 15 farmers was monitored. The number of weed species in the material harvested directly from the farmer was defined. Marking of weed seeds was made according to Kulpa (1988). For that purpose 0.5 kg of material was taken directly from the harvester on the aforesaid fields between 2008 and 2012. A list of weed species in the entire material was prepared based on the indexes of frequency and abundance of occurrence (Kulpa & Tabisz, 1963). It must be mentioned that farmers who took part in the research have small farms (usually up to 10 ha) and despite crop rotation the fields were more or less in the same area. Thus, the material could be compared.

3. Results and discussion

Extremely interesting weeds of crop fields occur in Niecka Nidziańska, on rendzina soils, which make 1% of Polish soils. Most of them are very rare plants in Poland (Dostatny, 2004). An example could be *Adonis flammea* which is endangered due to intensified farming systems. There are several factors causing the extinction of the species as well as other of the *Caucalido-Scandicetum* complex. The main include intensification and modernisation of contemporary agriculture: introduction of prolific cereal varieties, improved cleaning of seeding material, long-term usage of herbicides. Equally significant are changes of habitat conditions, particularly strong and continuing acidification of limestone soils (Aniol-Kwiatkowska, Popiela, 2011). Also urbanisation and changing arable land into non-arable as well as abandoning of farming on difficult land (e.g. high slopes) are of great importance. These factors had a strong influence on extinction of *Adonis flammea* and other species of the complex (calciphile archaeophytes related to traditional methods of cultivation, of Mediterranean reach).

In the analysed material, after harvest in the initial years of monitoring in Niecka Nidziańska area, a small number of weed species was observed (from 65 to 67 species, between 2008 - 2010) with high number of more common species such as: *Agropyron repens*, *Avena fatua, Convolvulus arvensis, Galium aparine*, *Polygonum convolvulus*, that were present in almost each of the 15 samples, with a high abundance index. In the consecutive years, the number of weeds in the material collected from farmers was increasing gradually. In the last 2 years (2011 – 2012) the differences in abundance between common and rare weeds were not so evident (from 71 to 91 species in 0,5 kg of collected material, in all of 15 samples) (graph 1). Abundance of common species dropped which was caused by occurrence of other, less common, species, such as: *Adonis aestivalis, Aethusa cynapium, Agrosthemma githago, Bupleurum rotundifolium, Camelina microcarpa, Lithospermum arvense, Neslia paniculata, Valerianella dentata,* between others. Specimens of these species probably came from the soil seed resources. What is important, single specimens of rare species have occurred in the fields, such as: *Anagallis foemina*, *Bupleurum rotundifolium* (It's increasing its coverage in the fields), *Caucalis platycarpos*. However, to date their seeds have not been identified in the collected material. After years of cultivation without the use of herbicides one may expect that vanishing weed species still present in soil seed resources will sprout and create a full composition of different vanishing weed complexes. A higher number of

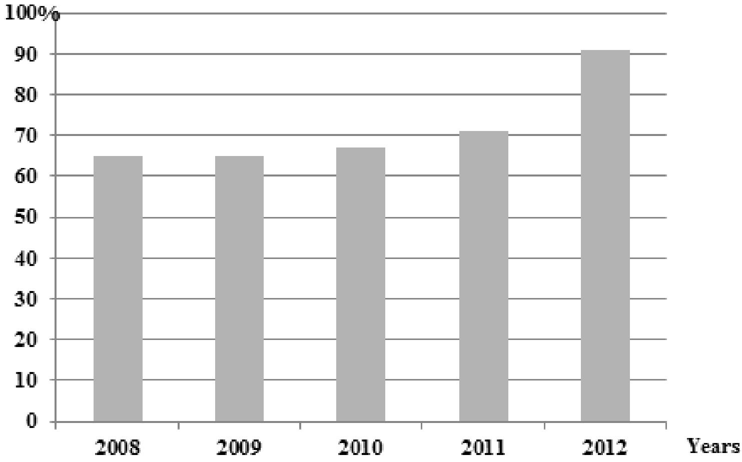

Figure 1. Frequency of occurrence of weeds in the seed material of 15 farms in Poland

segetal plants in crop fields equals increased abundance of other species such as: microorganisms, insects, birds, etc., that are necessary to keep agroecosystems in balance.

During the collection missions organised by National Centre for Plant Genetic Resources in the last 10 years, we observed that the South and Southeastern part of Poland is still abundant in local, old varieties of annual vegetable plants, leguminous plants, medicinal plants and rare species of weeds, as well as old varieties of fruit trees. Rare species of weeds are only present in the fields in small farms in the single villages in Poland, where the mosaic structure of crop fields is preserved, like in the researched area. Unfortunately such kind of place are becoming rare in Poland.

Further existence of populations of rare, annual weed species is connected with turning of soils surface during field works. This agrotechnical treatment prevents from occupation of biotopes of different grasses or perennials with higher competitive potential. We may hereby state that the seed resources in soil are of crucial significance for the preservation and dynamics of populations of segetal flora (Czarnecka, Czarnecka, 2006).

Species that accompany cultivations have the ability to adapt to the life cycles of crop plants (Kornaś, 1977). A given complex of weeds with a whole spectrum of species reflects a specific type of cultivation. If the cultivation is abandoned, then the accompanying species slowly yield. The same happens with bird and insect species that were directly connected with these plants. For example for the last 300 years approximately 150 species of mammals (another 240 are endangered) and 100 bird species have became extinct; of which around 70% species died due to elimination of their habitats. In the second half of the 20th century world agricultural production became 2.6 times higher and mineral fertilisation 8 times more intense. At the same time 6 million hectares of arable land per year changes into a desert owing to excessively extensive agricultural use. The national strategy of preservation and moderate use of biological diversity (2003) emphasises that all that has not been appreciated or even intentionally destroyed to date, e.g. 'pests and weeds' should be preserved. Therefore, from the point of view of the convention and nature there is no 'pest' or 'weed'. The strategy has been prepared upon request of the Polish Ministry of Environment and drawn up in accordance with the 'Convention on Biological Diversity' announced during the Earth Summit in Rio de Janeiro held in 1992. To maintain balance and increase diversity in agricultural ecosystems, a 'model refuge of agrobiodiversity' has been formed in Niecka Nidziańska, southern Poland. The model refuge has been created thanks to the funds of Ekofundusz Foundation and the Plant Breeding and Acclimatization Institute. Its aims is to preserve and maintain biodiversity in farming ecosystems and to protect field weed species that are threaten by extinction by maintaining typical weed species of the region in the fields.

Weeds prove many positive impacts in agroecosystems. They protect the surface of soil from crusting, drying and erosion. Furthermore, after ploughing weeds decay in soil replacing composting and organic fertilisation. They also stimulate growth of crop plants through its allelopathic activity - the so called positive allelopathy consists in improved growth of a given species in the vicinity of others, by emitting complexes of different chemical compounds. They are used as 'biological weapon'. Weeds may indicate actual habitat conditions and therefore they are used as bioindicators. They make food or an ingredient of fodder mixtures for animals. They are also widely used in phytotherapy and cosmetic industry.

Very often segetal plants compete with one another, not only the crop plant, which means that a bigger number of weeds, with low coverage, only slightly decrease the harvest of a crop plant. The phenomenon may be explained by the fact that the more species (partners) to share the resources of an ecological niche, which is a field, the more often growth of one of them limits the growth and development of other which results in absence of dominance. A reverse case occurs when one or several weed species predominate in fields treated with herbicides. Some of the species became resistant to herbicides which causes growing number thereof in the field (the so-called compensation), consequently resulting in a drop of crop plant harvest.

The layer in cornfield decides about getting of the weed seeds to the collected material (crop). Research made in Kurpie confirms the phenomenon (Dostatny, Małuszyńska, 2007). Most of the seeds came from the medium layer, some from the higher, and few from lower. Therefore, we do not have to be afraid of weeds from the lowest layer of cornfield getting to the harvested crop. Their presence is recommended as they protect soils from crusting (Dostatny, Małuszyńska, 2007).

As it has already been mentioned, weeds prove many positive impacts in agricultural systems and therefore they should be covered by protecting or preserving schemes (reserves and refuges are not sufficient). The base of an efficient plan of weed management is ecological knowledge of this plant group and relations thereof with other organisms. Research carried out in Great Britain (Marshall and others, 2003) show that many segetal plant species influence maintaining of high diversity of insects. A drop in the number of feeding plants, i.e. weeds, may have an impact on the reduction of insect population as well as other animal species, such as birds. Weeds play an important ecological role by giving shelter to spiders and insects on which birds feed (e.g. larks). Poland has 26% percent of the entire bird population depending on arable land (BirdLife International, 2004). In order to keep this abundance of bird species, current diversity of agricultural landscape must be preserved (Wuczyński i in., 2011), this refers among others to buffer zones planted with grass and papilionaceous plants (Dajdok, Wuczyński, 2008).

Transformation of natural environment and production of food including chemicals that have a negative impact of human life. A reaction to the situation was, among others, Directive 2078/92 of 1992 of the UE Parliament introducing the term of agri-environmental plans, i.e. such types of agricultural production that guarantee preservation of the natural environment values being the base of agricultural production and enable obtaining satisfactory economic results. Farmers joining the agri-environmental plans produce food and maintain diversity in agroecosystems. These activities are subsidised. In Poland, the national agri-environmental plan was established within the Rural Areas Development Plan aiming at satisfaction of objections, priorities and principles based on which activities towards a sustainable development are supported. The plan was drawn up the Ministry of Agriculture and Rural Development and approved by the European Commission. The Sixth Package (second stage: 2007-2013) – Preservation of endangered genetic plant resources in agriculture is directly connected with improvement of diversity in rural areas. Option 6.3 of the package – Seed production requested by gene bank, is addressed to small farms. Sub-option C provides for preservation of rare flora accompanying cultivations. Participation in this option allows farmers from Niecka Nidziańska (also from the rest of the country) to continue activities undertaken as part of the aforesaid project and enables other interested farmers from the entire country to join the plan which, with no doubt, contributes to improvement of diversity and maintaining the balance of agroecosystems.

4. Summary

Constant presence of rare weed species in crop fields does not mean “worse crop”, as a significant part of these species belong to the lowest layer of cornfield that will never be collected by a harvester. Additionally, after a longer period of ecological or extensive farming the ecosystems gains balance. Different species coexist, supplement and compete with one another, which does not end in expansion of any of them. This is, with no doubt, more favourable to nature than uniform landscapes with immense areas of one crop plant, where only few species of the most common weeds, resistant to herbicides, prevail, creating a simple system of agricultural ecosystems. The mosaic structure of crop fields of small farms ensures living conditions for many animals and plants already rare across Europe and may help us save some species that may have a crucial meaning for the generations to come.

5. References

Anioł-Kwiatkowska J., Popiela A., 2011. *Adonis flammea* (*Ranunculaceae*) – wymarły archeofit Dolnego Śląska. w „Zagrożony archeofity Dolnego Śląska” (red. Anioł-Kwiatkowka, Szcześniak E.), Acta Bot. Siles. Supl.1: 32-34.

BirdLife International, 2004. Birds in Europe: Population Estimates, trends and Conservation Status. BirdLife International. Cambridge.

Centralny Ośrodek Badań Odmian Roślin Uprawnych – COBORU, 2011.

Czarnecka J., Czarnecka B., 2006. Glebowy bank nasion rzadkich gatunków murawowych i segetalnych: solidne zabezpieczenia czy zawiedzione nadzieje? Ogólnopolska konferencja i warsztaty „Rzadkie, ginące i reliktowe gatunki roślin i grzybów. Problemy zagrożenia i ochrony różnorodności flory. Kraków.

Dajdok Z., Wuczyński A., 2008. Alien plants in field margins and fields of southwestern Poland. Biodiv. Res. Conserv. 9-10: 19-33.

Dostatny D., 1998-2000. Różnorodność gatunkowa chwastów polnych Nadnidziańskiego Parku Krajobrazowego, jej uwarunkowania i ochrona. Grant promotorski nr. 6 P04F 029 15.

Dostatny D.F., 2004. Preservation of weeds diversity in protected areas. Bulletin of Botanical Gardens, 13: 79-83.

Dostatny D.F., Małuszyńska E., 2007. Skład gatunkowy chwastów podczas wegetacji i w materiale ze zbioru w uprawach ekologicznych i konwencjonalnych. Pam.Puł. 145: 1-17.

FAO, 1996. The state of food and agriculture. Roma

Kornaś J., 1977. Zespoły synantropijne. (w:) Szata roślinna Polski (red. W. Szafer i K. Zarzycki), wyd. III Warszawa. s. 442- 462.

Kulpa W., Tabisz H., 1963. Zanieczyszczenie nasion koniczyny czerwonej w województwie lubelskim. Biul. IHAR 52 (1): 149-156.

Kulpa W., 1974. Nasionoznawstwo chwastów. Wyd. II, PWRiL, Warszawa.

Marshall E.J.P., Brown V.K., Boatman N.D., Lutman P.J.W., Squire G.R., Ward L.K., 2003. The role of weeds in supporting biological diversity within crop fields. Weed Res. 43: 77-89.

Wuczyński A., Kujawa K., Dajdok Z., Grzesiak W, 2011. Species richness and composition of bird communities in various filed margins of Poland. Agric. Ecos. Env. 141: 202-209.

RURAL AND REGIONAL POLICIES FOR RURAL DEVELOPMENT - A STRATEGIC APPROACH IN POLISH CONDITIONS

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Abstract

Rural and regional policies towards rural areas have been a subject of evaluation and discussions of results. As a consequence some changes have been taken place, even in fundamental assumptions, which determine strategic decisions in the field of public support for rural development. The aim of the paper is to identify similarities and differences in a strategic approach of rural and regional policies towards rural development in Poland basing on a document analysis of the National Strategy of Regional Development 2010-2020: Regions, Cities, Rural Areas and the Strategy for sustainable development of rural areas, agriculture and fisheries 2012-2020. Results of investigations display that both documents setting up strategic objectives for rural development in Poland have a lot in common with new paradigms of rural and regional policies described in OECD works. Both strategies tend towards multifunctional approach enhancing competitiveness of rural areas and assuming engagement of stakeholders of different levels. At this point it is not possible to asses to what extent instruments of the two discussed policies will close to the new approach. It results from a situation when construction of implementation mechanisms is highly influenced by solutions introduced by European cohesion and agricultural policies.

Keywords: agricultural policy, regional policy, rural development, strategy, Poland

1. Introduction

After the accession to the European Union rural development in Poland has been addressed especially by two policies: rural development policy (as the second pillar of the Common Agricultural Policy) and regional policy (which programmed at the European level is conducted as cohesion policy). Both of these policies have been undergoing transformations since the beginning of the Polish participation in their programming and implementation. There have been different sources of changes. Some of them have been results of evaluations performed at different levels, for instance European, national, regional or have been consequences of evaluations from a perspective of particular sectors (conclusions from agricultural policy implementation are one of the most important in this case). Deliberations on a shape of both regional and agricultural policies have been leading even to fundamental changes in strategic approaches of these policies.

The European perspective is not the only one important for development of strategies towards rural areas in Poland. The National Strategy of Regional Development 2010-2020: Regions, Cities, Rural Areas (NSRD) elaborated in the Ministry of Regional Development as well as the Strategy for sustainable development of rural areas, agriculture and fisheries 2012-2020 elaborated in the Ministry of Agriculture and Rural Development are parts of the new national development management system. The foundation of this system is required by the amended law of 6 December 2006 on the principles of development policy (Polish Journal of Laws of 2009 No 84, item 712, as amended) and by the document on Poland's Development Management System, adopted by the Council of Ministers on 27 April 2009. This holistic approach to the national development management system was established in order to organize the Polish development policy. The two above mentioned strategies with the most territorial significance for rural areas are parts of a group of nine integrated strategies accompanied by the Long-Term National Development Strategy and Medium-Term National Development Strategy.

At least these two dimensions, European and national, have influenced setting up strategic objectives of policy towards rural areas in Poland. When one type of territory, in that case rural areas, are addressed by two policies coordinated by two different institutions it seems to be fundamental to identify similarities and differences at least in a strategic approaches of these policies.

2. Material and methods

The aim of the paper is to identify similarities and differences in a strategic approach of rural and regional policies towards rural development in Poland. There were used the following sources of information in the research:

- publications in the area of rural development by Organisation for Economic Co-operation and Development (OECD),
- basic strategies for rural development in Poland till 2020: the National Strategy of Regional Development 2010-2020: Regions, Cities, Rural Areas (NSRD) elaborated in the Ministry of Regional Development and the Strategy for sustainable development of rural areas, agriculture and fisheries 2012-2020 elaborated in the Ministry of Agriculture and Rural Development.

To investigate similarities and differences in a strategic approach of rural and regional policies towards rural development document analysis was performed.

3. Paradigms of regional and rural policies

Wide discussions on fundamentals of both regional and rural policies have been taking place on a forum of countries gathered in the OECD. The results of analyses accompanying exchange of different points of view were presented in many publications. In the case of rural policy it is stressed that its challenge is to transform policy frameworks for rural regions, which have hitherto emphasized sectoral approaches, into policies and programs adapted to different economic development trajectories (OECD, 2006). It was expressed in so called the new rural paradigm. Evaluations and discussions on foundations of regional policy also have resulted in formulation of its new paradigm. A comparison of these two new approaches is presented in the table 1.

Table 1. The new rural and regional paradigms

Specification	New rural paradigm	New regional paradigm
Objectives	Competitiveness of rural areas, valorisation of local assets, exploitation of unused resources	Tapping under-utilised potential for enhancing regional competitiveness
Key target sector	Various sectors of rural economies (ex. rural tourism, manufacturing, ICT industry, etc.)	Integrated development projects
Main tool	Investments	Mix of soft and hard capital investment
Key actors	All levels of government (supranational, national, regional and local), various local stakeholders (public, private, NGOs)	Different levels of government; private sector and civil society

Source: own elaboration on: The new rural paradigm: policies and governance. OECD Rural policy reviews. OECD Publishing, 2006, p. 15; OECD Territorial Reviews. Sweden. OECD Publishing 2010, p. 90.

Both policies seem to head in the same directions. They stress competitiveness of whole territories in spite of equalisation and farm income (rural policy) and compensating temporarily for locational disadvantages (regional policy). They have switched from the sectoral to comprehensive approach with use of integrated instruments. Also both new rural and agricultural paradigm assume engagement of different actors (stakeholders) in programming and implementation in spite of the old centralised approach. This theoretical analysis of similarities would suggest that in fact these two policies should have much in common. However, a question always stays about a real process of programming and realization.

4. Strategies for rural development in Poland till 2020

The National Strategy of Regional Development 2010-2020: Regions, Cities, Rural Areas directly refers to the paradigm of regional policy described primarily by the OECD. It assumes support for rural areas especially within the following objectives:

1) Support for the growth of competitiveness of regions ("competitiveness") for instance through increasing employment opportunities through increased professional and spatial mobility:
   – ensuring effective transport infrastructure and improving public transport,
   – support for the development of poviat towns and other towns,
   – creating institutional conditions for increasing non-agricultural investments,
   – stimulating the local development.
2) Building territorial cohesion and preventing the marginalization of problem areas ("cohesion"):
   – support to rural areas with the lowest level of inhabitants access to the goods and services following from the development possibilities (education and training services, medical services, communication services, municipal and environmental protection services, cultural services),
   – overcoming the difficulties related to the situation of the border areas, especially along the external EU borders,
   – increasing transport accessibility to voivodeship centres situated within the areas with the lowest accessibility.

Five objectives of the Strategy for sustainable development of rural areas, agriculture and fisheries 2012-2020 cover a wide range of topics:

1) Increase of the quality of human and social potential, employment and entrepreneurship in rural areas;
2) Improvement of life standard on rural areas and improvement of their spatial accessibility;
3) Food security;
4) Increase of productivity and competitiveness of agri-food sector;
5) Environmental protection and adaptation to climatic changes in rural areas.

It proves that policy makers thought here not only about agriculture as a traditional sector of operations on rural areas but they could see also non-agricultural role of these territories. However, taking into account the field of activities of the institution responsible for this Strategy it could appear that the sectoral agricultural dimension is strong there. A process of programming in the case of this strategy involved external experts as well as actors of different levels (regional and local authorities, representatives of Local Action Groups, etc.). Mechanisms of the Strategy's coordination assume a close cooperation with entities responsible for realization of regional and local development strategies. Taking into consideration the above mentioned facts referring to the Strategy for sustainable development of rural areas, agriculture and fisheries 2012-2020, it could be concluded that it is also close to the new rural paradigm described by OECD.

5. European dimensions of the Polish strategic approach to rural areas

Taking into account that a considerable part of financial resources supporting rural areas comes from the European Union, it is reasonable to construct such strategies which are consisted with the EU approach to development policy in case of rural areas. Two analysed documents refers to this fact directly.

The NSRD is binding until 2020. This time horizon assume gradual implementation of many proposed instruments of institutional and legal character and it should simultaneously ensure their application in the programming of activities co-financed within the framework of the next European Union financial perspective covering the 2014–2020 period.

Five objectives of the Strategy for sustainable development of rural areas, agriculture and fisheries 2012-2020 were defined with reference to the European Strategy “Europe 2020”. It is clearly stated that the Strategy’s budget is going to be financed in nearly 48% from the EU funds, and thus the accessibility and allocation of measures from cohesion policy and Common Agricultural Policy shall have a big impact on the level of achievement of the Strategy’s objectives.

The relations between rural and regional policies are also strengthened at the EU level, for example by proposal of the regulation of the European Parliament and of the Council laying down common provisions on the European Regional Development Fund, the European Social Fund, the Cohesion Fund, the European Agricultural Fund for Rural Development and the European Maritime and Fisheries Fund covered by the Common Strategic Framework and laying down general provisions on the European Regional Development Fund, the European Social Fund and the Cohesion Fund and repealing Regulation (EC) No 1083/2006. Without detailed knowledge about specific solutions proposed there and in proposals concerning particular funds it is difficult to assess their impact on strategic planning of rural development in Poland. However, it seems that for example specially designed tools, like community-led local development or integrated territorial investments, will influence on implementation of objectives of both considered strategies.

6. Conclusions

Results of document analysis performed for the National Strategy of Regional Development 2010-2020: Regions, Cities, Rural Areas (NSRD) and the Strategy for sustainable development of rural areas, agriculture and fisheries 2012-2020 indicate that there is a general common strategic approach for rural development. Objectives set in both strategies, processes of their elaboration as well as coordination mechanisms seem to be coherent with new approaches to rural and regional development postulated in OECD works. However, it is not obvious if the implementation of the strategies allow to lead this way in reality. It is not possible to asses to what extent instruments of the two discussed policies will close to the new approach because they are still a subject of works for detailed solutions at the European level in agricultural and cohesion policy.

7. References

Ministerstwo Rolnictwa i Rozwoju Wsi, 2012: Strategia zrównoważonego rozwoju wsi, rolnictwa i rybactwa na lata 2012-2020, Warszawa.

Ministerstwo Rozwoju Regionalnego, 2010: Krajowa Strategia Rozwoju Regionalnego 2010-2020: Regiony, Miasta, Obszary Wiejskie. Warszawa

Ministerstwo Rozwoju Regionalnego, 2009: Założenia systemu zarządzania rozwojem Polski, Warszawa.

OECD, 2006: The new rural paradigm: policies and governance. OECD Rural policy reviews. OECD Publishing, 15.

OECD Territorial Reviews. Sweden. OECD Publishing 2010, 90.

Proposal of the regulation of the European Parliament and of the Council laying down common provisions on the European Regional Development Fund, the European Social Fund, the Cohesion Fund, the European Agricultural Fund for Rural Development and the European Maritime and Fisheries Fund covered by the Common Strategic Framework and laying down general provisions on the European Regional Development Fund, the European Social Fund and the Cohesion Fund and repealing Regulation (EC) No 1083/2006.

Ustawia z dnia 6 grudnia 2006 r. o zasadach prowadzenia polityki rozwoju (Dz. U. z 2009 r. Nr 84, poz. 712, z późn. zm.).

SOURCES OF FINANCE FOR MICRO, SMALL AND MEDIUM ENTERPRISES IN NIGERIA

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Abstract

Initial attempts of developed and developing countries to eradicate poverty focused on the development of large scale industries, based on the traditional economy of scale theory. However, the economic downturn that followed the collapse of the world oil market in 1980s and the financial crisis in Asia in the 1990s brought to fore the important role of Micro, Small and Medium Enterprises (MSMEs) in industrial and economic development in any given country. It has been recognized that among the constraints to effective development of MSMEs in Nigeria is the limited access of the investors to long term credit. Various credit initiatives have been instituted in the past to improve the access of MSMEs to long term funds. Analysis carried out in this study showed that commercial banks loans constituted over 90 percent of sources of funds to MSMEs in Nigeria and their loans and advances to agriculture and manufacturing sectors combined(where the MSMEs are dominant) grew from ₦83.40million in 1970 to ₦1,129,158.30 million in 2009 and averaged ₦149,106.08 million per annum thereby constituting 17.81% of total commercial banks loans and advances to the Nigerian economy on the average between 1970 and 2009, whereas the MSMEs currently contribute about 50% to the nation's Gross Domestic Product. Furthermore, the survey results indicated that MSME operators still do not have enough funds for their operations as a frequency analysis indicated that inadequate fund/working capital was the most mentioned problem with a percentage share of 60.7%. In view of the assured role of MSMEs in economic development and poverty alleviation, it is recommended that all the funding apparatus directed at the MSMEs in Nigeria, be sustained and intensified.

Keywords: micro, small and medium enterprises, financing, economic development

1. Introduction

1.1. Definition and concept of micro, small and medium enterprises

Enterprises may be classified by size, sector, organisation, technology and location. From the perspective of policy and planning, size provides the most practical basis for classification. The usual criteria include one or more of the following; employment, turnover, assets, and paid-up capital (SMEDAN, 2007). However, definitions vary from country to country relative to the overall size and structure of the domestic economy.

In countries such as the USA, Britain, and Canada, small-scale business is defined in terms of annual turnover and the number of paid employees. In Britain for instance, small-scale business is defined as that industry with an annual turnover of 2 million pounds or less with fewer than 200 paid employees.

According to the European Commission (EC) Small enterprises are defined as those employing less than 50 persons and with annual sales or total assets that do not exceed $13 million, while, micro enterprises are defined as those which employ fewer than 10 persons and with annual sales or total assets that do not exceed $3 million.

Meanwhile Asia Pacific Economic Cooperation (APEC) defines micro, small and medium enterprises (MSMEs) as enterprises with less than 100 people, whereby, a medium sized enterprise employs between 20 and 99 people, a small firm employs between 5 and 19, and a micro firm employs less than 5 employees which include self employed managers.

In Japan, small-scale industry is defined according to the type of industry, paid-up capital and number of paid employees. Consequently, small and medium-scale enterprises are defined as: those in manufacturing with 100 million yen paid-up capital and 300 employees, those in wholesale trade with 30 million yen paid-up capital and 100 employees, and those in the retail and service trades with 10 million yen paid-up capital and 50 employees (Elijah and Nsikak, 2011).

In Nigeria, before the launch of the National Policy on MSMEs in Nigeria in 2007, various institutions have adopted varying definitions according to their perception of the concept. For the purpose of a coherent national policy, the standard definition in order to provide a common object of reference by stakeholders in Nigeria today as contained in the National Policy on MSMEs in Nigeria (SMEDAN, 2007), is adopted in this paper as shown in Table 1. The National Policy document states that, where there exist a conflict in classification between employment and assets criteria (for example, if an enterprise has assets worth seven million naira (₦7m) but employs 7 persons), the employment-based classification will take precedence and the enterprise would be regarded as micro. This is because employment-based classification tends to be relatively more stable definition, given that inflationary pressures may compromise the asset-based definition.

Table 1. Classification of MSMEs in Nigeria

Size Category	Employment	Assets (₦ million) (excluding land and buildings)
Micro enterprises	Less than 10	Less than 5
Small enterprises	10 -49	5 less than 50
Medium enterprises	50 -199	50 – less than 500

Source: Small and Medium Enterprises Development Agency of Nigeria (SMEDAN), Abuja, 2007

1.2. Problem statement

The importance of micro, small and medium scale enterprises cannot be overemphasised. They are known to adapt with greater ease under difficult and changing circumstances because they are typically low in capital intensity and allow product lines and inputs to be changed at relatively low cost. They also retain a competitive advantage over large enterprises by serving dispersed local markets and produce various goods with low scale economies for niche markets (Olorunshola, 2003). In furtherance of this, MSMEs in Nigeria have expanded following the adoption of the Structural Adjustment Programme (SAP) to fill the supply gap in industrial consumer goods created by the difficulties faced by large scale firms which could not easily adapt to the policy changes of SAP (Adebusuyi, 1997). Similarly, in Indonesia their contribution to the country's Gross National Product (GNP) grew during the period of the monetary crisis as opposed to that of large scale enterprises which were more affected by the crisis (Timberg, 2000).

In both developed and developing economies, there are evidences of the immense contributions of MSMEs (WBCSD, 2004). In Indonesia, SMEs account for 98% of her enterprises and over 60% of her GNP (Timberg, 2000). Not all these MSMEs are in the formal sector; some occupy the unofficial labour market, which varies in size from an estimated 4-6% in developed countries to over 50% in developing nations (WBCSD, 2004). By global standards large enterprises are very few in Nigeria. Peasant agriculture predominates, accounting for about 95% of total agricultural output in Nigeria and employment in the sector (Central Bank of Nigeria (CBN), Research Dept., 2000), while the agricultural sector has been the mainstay of the Nigerian economy and currently accounts for 40.9% of the country's GDP (CBN, 2010). It is also estimated that non-farm MS-MEs account for over 25% of total employment and 20% of GDP in Nigeria (SMEDAN, 2007). Empirical evidence shows that MSMEs dominate the industrial sector in Nigeria, accounting for about 70% of industrial employment and 10 – 15% of manufacturing output (CBN, 2000). Available information confirms that informal manufacturing enterprises are dominated by small-size operators in the country, in terms of number of people employed with percentage distribution ranging between 92 and 98 across activity sectors. Furthermore, the contribution of the entire informal sector (agricultural sector inclusive) to the GDP was put at 38.7% (CBN/FOS/NISER, 2001). They have been very prominent in the manufacture of bakery products, leather products, furniture, textiles and products required for the construction industry.

It has been recognized that among the constraints to effective development of MSMEs in Nigeria is the limited access of the investors to long term credit and the general non availability of comprehensive information which can guide potential investors and hence reduce the cost of pre-investment information gathering which may be very high and prohibitive (Inang and Ukpong 1993, Essien 2001, Owualah, S. I. 2002, Anyanwu, Adebusuyi and Okafor 2003, Ogujiuba, Ohuche and Adenuga 2004, Akinyosoye 2006, Adelaja, 2007, Adamu, 2009).

While financing is obviously not the only problem militating against the MSME sector, it is certainly the most formidable. Like any other investment in the real sector of the economy (where the MSMEs are dominant), investment in MSMEs is relatively bulky because of the need for fixed assets such as land, civil works, buildings, machinery and equipment and movable assets. Moreover, empirical studies (Udechukwu, 2003; NISER, 2005), show that the incidence of the extra outlays required to compensate for deficiencies in the supply of basic utilities in Nigeria, is relatively heavier on MSMEs than large enterprises. While such extra investments have been shown to account for about 10% of the cost of machinery and equipment of large enterprises, they represent about 20 to 30% of that of MSMEs because of the absence of economies of scale. Similarly, The World Bank in its 1989 report notes that finance is the key to investment and hence to growth (World Bank, 1989).

Various funding initiatives have been instituted in the past to improve the access of MSMEs to long term funds in order to improve their performance and contribution to the economy. Funding consists of the financial resources required to transform the ideas of an entrepreneur into a viable project. It can take the form of loans, equity capital, venture capital, working capital or any other form (Raji, 2000). The main objective of this paper is to determine if access to credit by MSMEs in Nigeria has improved over the years with the introduction of various finance initiatives with specific focus on those in the agricultural and manufacturing sub-sectors where MSMEs are dominant in the country.

1.3. Data and methodology

Both secondary and primary data were used for the study. Secondary data were sourced from the Central Bank of Nigeria on the disbursements of funds to MSMEs by commercial banks, development finance institutions and under the various funding schemes over the years. With the aid of a structured questionnaire, primary data were sourced from MSMEs in five of the six geopolitical zones of the country where the SMEEIS funds were disbursed being the most recent finance initiative in the country. From inception in 2001 to March 2009 when the participation in SMEEIS was made optional to banks, a total of 333 projects were financed in 24 states and the Federal Capital Territory. Thus, a purposive random sampling technique was used to draw a sample of 100 for the study. The questionnaire was used to gather information on the socio-economic characteristics of MSME operators, firm characteristics, financing and operations of the MSMEs as well as their constraints.

A combination of analytical tools was employed in order to achieve the objective of the study. These include descriptive statistics (measures of central tendency and dispersion, proportional analysis, growth rate and trends, and frequency distribution) and analysis of variance.

2. Government funding schemes for micro, small and medium enterprises in Nigeria

A brief review of both the old and new funding initiatives for MSMEs in Nigeria is presented below (see CBN Briefs, 1992 to 2006 for details).

- **The Nigerian Industrial Development Bank (NIDB).** The NIDB was established in 1964 and charged with the function of harnessing local and foreign skills and local and foreign private capital in the development of new industries and the expansion of existing ones.
- **Small-Scale Industries Credit Scheme (SSICS).** The small-scale industries credit scheme was introduced in 1971 as a revolving grant by the federal and state governments to assist in meeting the credit needs of small-scale enterprises on liberal terms.
- **Promotion of small-Scale Enterprises.** The CBN, from 1970, was instrumental in promoting wholly-owned Nigerian enterprises. In its then Policy Guidelines, the Bank directed that with effect from April 30, 1970; credit to indigenous borrowers was to be at least 35% of commercial and merchant banks' total loans and advances. The proportion of loans to indigenous borrowers was raised in subsequent years with special emphasis on small-scale enterprises.
- **Promotion of Agricultural and Manufacturing Activities.** Through its Monetary Policy Circulars (before its abrogation in 1996), the CBN prescribed that not less than 15% of commercial and 10% of merchant banks' credit be granted to agricultural activities. The banks were also to allow grace periods on agricultural loans: one year for small-scale peasant farming, four years for cash crop farming, five years for medium and large-scale mechanized farming and seven years for ranching. To promote manufacturing activities, the Bank stipulated in its guidelines that not less than 35% of commercial and 40% of merchant banks' credit be granted to manufacturing enterprises.
- **Promotion of Rural Banking.** To encourage banking habit nationwide and channel funds into rural development, the CBN introduced the Rural Banking Scheme in June 1977 in three phases-1977-1980, 1980-1985 and 1st August, 1985 through 31st July, 1989. As at end-June 1992, 765 of the 766 branches stipulated by the CBN had been opened. Also, the CBN stipulated that not less than 50% of the deposits mobilized from the rural areas be advanced as credit to rural borrowers to solve the problem of inadequacy of credit to rural based small-scale industries.
- **The Nigerian Agricultural and Co-operative Bank (NACB).** The NACB was established in 1972 to assist in financing viable agricultural projects and thus enhance the level and quality of agricultural production.
- **The Nigerian Bank for Commerce and Industry (NBCI).** It was established by Decree 22 of May, 1973 and charged with the function of providing equity capital funds by way of loans to small and medium scale industries

- **The Agricultural Credit Guarantee Scheme Fund (ACGSF).** The Agricultural Credit Guarantee Scheme Fund (ACGSF) was established in 1977 and it took off in April, 1978 under the management of the CBN, while a Board of Directors was constituted for policy making. The scheme was designed to encourage banks to increase lending to the agricultural sector by providing some form of guarantee against risks inherent in agricultural lending. In case of default, the lending banks is expected to exhaust all legal means of loans recovery, including realisation of any security pledged for loan, before the ACGSF pays 75% of guaranteed loans in default.
- **The National Economic Reconstruction Fund (NERFUND).** NERFUND was set up by Decree No. 25 of 1988 as a funding mechanism aimed at bridging the gap in the provision of local and foreign funds to small and medium scale enterprises. The federal government set it up to provide relatively long-term loans (5-10 years) to small and medium scale enterprises at relatively concessionary rates of interest.
- **People's Bank of Nigeria.** The People's Bank of Nigeria (PBN) was established by the Federal Government in 1988 with an initial take-off grant of ₦30 million to meet the credit needs of small borrowers who cannot satisfy the stringent collateral requirements normally demanded by conventional banks. The bank was designed to cater for the credit needs of informal sector operators such as artisans and petty traders's in both the urban and rural areas and thereby increase their self-reliance.
- **Community Banks (CBs).** These were established in 1990 with the objectives of providing effective financial services for the rural areas as well as micro-enterprises in the urban centres. Community banks in Nigeria were self-sustaining financial institutions owned and managed by local communities such as community development associations, town unions, cooperative society's, farmers' groups, social clubs, etc to provide financial services to the respective communities.
- **The Small and Medium-Scale Enterprises (SME) Apex Unit Loan Scheme.** In order to increase access to credit by the SMEs, the CBN and the Federal Ministry of Finance, on behalf of the Federal Government, obtained a World Bank Loan for SMEs. The total project cost was US$451.8 million, of which the World Bank provided US$270 million or 64%. The CBN established an SME Apex Unit in the Bank in 1990 to administer the credit components and other related activities of the World Bank loan in order to facilitate project implementation. Loans disbursement under the Scheme ceased in 1996.
- **Nigerian Export-Import Bank (NEXIM).** The Nigerian Export Import Bank (NEXIM) was established by Decree 38 of 1991 to manage a number of credit facilities introduced specifically to boost Nigeria's non-oil export sector. The bank commenced operations on 2nd January, 1991 with facilities in the following areas: trade finance, project finance, treasury operations, export advisory service, and market information.
- **The Nigerian Agricultural, Cooperative, and Rural Development Bank (NACRDB), now Bank of Agriculture (BOA).** The bank was set up in October 2000 as an amalgam of the old Peoples Bank of Nigeria (PBN), Nigerian Agricultural and Cooperative Bank (NACB) and Family Economic Advancement Programme (FEAP). It is jointly owned by the Federal Ministry of Finance Incorporated (MOFI) and the Central Bank of Nigeria (CBN) with a shareholding ratio of 60 and 40% respectively. The primary aim is to finance agriculture as well as small and medium enterprises. While micro credit facilities account for 70%, the balance of 30% is for macro-credit facilities.

- **The Bank of Industry (BOI).** This is also an amalgam of the former Nigerian Industrial Development Bank (NIDB), the Nigerian Bank for Commerce and Industry (NBCI) and the National Economic Reconstruction Fund (NERFUND). It was set up in 2000 principally to provide credit to the industrial sector. The mandate of the BOI include providing financial assistance for the establishment of large, medium, and small projects; as well as expansion, diversification and modernization of existing enterprises; and rehabilitation of ailing industries. The percentage of its annual lending to MSMEs increased to 96% by December 2010 from 35% in 2005 (Bank of Industry, 2011).
- **Small and Medium Enterprises Equity Investment Scheme (SMEEIS).** Bothered by the persistent decline in the performance of the Industrial sector and with the realization of the fact that the small and medium scale industries hold the key to the revival of the manufacturing sector and the economy, the Banker's Committee in 1999, initiated the Small and Medium Industries Equity Investment Scheme (SMIEIS) aimed at ensuring assistance to small-scale industries. Under this new scheme, banks are required to set aside 10.0% of their profit before tax for investment in small-scale industries in the country. A bank's investment in the scheme is conceived to be in the form of equity participation, project packaging/monitoring, advisory services and nurturing of specific industries to maturity. The SMIEIS was named Small and Medium Equity Investment Scheme (SMEEIS) in March 2005, to broaden the scope of activities that can be funded under it.

3. Examination of trend in institutional financing of MSMEs in Nigeria

3.1. Commercial banks

The financial system plays a fundamental role in the growth and development of an economy, particularly by serving as the fulcrum for financial intermediation between the surplus and deficit units in the economy. For many years, theoretical discussions about the importance of credit development and the role that financial intermediaries play in economic growth have occupied a key position in the literature of developmental finance. Shaw (1973), stated that financial or credit development can foster economic growth by raising savings, improving efficiency of loan-able funds and promoting capital accumulation.

Table 1. Commercial Banks Selected Performance Indicators (Averages, 1970-2009, in Million Naira)

Total Credit to the Economy(A)	Demand Deposits	Time, Savings and Foreign Currency Deposits(B)	Total Deposit Liabilities (C)	B as a proportion of C	A as a proportion of C
836,995.45	382,923.58	499,172.44	882,096.02	56.59%	94.89%

Source: Data Analysis

Table 1, indicates that between 1970 and 2009 total deposit liabilities of the deposit money banks in Nigeria averaged ₦882.1 billion, while total credit to the Nigerian economy averaged ₦837.0 billion. This means that banks gave out 94.9% of the total deposits mobilized as credit for productive activities in the Nigerian economy in the period under review on the average. However, the table also reveals that demand deposits constituted almost half of the banks' total deposit liabilities from which loans were granted to the economy as time deposits constituted 56.6% of total deposit liabilities, and these have implications for tenure of these loans. Further analysis of commercial banks loans and advances revealed that credit to agriculture and manufacturing sectors combined grew from ₦83.40 million in 1970 to ₦1,129,158.30 million in 2009 and averaged ₦149,106.08 million per annum.

Table 2. Commercial Banks Loans and Advances to Agriculture and Manufacturing as Proportion of Loans to the Economy

Year	Average loans & Advances to Agric. & Manufacturing(A)	Average Total Loans to the Economy(B)	A as a Proportion of B
1970-2009	₦149,106.08 mil	₦836,995.45 mil	17.81%

Source: Data Analysis

Similarly, total commercial banks loans and advances to the whole economy grew from ₦351.5 million in 1970 to ₦9, 667,876.70 million in 2009, averaging ₦836,995.45 million per annum. Consequently, commercial banks loans and advances to agriculture and manufacturing constituted 17.81% of total commercial banks loans and advances to the Nigerian economy on the average between 1970 and 2009 (Table 2).

3.2. Other institutional loans/funds granted to MSMEs in Nigeria

An attempt is made to analyze the fund that has been targeted at MSMEs in Nigeria by the two development finance institutions (BOI and BOA) and the two special fund and scheme (ACGSF and SMEEIS) reviewed above.

Table 3. Summary Statistics of the Other Institutional Loans/Funds Granted to MSMEs in Nigeria (1978 -2009)

	ACGSF (₦ ‘M)	BOI (₦ ‘M)	BOA (₦ ‘M)	SMEEIS (₦ ‘M)
Maximum	8,328.566	17,798.4	6,104.2	7054.1
Mean	1,069.073	2,372.6	931.695	3525.51
Minimum	12.839	16.5	6.7	99.3
Total	34,210.333	66,432.96	23,292.39	28204.1
S. D.	2,046.504	4,688.376	1,530.163	2215.75
C.V.	1.914	1.976	1.642	0.628
No. of Years	32	28	25	8

Source: Data Analysis

A descriptive analysis of other institutional loans/funds granted to MSMEs in Nigeria is as shown in Table 3, while Table 4 shows the analysis of variance to test the difference among the mean values of the annual value of loans given to the MSMEs by the various institutions. Results indicate that there is clearly a significant difference among the mean values of loans disbursed at 5 and 1% levels of significance, as the calculated F-value is higher than the critical value at 3 degrees of freedom.

Table 4. Analysis of Variance

ANOVA						
Source of Variation	SS	Df	MS	F	P-value	F crit
Between Groups	2.39023E+13	3	7.96744E+12	5.461596987	0.00171506	2.706998797
Within Groups	1.29834E+14	89	1.45881E+12			
Total	1.53737E+14	92				

Source: Data Analysis

The Small and Medium Enterprises Equity Investment Scheme (SMEEIS) has the highest mean annual value of funds granted to SMEs which averaged, ₦3, 525.51 million per annum followed by the Bank of Industry (BOI) which gave an average of ₦2, 372.6 million per annum. Under the Agricultural Credit Guarantee Scheme Fund (ACGSF), an average of ₦1,069.07 million was granted per annum while the Bank of Agriculture (BOA) recorded the lowest mean annual value of loans disbursed, ₦931.69 million. The major reason that might be responsible for the huge volume of funds by the SMEEIS is that it was an initiative of the Bankers' Committee and so they were committed to it and backed it by their financial strength, commercial banks being the custodian of most of the deposits in the Nigerian economy. On the other hand, the BOA has suffered policy interventions and inconsistencies which have affected its viability and ability to achieve self-sustainability over the years hence it offered the least volume of funds to the MSMEs in the period under consideration (CBN./World Bank, 1999; Evbuomwan, 2002; Akinyosoye, 2005; CBN, 2006). In terms of variability, grants from the SMEEIS were much less dispersed around the average compared with those of the other three. This is an indication of the fact that in some years the grants were very high while in some others they were very low in the three others that showed high coefficient of variation (CV). This further confirms the fact that the capital bases of the various specialized financial institutions established by the government were seriously eroded and thus prompted their restructuring and merger in the late 1990s. Unfortunately, the situation seem not to have abated as even in 2006 the CBN reported in its Annual Report and Statement of Accounts that, 'an analysis of the asset portfolio of the DFIs indicated a general deterioration in quality………a far cry from what is required for these institutions to play their expected role of financing development projects in the economy.' It will be recalled that it was also the failure of the past financing initiatives to purvey enough funds to the MSMEs that prompted the evolution of the SMEEIS which provided substantial funding for SMEs from 2001 before it was suspended in the third quarter of 2008. An assessment of the funds disbursed under the SMEEIS now follows.

3.3 Disbursement under the Small and Medium Enterprises Equity Investment Scheme

From inception in 2001 to end December 2008, the cumulative sum set aside by banks under the SMEEIS was ₦42.0 billion. The sum of ₦28.2 billion or 67.1% of the sum was invested in 333 projects, out of which the real sector accounted for 205 projects, and the service-related sector, excluding trading, accounted for 128 projects (CBN, 2008). Table 5, indicates that 45 projects were funded under agro-allied (including wood work and water bottling), to the tune of

₦2.3 billion, and this represented 13.5% of the total number of projects financed and 8.2% of total amount invested by banks in SMEs from 2001 to 2009. In the manufacturing (including printing & publishing) sector, 144 projects were funded to the tune of ₦8.1 billion, which represented 43.2% of the total number of projects financed and 28.7% of the total amount invested by all the banks under SMEEIS. In total 189 projects were funded under SMEEIS in the agricultural and manufacturing sector to the tune of ₦10.4 billion, representing 56.8% of the total number of projects financed and 36.9% of total amount invested during the period under review. In proportional terms, this 36.9% of total amount invested in the agricultural and manufacturing sector under SMEEIS compares favourably with the 17.8% of total credit which was given to the agricultural and manufacturing sector by all the commercial banks between 1970 and 2009 (refer to Table 2). An analysis of the geographical distribution of SMEEIS investments revealed that Lagos State got the highest number and amount. Banks funded 187 projects in Lagos to the tune of ₦11.6 billion, which represented 56.2% of the total number of projects funded and 41.3% of total amount invested. This is not unconnected with the fact that most of the banks' headquarters are in Lagos where the officers in charge of the SMEEIS were domiciled.

Table 5. Sectoral Distribution of SMEEIS Investments

A. Real Sector/Enterprise	Investment as at March, 2009			
	No. of Projects	Amount (₦)	Number %	Amount %
Agro-allied (including wood work and water bottling)	45	2,311,975,707	13.51	8.20
Manufacturing (inclu-ding printing and publishing)	144	8,103,773,769	43.24	28.73
Construction (including quarrying)	13	2,786,287,000	3.90	9.88
Solid Minerals	3	59,440,000	0.90	0.21
Sub- Total	205	13,261,476,476	61.56	47.02
B. Service- related Sector				
Information Technology and Telecommunications	24	1,821,809,249	7.21	6.46
Educational Establishment	7	897,935,000	2.10	3.18
Services	74	4,768,855,719	22.22	16.91
Tourism & Leisure	23	7,454,001,847	6.91	26.43
Sub-Total	128	14,942,601,815	38.44	52.98
C. Micro Enterprises Sector	0	0	-	-
Grand Total	333	28,204,078,292	100	100

Total Amount Set Aside under SMEEIS by Consolidated Banks: ₦42, 024,988,746.00

Source: Development Finance Department, Central Bank of Nigeria, Abuja

Certainly, it was cheaper and more convenient for the banks since they were required to appoint their staff as Directors on the Board of the Companies they financed. However, this skewed distribution of SMEEIS investments has negative implications as 12 out of the 36 states in Nigeria did not benefit from the SMEEIS during the period under review (Table 6).

Table 6. Geographical Distribution of SMEEIS Investments

	Investment as at March 2009				
S/N	State	No. of Projects	Amount (₦)	Number (%)	Amount (%)
1	Abuja FCT	10	1,548,335,999	3.00	5.49
2	Abia	9	728,400,000	2.70	2.58
3	Adamawa	0	-	0.00	0.00
4	Akwa-Ibom	2	118,075,000	0.60	0.42
5	Anambra	6	422,398,123	1.80	1.50
6	Bauchi	1	68,400,000	0.30	0.24
7	Bayelsa	0	-	0.00	0.00
8	Benue	3	88,420,000	0.90	0.31
9	Borno	0	-	0.00	0.00
10	Cross-River	7	6,190,341,647	2.10	21.95
11	Delta	7	247,731,000	2.10	0.88
12	Ebonyi	0	-	0.00	0.00
13	Edo	8	493,144,958	2.40	1.75
14	Ekiti	2	57,600,000	0.60	0.20
15	Enugu	2	117,994,000	0.60	0.42
16	Gombe	0	-	0.00	0.00
17	Imo	2	214,938,994	0.60	0.76
18	Jigawa	0	-	0.00	0.00
19	Kaduna	7	436,000,000	2.10	1.55
20	Kano	8	343,898,346	2.40	1.22
21	Katsina	0	-	0.00	0.00
22	Kebbi	0	-	0.00	0.00
23	Kogi	0	-	0.00	0.00
24	Kwara	5	274,004,000	1.50.	0.97
25	Lagos	187	11,634,618,774	56.16	41.25
26	Nassarawa	1	153,000,000	0.30	0.54
27	Niger	0	-	0.00	0.00
28	Ogun	26	1,923,606,250	7.81	6.82
29	Ondo	6	622,700,000	1.80	2.21
30	Oshun	1	80,000,000	0.30	0.28
31	Oyo	18	443,201,792	5.41	1.57
32	Plateau	4	194,661,228	1.20	0.69
33	Rivers	9	1,724,943,181	2.70	6.12
34	Sokoto	1	27,665,000	0.30	0.10
35	Taraba	0	-	0.00	0.00
36	Yobe	0	-	0.00	0.00
37	Zamfara	1	50,000,000	0.30	0.18
	Total	333	28,204,078,292	100	100

Source: Development Finance Department, Central Bank of Nigeria, Abuja

As stated in the SMEEIS guidelines, a minimum of 10% of the total sum set aside by banks was to be invested in Micro Enterprises, but this never happened despite the fact that as much as ₦13.8 billion or 32.9% of the total sum set aside remained un-invested as at end December, 2009. In addition, following the decision to make participation under the SMEEIS optional for banks, the balance of the total funds set aside by banks under the scheme and total sum invested remained at ₦42.02 billion and ₦28.2 billion respectively, just like in December 2008, while the cumulative number of projects was reported to be 336 (CBN, 2009). All these have negative implication for the purveyance of finance to the MSMEs. In specific terms, the access of MSMEs to funds under the SMEEIS did not improve between 2008 and 2009 because the SMEEIS had become optional for banks from the 3rd quarter of 2008. This confirms the views by previous authors that increased access of MSMEs in developing countries and Africa in particular, can only be achieved and(or) enhanced by deliberate policy (WBCSD, 2004; UNEP Finance Initiative, 2007; Adamu, 2009; and Kormawa et al, 2011).

3.4. Comparative analysis of per beneficiary loan/fund disbursement under the ACGSF and the SMEEIS

Analysis of available data indicated that the amount disbursed under SMEEIS averaged ₦83.9 million per project between 2001 and 2009, compared with an average of ₦0.053 million disbursed under the ACGSF per project from inception in 1978 to 2009. This implies that per beneficiary amount under the ACGSF is only about 0.1% of that under the SMEEIS. Thus, the SMEEIS made more money available to their beneficiaries compared with the ACGSF (Table 7).

Table 7. Average amount of loan/fund per beneficiary under ACGSF and SMEEIS

Total Value of Loans Granted under ACGSF(1978-2009)	Total Number of Beneficiaries	Average amount per beneficiary
₦34,210.35 million	642,886	₦0.053million
Cumulative Value of Investment under SMEEIS	Cumulative Number of Project Funded under SMEEIS	Average amount per beneficiary
₦28,203.10 million	336	₦83.94 million

Source: Data Analysis

3.5. Geographical analysis of per beneficiary loan/fund disbursement under the ACGSF and the SMEEIS

The geopolitical analysis of per beneficiary funding revealed that the South-South Zone came first both under the ACGSF and the SMEEIS with ₦99, 250.53 and ₦264, 413,127.4 respectively. Under the ACGSF, the North-Central Zone came last with ₦39, 748.04 while, the North-West Zone came last under the SMEEIS with ₦40, 217,431.08 (Table 8). These have implication for the level of economic activity in the zones and ultimately on poverty level. Inadequate credit or the lack of it has been cited as being responsible for MSMEs not being able to expand their operations and have therefore remained poor (Owualah, 2002; CBN/CeRAM, 2007). In the same vein, poverty indices have been reported to be highest in the Northern part of the country (CBN, Research Department, 1998; NBS, 2004). In fact, available data from the National Bureau of Statistics show that the North East zone recorded the highest poverty incidence of 54.9, 54.0 and 72.2% in 1985, 1992 and 2004 respectively, while the North West zone recorded the highest incidence of 37.7% and 77.2% in 1980 and 1996 respectively.

Table 8. Per Beneficiary loan/funds Distribution by Zone

Zone	Loan Per beneficiary under ACGSF (1978-2009)	Ranking	Fund Per beneficiary under SMEEIS (2001-2009)	Ranking
South-South	N99,250.53	1st	N264,413,127.4	1st
South-East	N77,372.49	4th	N79,449,879.42	3rd
South-West	N81,119.05	2nd	N62,234,620.6	5th
North-West	N45,452.72	5th	N40,217,431.08	6th
North-East	N77,649.36	3rd	N68,400,000.00	4th
North-Central	N39,748.04	6th	N83,843,125.75	2nd

Source: Data Analysis

The trends in geographical distribution of poverty in Nigeria seem to move in tandem with trend in geographical distribution of per beneficiary loan/fund under ACGSF and SMEEIS. Furthermore, out of the six states reported with the highest incidence of poverty in 2004 (NBS, 2004), namely Jigawa, Kebbi, Kogi, Bauchi, Yobe and Kwara, four of them namely; Jigawa, Kebbi, Kogi and Yobe did not benefit from the SMEEIS fund. Similarly, out of the six states with the lowest incidence of poverty, namely; Oyo, Osun, Imo, Bayelsa, Abia and Ogun, only one state (Bayelsa) did not benefit from the SMEEIS fund (refer to Table 6 above). This further confirms the fact that access to credit can help alleviate poverty.

3.6. Survey result

Out of the 100 questionnaires that were administered, 80 gave consistent response. This signifies a response rate of 80%. However, information supplied by the respondents were quite revealing and confirmed the findings of previous surveys by the Central Bank of Nigeria, the National Bureau of Statistics and the Nigerian Institute for Social and Economic Research on the structure of MSMEs in Nigeria (2001 and 2004).

Type of business enterprise

In line with the Central Bank of Nigeria classification of enterprises eligible for funding under the SMEEIS, the type of businesses engaged in by the respondents were analyzed. Results show that 37.7% of the respondents were engaged in the agriculture/agro-processing sector, 42.9% were in the manufacturing sector, 16.9% were in the services sector while 2.6% were in the construction sector. This sectored distribution of business enterprises confirms that MSMEs are dominant in the real sector of the Nigerian economy (80.6%).

Size of enterprise

Enterprises were classified into sizes based on the number of employees as contained in the National Policy on MSMEs (SMEDAN, 2007). The analysis revealed that more than half of the respondents (53.5%), were in the micro-enterprise category (having less than 10 workers). This was followed by those in the small-scale category (29.6%), employing 10 to 49 workers. The medium enterprise category constituted 14.1% (employing 50 to 199 workers). The least were those in the large scale category (2.8%), employing 200 workers and above. This result further validates previous studies that MSMEs dominates Nigeria's economic landscape (CBN, 2004, SMEDAN, 2007, Ojo, 2010).

Sources of fnance

Analysis of survey results indicated that 75.7% of respondents relied mostly on own funds to finance their businesses while 20.3% relied mostly on banks to finance their operations. About 2.7% of the respondents financed their operations from the share capital while 1.3% relied on suppliers'credit. This survey result confirms the copious literature on the problem of access to credit by MSMEs in Nigeria (Inang and Ukpong 1993, Essien 2001, Owualah, S. I. 2002, Anyanwu, Adebusuyi and Okafor 2003, CBN 2004, Ogujiuba, Ohuche and Adenuga 2004, Akinyosoye 2006, Adelaja, 2007, Meludu and Adekoya, 2007; Adamu, 2009).

Distribution of operating expenses and capital expenditure

Analysis of the survey data revealed that on average, raw materials constituted 61.7% of respondents operating cost, while labour cost was about 12.5%. This has implication for working capital availability. As regards capital expenditure, plant and machinery took the highest proportion (about 40%), confirming the fact that plant and machinery constitute a huge part of MSMEs investment outlay (Udechukwu, 2003). The study by Ogunrinola and Alege, 2007, further confirm that business equipment and working capital constitute major expenditure items for credit users.

Constraints limiting the performance of MSMEs in Nigeria

MSMEs in Nigeria have not performed like their counterparts in Asia, Latin America and some other African countries (Oyelaran-Oyeyinka, 2007; Ojo, 2010; Elijah and Nsikak, 2011). In order to appreciate the problems militating against their effective performance, they were asked to list them in the questionnaire administered to them. Analysis of their responses is presented in Table 9. A frequency analysis indicated that inadequate fund/working capital was the most mentioned problem with a percentage share of 60.7%. This therefore means that access to credit is still a major problem militating against the effective performance of MSMEs in Nigeria despite all the funding programmes that have been put in place all over the years.

The problem of poor power supply/inadequate infrastructure was also mentioned severally. It took a percent share of 55.7%. This also confirms that the problem of inadequate infrastructure which has been a major issue being focused since the new democratic governance started in Nigeria in 1999 is still with us. Inadequate power supply has been reported as largely responsible for low capacity utilization rates by the Manufacturers Association of Nigeria (MAN) while this together with poor road network and other infrastructure has been reported to have been responsible for high overhead cost (MAN, 2008), which ultimately reduce MSMEs operators profit margin.

Table 9. The major constraints listed by MSMEs in order of severity

Type of Constraint	Percentage share
Inadequate fund/working capital	60.7
Poor power supply/inadequate infrastructure	55.7
Unfriendly Macroeconomic Policy	26.2
High Cost of Raw Materials	21.3
Low Demand	21.3
High labour Turnover/Unskilled Labour	13.1
No Modern Equipment	8.2
Natural Disaster	4.9
Security Problems	3.3

Source: Survey Returns

Unfriendly macroeconomic policy (monetary, fiscal and external sector policies) also rated highly at 26.2%. High cost of raw materials also featured prominently at 21.3%. So was the problem of low demand due to a sluggish economy. MSMEs also complained of problem of high labour turnover/unskilled labour. This may not be unconnected with problem of poor wages as workers will always seek ‘greener pastures’. The problem of lack of modern equipment was also mentioned (8.2%) which may not be unconnected with the problem of inadequate funding which most of them complained about.

Use of SMEEIS funds

According to Frank and Bernanke (2007), credit is not an end in itself; it is a means to an end. The ultimate goal is to affect productivity. Thus, a successful economy not only saves, but also uses its savings wisely by applying these limited funds to the investment projects that seem likely to be the most productive. Consequently, this study sought to know the use(s) to which the SMEEIS funds were applied by the MSMEs. The result of the survey analysis revealed that business expansion took the greatest proportion (36.4%), followed by working capital finance (27.3%). A good number of the respondents (22.7%) used it to purchase new equipment while 9.1% of the respondents used it for debt finance. The rest of them (4.5%) used the SMEEIS fund to resuscitate their dying businesses. Similarly, the study by Ogunrinola and Alege (2007), revealed that 67% of their respondents claimed to have invested the last loan received on business equipment, while the remaining 33% maintained that theirs was spent on working capital for their business expansion. This analysis is quite instructive on the enormous potentials of the MSMEs in the Nigerian economy if their access to credit is enhanced.

Problem with SMEEIS

As stated in the SMEEIS guidelines, a minimum of 10% of the total sum set aside by banks was to be invested in Micro Enterprises, but this never happened despite the fact that as much as N13.8 billion or 32.9% of the total sum set aside remained un-invested as at end December, 2009 (CBN 2009 Annual Report and Statement of Accounts). This state of affairs is an indication that there is a problem. Thus, respondents were requested to list the problem with SMEEIS from their perspective. The major problems the respondents complained about with the SMEEIS are presented in Table 10. The MSMEs complained of too stringent requirements for the assessment of SMEEIS. This problem scored 48.1%. This is not surprising as less than fifty percent of them did not register their company as limited liability company which is a major requirement to assess the SMEEIS. This was followed by the problem of long/cumbersome processing period which scored 37%. This is a problem that had characterized the earlier funding schemes and the SMEEIS was not spared because of our peculiar environment.

Table 10. Respondents’ Problem with the SMEEIS

Type of Problem	Percentage share
Stringent Requirement	48.1
Long/Cumbersome Processing Period	37.0
Inadequate Enlightenment	14.8

Source: Analysis of Survey Returns

4. Summary and conclusions

From the result of the survey carried out the fact that MSMEs dominate the country's landscape has once again been validated and they are dominant in the real sector of the Nigerian economy (agriculture and manufacturing). This calls for need to focus on policies that will support their activities as they have been confirmed as agents of economic development. In specific terms, as stated by the World Business Council for Sustainable Development (WBCSD), 'the key to poverty alleviation is economic growth that is inclusive and reaches the majority of people. Improving the performance and sustainability of local entrepreneurs and micro, small and medium enterprises (MSMEs), which represent the backbone of global economic activity, can help achieve this type of growth' (WBCSD, 2004). In this vein, the activities of government institutions focused on MSMEs in Nigeria such as the Small and Medium Enterprises Development Agency of Nigeria (SMEDAN), as well as those in the organized private sector such as the National Association of Small Scale Industries (NASSI), Lagos Chamber of Commerce and Industry (LCCI), etc. should be encouraged, particularly now that unemployment rate and poverty index in Nigeria are on the upward trend (CBN, 2010, World Bank, 2012). Furthermore, the Action Plan and Institutional Framework for the Implementation of the National Policy on MSMEs in Nigeria (which is one of the key literature for this study) is quite comprehensive. It is recommended that it should be implemented fully to achieve the laudable goals of the Federal Government in the MSME sector.

Empirical studies have confirmed a positive relationship between volume of credit and performance of MSMEs Worldwide, it is therefore recommended that every effort should be made to improve access to credit by MSMEs so that they can play their effective roles of employment generation and wealth creation and move the nation out of poverty. In specific terms, it is recommended that the deposit money banks in Nigeria should increase the proportion of their credit portfolio to the agricultural and manufacturing sectors as these two sectors are dominated by MSMEs. Furthermore all the funding institutions, schemes and funds directed at the MSMEs in Nigeria, such as the Bank of Industry, the Bank of Agriculture, The Agricultural Credit Guarantee Scheme Fund, the Small and Medium Enterprises Credit Guarantee Scheme Fund (SMECGS) should be sustained, in order to improve the access of MSMEs to credit as it has been demonstrated that MSMEs access to funding is boosted by specific funds/schemes targeted at them. In addition, adequate attention should be paid to geographical spread in credit initiatives as the poverty indices seem to have been moving in tandem with access to credit as demonstrated by the result of the geopolitical analysis carried out in this study with the SMEEIS disbursement data and the National Bureau of Statistics data on geopolitical distribution of poverty in Nigeria. Most of the states with high poverty incidence did not access the SMEEIS, while most of those that could access the SMEEIS had low poverty indices.

The problem of inadequate power supply needs to be urgently tackled as it is really hampering the activities of the MSMEs and impoverishing Nigerians. Similarly, the problem of inadequate road network and bad roads if addressed will boost MSMEs activities in Nigeria. Finally, the Central Bank of Nigeria and the Ministry of Finance and other government agencies in charge of Nigeria's economic management process should intensify efforts to provide a conducive macroeconomic environment for MSME operations.

5. References

Adebusuyi, B.S., 1997. Performance Evaluation of Small and Medium Enterprises (SMEs) in Nigeria. Bullion Vol. 21(4). CBN.

Adelaja, Modupe, 2007. ''Microfinance as a Tool for Building and Enhancing Capacities in the Informal/SME Sectors of the Economy''. Paper presented at the Workshop Organized by Poultry Association of Nigeria, Lagos Chapter, at the Events Centre, Alausa, Lagos, Nov. 2007.

Akinyosoye, V. O., 2005. Government and Agriculture in Nigeria: Analysis of Policies, Programmes and Administration. Macmillan Nigeria Publishers Ltd., Yaba, Lagos, and Ibadan.

Akinyosoye, V. O., 2006. Plant Size and Factor Productivity in Agro-allied Industries: Implications for Nigeria's New Industrial Policy. Journal of Rural Economics and Development, Vol.15, No.2, 2006.Dept. of Agric. Economics, University of Ibadan, Nigeria.

Anyanwu C. M., Adebusuyi, B. S. and Okafor, B. O. N., 2003. The Slow Pace of Disbursement of the SMIEIS and Need for Remedial Measures. Central Bank of Nigeria Occasional Paper No.30, October, 2003.

Bankers' Committee, 2001. Small and Medium Industries Equity Investment Scheme(An Initiative of the Bankers' Committee). Guidelines for Beneficiaries. June 19, 2001.

Bank of Industry, 2011. Delivering on our Mandate. Special Edition, March, 2011.

Central Bank of Nigeria, 1992. ''Developmental Activities of the Central Bank of Nigeria''. In CBN BRIEFS, Research Department Series No. 92/06, July, 1992.

Central Bank of Nigeria, Research Department, 1998. Measuring and Monitoring Poverty in Nigeria. Proceedings of the Seventh Annual Conference of Zonal Research Units. Held in Makurdi, Benue State Nigeria from 8th to 12th June, 1998.

Central Bank of Nigeria, Research Department, 2000. The Changing Structure of the Nigerian Economy and Implications for Development. Printed and published by Realms Communications Ltd. Lagos. August, 2000.

Central Bank of Nigeria/The World Bank, 1999. Assessment of the Performance of Nigeria's Rural Financial Institutions. A study by the Research Department, Central Bank of Nigeria in collaboration with the World Bank, June 1999.

CBN/FOS/NISER, 2001. A Study of Nigeria's Informal Sector, Volumes 1 and 2, September, 2001.

Central Bank of Nigeria/NISER, 2004. Baseline Economic Survey of Small and Medium Scale Industries in Nigeria, October, 2004.

Central Bank of Nigeria, 2006. Small and Medium Enterprises Equity Investment Scheme(SMEEIS), Revised Guidelines for Operation of the Scheme (An Initiative of the Bankers' Committee).

Central Bank of Nigeria, 2006. Central Bank of Nigeria Annual Report and Statement of Accounts for year ended 31st December, 2006.

Central Bank of Nigeria/CeRAM, 2007. Agricultural Credit Guarantee Scheme Fund of Nigeria (ACGSF): An Impact Assessment. Study conducted by Centre for Resource Analysis and Management (CeRAM) for the Governing Board of the Agricultural Credit Guarantee Scheme Fund, Central Bank of Nigeria, February, 2007.

Central Bank of Nigeria, 2009. Central Bank of Nigeria Annual Report and Statement of Accounts for year ended 31st December, 2009.

Central Bank of Nigeria, 2009. Central Bank of Nigeria Statistical Bulletin, Vol. 20, December, 2009.

Central Bank of Nigeria, 2010. Central Bank of Nigeria Annual Report and Statement of Accounts for year ended 31st December, 2010.

Development Finance Department, Central Bank of Nigeria, 2009. Ist Quarter 2009 Activities Report.

Elijah, U. and Nsikak, J., 2011. Small and Medium Scale Enterprises (SMEs) Development Planning in Nigeria: Lessons from Malaysian Experience. In Proceedings of the 52nd Annual Conference of the Nigerian Economic Society.

Essien, O. E., 2001. The Role of Development Finance Institutions in the Financing of Small-Scale Industries. CBN Bullion, Volume 25 No.3 July/Sept. 2001.

Evbuomwan, G. O., 2002. ''Framework for the Provision of Financial Services to the Rural Sector''. Central Bank of Nigeria, Research Department Mimeograph.

Frank, R. H. and Bernanke, B. S., 2007. Principles of Economics. Third Edition. McGraw Hill/Irwin New York, USA.

Inang, E. E. and Ukpong, G. E., 1993. A Review of Small-Scale Enterprises Credit Delivery Strategies in Nigeria. Central Bank of Nigeria Research Department Occasional Paper, No.5, March, 1993.

Kormawa, P. M. and Delvin, J., 2011. ''Promoting Effective and Innovative Financing''. In ''Agribusiness for Africa's Prosperity''. United Nations Industrial Development Organisation, Austria, May, 2011.

Lawal, A. P., 2005. ''Management Practices and Organisational Effectiveness of Nigerian Small and Medium Enterprises in Lagos State''. A Doctoral Thesis in the School of Post Graduate Studies, General Management, University of Lagos, Akoka, Lagos, Nigeria.

Manufacturers Association of Nigeria, 2008. MAN Newsletter, Oct.-Dec. 2008. MAN House, Ikeja, Lagos.

Manufacturers Association of Nigeria, 2010. MAN Newsletter, August-October, 2010. MAN House, Ikeja, Lagos.

Meludu, N. T. and Adekoya, A. E., 2007. Enhancing Institutional Micro-credit Foundations for the Sustainability of Women Farmers Entrepreneurship Development in Nigeria. In Journal of Rural Economics and Development, Vol. 16, No. 1, 2007. Department of Agricultural Economics. University of Ibadan, Ibadan, Nigeria.

Mertler, C. A. and Vannata, R. A., 2010. ''Advanced and Multivariate Statistical Methods: Practical Application and Interpretation''. Pyrczak Publishing, Glendale, California, USA, Fourth Edition, 2010.

National Bureau of Statistics, 2004. ''Poverty Profile in Nigeria''. National Bureau of Statistics, Abuja.

National Bureau of Statistics, 2010. ''Gross Domestic Product for Nigeria''. National Bureau of Statistics, Abuja.

Nigerian Association of Small and Medium Enterprises (NASME), 2003. The Small and Medium Enterprises: Prospects and Perspectives, Handbook/Directory. Published by Amanda Communications Ltd. Ikeja, Lagos. March, 2003.

Nigerian Institute of Social and Economic Research (NISER), 2005. Strategic Options for Reforms in Small and Medium Industries in Nigeria: NISER Occasional Paper No. 4, 2005.

Ogujiuba, K. K.,Ohuche, F. K., Adenuga, A. O., 2004. Credit Availability to Small and Medium Scale Enterprises in Nigeria: Importance of New Capital Base for Banks-Background and Issues. Working Paper. JEL Classification: E5, E51, G2, G21. November 2004.

Ogunrinola, O. I. and Alege, P. O., 2007. Micro-Credit and Micro-Enterprise Development: An Analysis of Some Rural-Based Enterprises in Nigeria. In the Nigerian Journal of Economic and Social Studies, Vol. 49, No. 1, March, 2007. Published by the Nigerian Economic Society.

Ojo, J.A.T., 2010. ''The Nigerian Maladapted Financial System-Reforming Tasks and Development Dilemma''. The CIBN press Ltd., Lagos Nigeria, 2010.

Olorunshola, J.A., 2003. Problems and Prospects of Small and Medium Scale Industries in Nigeria. In CBN Seminar on SMIEIS, 2003. In CBN Seminar on SMIEIS, 2003.

Owualah, S. I., 2002. Do Nigerian SMEs Face Equity or Credit Gap Problems? Nigerian Economic Summit Group (NESG) Economic Indicators. July/September, 2002.

Oyelaran – Oyeyinka, Banji, 2007. SME: Issues, Challenges and Prospects. A presentation at the International Conference on Financial System Strategy (FSS) 2020. Organized by the Central Bank of Nigeria in Abuja from 18th to 20th June, 2007.

Raji, M.A., 2000. Equity Participation, Productivity and Loan Default Factors in Externally-Funded Agro and Non-Agro Allied Enterprises in Nigeria. Unpublished Ph.D. Thesis Dept of Agric-Economics, University of Ibadan.

Shaw, E., 1973. Financial Deepening in Economic Development. New York: Oxford University Press.

Small and Medium Enterprises Development Agency of Nigeria (SMEDAN), 2007. ''National Policy on Micro, Small and Medium Enterprises''. Federal Republic of Nigeria, SMEDAN, Abuja, Nigeria, January, 2007.

SMEDAN, 2010. ''2010 Annual Report. SMEDAN, Abuja,

Sule, E.I.K., 1986. Small Scale Industries in Nigeria. Concepts, Appraisal of Government Policies and Suggested Solutions to Identified Problems. CBN Economic and Financial Review (EFR). Vol. 24 No. 4.

Timberg, T., 2000. ''Strategy of Financing Small and Medium Enterprises in a New Economic Environment''. Paper presented at the Conference on The Indonesian Economic Recovery in Changing Environment, held by the Faculty of Economics, University of Indonesia, Jarkata, October, 4-5, 2000.

Udechuckwu, F.N., 2003. Survey of Small and Medium Scale Industries and their Potentials in Nigeria. In CBN Seminar on SMIEIS, 2003.

UNEP Finance Initiative, 2007. ''Innovative Financing for Sustainable Small and Medium Enterprises in Africa''. International Workshop, Geneva, Switzerland. 2007 Meeting Report. Event organized by UNEPFI African Task Force (ATF); WWF (the Global Conservation Organisation); Geneva International Academic Network (RUIG-GAIN); International Organisations MBA, University of Geneva. Published in 2008 by UNEPFI.

World Bank, 1989. ''The World Bank Report, 1989. The World Bank, Washington DC. USA.

World Bank, 2012. The World Bank Report, 2011. The World Bank, Washington DC. USA

World Business Council for Sustainable Development (WBCSD), 2004. Promoting Small and Medium Enterprises for Sustainable Development. Development Focus Area/Issue Brief. A Business Guide to Development Actors (WBCSD, 2004).

CROP FARMERS' ADAPTATION TO THE TEMPORAL CHANGES IN CLIMATE VARIABLES IN ANAMBRA STATE, SOUTHEAST NIGERIA

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Abstract

The study investigated crop farmers' adaptation to the temporal changes in climate variables in Anambra state, Southeast Nigeria. The multi–stage sampling technique was used in selecting the respondents. A total of 80 respondents were randomly selected and interviewed with the aid of questionnaire. Data were analyzed using simple descriptive statistical tools and ordered regression model. Results of the analysis showed that most of the farmers are small scale farmers, with moderate household sizes to provide labour as well as old and well experienced in farming. Also from the results, the use of changing planting date was the most adaptation strategy practised to ameliorate the catastrophic effect of climate variability. The results of logit regression showed that gender, membership of co-operative societies and income from farm business were determinants of the level of adaptation to climate change in the area. Farmers should adopt more adaptation strategies as this will increase their resilience to the changes emanating from climate variability.

Keywords: temporal, adaptation, climate change

1. Introduction

Climate change is already affecting people, their livelihoods and ecosystems and presents a great development challenge for the global community in general and for the people in developing countries particularly (Khanal, 2009). Indeed the warming of the earth's climate is an environmental catastrophe on a new scale with the potential to violently disrupt virtually every ecosystem and many of the structures and institutions that humanity has grown to depend on (Aju, 2008). Clearly, agriculture is highly dependent on climate conditions and is therefore subject to change and variability, with obvious impacts on food security. Changing environmental conditions such as rising temperatures, changing precipitation patterns and an increase of extreme weather events seriously affect agricultural productivity, as vulnerability increases and even farming viability (FAO, 2007). Moreover, the scarcity of capital for adaptation measures predisposes African agriculture to be more vulnerable to climate change (Nnachi, Ozor, 2009). Climate change will have a global impact on agriculture, the world's poorest people and countries are more at risk (Eze, 2010). This is because of their sole dependence on agriculture for livelihood as well as a generalised capacity to cope and adapt to climate extremes (Rarieya, 2007). Therefore, the quest for climate-proof food systems is of interest to all. Nigerian agriculture is already under pressure to meet the demand of the rising population using finite, often degraded soil and water resources, which are now stressed by the impact of climate change (Awotoye, Mathew, 2010). Besides, food crops are particularly sensitive to climate variability because crop yields depend largely on prevailing climate conditions (rainfall patterns and temperature) (Platnik, Roson, 2009). There is therefore the need to isolate the adaptation strategies. This is attributed to some impacts of the warmer world which are irreversible implying that adaptation especially in the most vulnerable regions of the world must begin swiftly (Okezie, Okorie, 2009). It is therefore evident that farmers adjust their adaptive strategies in some cases to integrate the organic farming practices on practical mitigation actions and measures to respond to climate change. Adaptations are adjustments or interventions which take place in order to manage the losses or take advantage of the opportunities presented by a changing climate (IPCC, 2001). The study sought to achieve the following objectives: to determine the socio-economic characteristics of the respondents in the area, identify their adaptation strategies as well as ascertain factors affecting adaptation of farmers to changes in temporal weather variabilities in the study area.

2. Materials and methods

The study was carried out in Anambra state. A multi-stage random sampling technique was employed in sample selection. Anambra state was chosen due to the high number of crop farmers as well as changing climate variable prevalent in the area. In the first stage, two (2) agricultural zones namely Onitsha and Anambra agricultural zones were selected. In the second stage, two (2) Local Government Areas were selected from each agricultural zone. In each Local Government Area, eight (8) villages were randomly selected. Finally, ten (10) crop farmers were randomly selected from the list of crop farmers in each selected village, making a sample size of eighty (80) farmers in the area.

Data for the study were collected from both primary and secondary sources. The primary data were obtained using a set of questionnaire as well as oral interviews. The secondary sources of data were from textbooks, journals, internet data base and other relevant literature.

Simple descriptive statistical tools such as mean, frequency distribution and percentages and logit regression technique were employed in the data analysis.

Where, the Logit model is expressed as:

$$Y^* = \beta' X + \varepsilon i$$

$$\text{Logit}(P_i) = \ln = \frac{P_i}{\text{eqn1}} \quad \alpha + \beta_i X_i, + 1 + \ldots + \beta_k X_k \text{ i} \ldots \qquad \ldots\ldots\ldots\ldots\ldots\ldots \text{ eqtn1}$$

$$1 - P_i$$

$$I = 1, \ldots n,$$

Where:

Y_i = Level of adaptation (D: 1= Adapted; 2= not adapted)

X_1 = Gender (D : 1= Male; 2 = Female)

X_2 = Age (years)

X_3 = Household Size (no)

X_4 = Farming Experience (years)

X_5 = Farm size (hectare)

X_6 = Membership of co-operative societies (D: 1 = Yes; 2 = No)

X_7 = Income from farm business (naira)

E = Error term

It is expected a priori that the coefficients of X_1, X_2, $X_{4,}X_5$, X_6, $X_7 > 0$; $X_2 < 0$.

3. Results and discussion

3.1. Socio-economic characteristics of farmers in Anambra State

Table 1 shows that the mean age of the farmers was 54 years. This is an indication that cassava farming is dominated by old people, while the young people go in search of white collar jobs in the cities. Onuoha and Nnadi (1999) asserted that older farmers are more conservative and treat new ideas with sceptism. Also from Table 1, farming in the area is dominated by males (75%) while women (25%) are less involved in farming. This according to Eze *et al*., (2010) is because, farming is more laborious and women are more involved in less laborious activities. This is contrary to the findings of Henri-Ukoha *et al* (2012), that women are more involved in farming than men. Moreover, the mean household size of 7 persons in the households surveyed. This shows that the farmers had probably reasonable farm hands that could help in crop production. This is consistent with Adegbite *et.al*., (2008). This implies that most of the farm hands (labour force) can be sourced within the household. The mean farm size was 2.5 hectares, this shows that crop farming is dominated by small scale farmers in the area. The farmers are well experienced in crop production, this is evident in their mean years of experience of 40.2 years as crop farmers. This suggests that these farmers could have a better knowledge and information on changes in climatic conditions.

As shown in the table 2, use of mulch and tree planting (3.1%) were the least strategy employed by the farmers while changing planting dates (43.4%) was the strategy practised most. This could be due to the fact that this method is associated with convenience and had no direct labour cost whereas the limited use of other methods could be attributed to inaccessibility, poor access to information as well as higher expenses associated with adaptation of such

Table 1. Socio-economic characteristics of the respondents in Anambra State

Variables	Frequency	Percentage
Age		
16-25	3	3.75
26-35	6	7.5
36-45	22	27.5
46-55	8	10
56-65	18	22.5
66-75	20	25
76-85	3	3.75
Mean	54 years	
Gender		
Male	60	75.00
Female	20	25.00
Household Size		
1-5	20	25.00
6-10	54	67.50
11-15	5	6.25
16-20	1	1.25
Mean	7	
Farm size (ha)		
0.5-1.0	20	25.00
1.5- 2.0	11	13.75
2.5-3.0	26	32.50
3.5-4.0	18	22.50
4.5-5.0	5	6.25
Mean	2.5	
Farming experience		
1-20	19	23.75
21-40	23	28.75
41-60	20	25.00
61-80	18	22.50
Mean	40.2 years	
Total	80	100

Source: Field Survey, 2011

Table 2. Adaptation strategies to changing climate variability

Variable	Frequency	Percentage
Plant different varieties of crops	38	23.9
Cultivating different crops	25	15.7
Changing planting dates	69	43.4
Use of chemicals	20	12.6
Mulch and tree planting	2	1.3
No adaptation method used	5	3.1

Table 3. Result of ordered logit model on crop farmers adaptation to climate variability.

Variables	Logit Regression	Coefficient P-values
Gender (X_1)	1.294592***	0.009
Age (X_2)	-0.0510896	0.273
Household Size (X_3)	-0.0534447	0.325
Farming Experience (X_4)	0.0482796**	0.025
Farm size (X_5)	-0.03735008	0.871
Membership of Co-operative (X_6)	0.5395975*	0.053
Income from farm business (X_7)	-0.7970237	0.131
D1	2.401853	
D2	4.066338	

Log likelihood = 87.159125; Chi^2 = 22.08; Prob. > Chi^2 = 0.0025; Pseudo R^2 = 0.1124; ***Significant at 1%; **Significant at 5%; *Significant at 10%
Source: Computed from survey data, 2011

strategies. Jagtap (1995) also identified changing planting dates as a strategy used by most farmers in overcoming climate variability.

From the results of the Logit regression model, the likelihood = 87.159125 and Chi square of 22.08 with a p- value of 0.0025 showed that the model is statistically significant. Threshold D1 and D2 indicated that the two categories in the response were indeed ordered. The gender of the respondents were positive and significantly related to level of adaptation. This is in line with a priori expectation. This implies that males were more likely to adapt to climate change than females. Income from farm business was also positive and significantly related to level of adaptation. This suggests that the higher the income obtained from farm business, the higher the ability to adapt to climate change. This could be attributed to the fact that income makes one resilient to shock from climate variability. Membership to co-operative societies was also positive and significantly related to level of adaptation. This is expected, because members of co-operative groups were more likely to adapt to climate change than others. This is because co-operative societies expose its members to information as well as opportunities that will enhance their adaptive capacities and capabilities doing things jointly.

4. Conclusions

The study revealed that the crop farmers are small scale farmers, with moderate household sizes to provide labour for the households, they are aged and experienced in farming. The study also showed that the use of changing planting date was the most important adaptation strategy practised to reduce the effect of climate variability. The results of logit regression showed that gender, membership of co-operative societies and income from farm business significantly influenced the level of adaptation to climate change in the area.

5. Recommendation

Farmers should adopt more strategies that will not only increase but also improve their levels of adaptation to the effects of climate change in the area.

6. References

Adegbite D.A., Oluruntoba O.A., Adubi K.O., Shobanke S.B., 2008. Impact of National Fadama Development Project II on Small Scale Farmers' Income in Ogun State. Implications for Agricultural Financing in Nigeria. *Journal of Sustainable Development in Africa,* Vol 10, No. 3, 2008.

Aju P.C., 2008. The Development Mechanism and Investment opportunities in the forestry sub-sector of the Nigerian Economy: In Poppol, L. (ed). Climate Change and Sustainable Renewable Natural Resource Management. Proceedings of the 32nd Annual Conference of the FAAN held in Umuahia, Abia State, Nigeria 20th – 24th October, 2008, pp. 47-53.

Awotoye O.O., Mathew O.J., 2010. Effects of temporal changes in climate variables on crop production in sub-humid south-western, Nigeria. *African Journal of Environmental Science and Technology,* 4(8)500-505. http/www.academicjournals.org/AJEST.

Eze C.C, Eze V.C., Blessing A., 2010. Factors influencing the use of fertilizer in arable crop production among smallholder farmers in Owerri Agricultural Zones of Imo State, Nigeria, *Academia Arena 2*(6) 90-96.

Eze A.N, 2010. Assessment of farming households perception and knowledge of climatic change challenges and its coping strategies in Ebonyi state, Proceedings of the 44th Annual Conference of Agricultural society of Nigeria held at Ladoke Akintola University of Technology, Ogbomosho, 18th-22nd October, 2010, Pp 1419-1422.

Food and Agriculture Organisation of the United Nations (FAO), 2007. Adaptation to Climate Change in Agriculture, Forestry and Fisheries: Perspective, Framework and Priorities. FAO, Rome, Italy.

Henri-Ukoha A, Orebiyi J.S., Lemchi J.I., Ibekwe U.C., Onyeagocha S.U.O., Ben-chendo B.N., 2011. Comparative Analysis of Agricultural Credit Users and Non -credit users among cassava farmers in Ohafia Local Governmnet Area of Abia State, South East, Nigeria. *International Journal of Agricultural Management & Development Vol2(1)*7-11.

IPCC, 2007.Summary for Policy makers in ICC Fourth assessment Report" working crop II report, impacts, adaptation, and http:/www.IPCC.ch/pdf/assessment report/ar4/wgz/ar4-wg 2-sp

Jagtap (1995) in Otitoju M.A., Enete A.A., Nwagbo E.C., 2012. A Multi-variate analysis of farm-level determinants of food crop farmers adaptation strategies to climate change in Southwestern Nigeria. Proceedings og the 26th Annual conference of the Farm Mnagement Association of Nigeria held at Federal University of Agriculture Umudike, Oct. 15-19th, 2012.

Khanal R.C., 2009. Climate change and organic agriculture. *The Journal of Agriculture and Environment*, 10, 100-109, Review paper.

Nnachi H.C., Ozor N.O., 2009. Climate change and uncertainties facing communities in the middle belt region of West Africa. Paper presented at the 7th International conference on Human Dimensions of Global Environment Change held at the United Nations University, Bonn, Germany.

Okezie C.A., Okorie N.O., 2010. Climate variability and change implications for household food security. Proceedings of the 43rd Annual Conference of Agricultural society of Nigeria held at Abuja, 20th-23rd October, 2009, Pp 409-412 .

Onuoha E.R, Nnadi F.N., 1990. *Fundamentals of Agricultural Extension and Rural Sociology,* Ibadan, Nigeria: Sibon books Ltd.

Platnik R. R, Roson R., 2009. Climate change assessment and agriculture in general equilibrium models:alternative modelling strategies. In Carraro (ed) Sustainable Development Series, Notado Di Lavoro, 67.

Rarieya M., 2007. Creating trading zones and expertise for climate infromaation. http: www:Reien@Piedu.USA.

DEVELOPMENT OF A BENCHMARKING SYSTEM FOR IRISH BEEF FARMS USING DATA ENVELOPMENT ANALYSIS

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Abstract

Agricultural extension trends have involved greater use of collaborative "discussion group" dissemination approaches. These discussion groups involve regular participatory meetings between a consistent cohort of farmers and extension practitioners with occasional input from industry and research stakeholders. In Ireland, policy change, small farm scale and low incomes are some of the factors incentivising beef farmers and industry to seek increased whole-farm income efficiency. Whole-farm comparative analysis may provide a means of identifying and explaining efficiency drivers at farm level. This article describes the development of BEEFMARK, a benchmarking model with potential to act as a tool to facilitate farmer-farmer and farmer-adviser group learning within discussion groups. BEEFMARK utilised Data Envelopment Analysis (DEA) to measure beef farm income and scale efficiency and to identify and characterise efficient peer farms which act as benchmarks for similarly structured, but lower efficiency farms. Market derived gross output (€) per livestock unit was positively associated with farm efficiency while greater overhead and concentrate feed expenditure was negatively associated with income and scale efficiency.

Keywords: beef, benchmarking, comparative analysis, efficiency, efficient peers

1. Introduction

Internationally, beef production is characterised by low productivity, and consequently low profitability relative to other farm enterprises (Rakipova *et al.*, 2003; Newman and Matthews, 2007). In Ireland, incomes on beef farms have typically been supplemented by other farm enterprises, direct payment farm subsidies and off-farm incomes (Kinsella *et al*., 2000; Hennessy and Rehman, 2008). The domestic and international macro-economic environment since 2007 has resulted in decreased availability of off-farm employment in rural regions of Ireland (CSO, 2012). This reduced off-farm employment, coupled with impending changes in the distribution of farm subsidies under reform of the European Union (EU) Common Agricultural Policy (CAP) has led to a renewed focus on beef farm profitability and efficiency amongst farmers and agricultural extension.

1.1. The discussion group in comparative analysis

Farm comparative analysis involves identifying and measuring the management and structural differences between successful and unsuccessful farms. The ultimate objective is to help extension practitioners and farmers themselves identify specific production strategies likely to increase farm profits (Sheehy and McAlexander, 1965; Fleming *et al*., 2006). While traditionally blueprints for efficient farm production were devised by agricultural researchers and passed down to farmers via the medium of farm advisors, the identification of successful farm systems has in recent decades

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become more of a participative process (Lacy, 2011; Hennessy and Heanue, 2012). This change has been partly driven by a realisation that research findings are not universally relevant to all farmers in practice and participatory approaches enable exploration of on-farm issues which may not be considered by the top-down approach (Lacy, 2011). Discussion groups, farm open days and group forums utilising multi-directional communication channels have become increasingly common means of information dissemination and exchange in farm extension (Millar and Curtis, 1997).

1.2. Whole-farm analysis and benchmarking

Gross margin per hectare (GM/ha) is commonly used as a profit measure when comparing farms employing pasture-based production systems (McCall and Clark, 1999). However two criticisms are often made of the "partial accounting" nature of this measure:

- The exclusion of fixed costs from gross margin calculation means that farm systems which employ inherently higher ratios of fixed costs to variable costs appear to achieve greater profits (Firth, 2002; White *et al*., 2010).
- The expression of profit on a per hectare basis neglects the productivity of other assets employed. It creates a bias in favour of farms which substitute other fixed assets (e.g. buildings or machinery) for land in their production system (Farrell, 1957; Fleming *et al.*, 2006; Shadbolt, 2012).

A solution to these weaknesses is the measurement of *whole-farm economic efficiency*. This concept was based on the principles described by Farrell (1957). Including all fixed and variable costs in whole-farm; rather than partial measures of efficiency permits more robust specification of strategies that may improve profitability over both the short and long-term (Tauer, 1993).

Benchmarking is a comparative analysis approach which involves identifying tangible blueprint targets with the aim of improving efficiency and profitability (Fleming *et al*., 2006). This paper describes the development of a benchmarking model BEEFMARK, which utilised data envelopment analysis (DEA) to measure whole-farm income and scale efficiency on Irish beef farms. The qualitative validation of BEEFMARK using an independent commercial farm dataset and its ability to identify efficient peer farms are discussed in the context of designing a discussion group tool.

2. Methodology

Data envelopment analysis is a non-parametric linear programming methodology for measuring efficiency (Farrell 1957; Charnes *et al*. 1978). DEA is non-parametric in that the efficiency frontier is defined by the most efficient farms in the sample rather than by the modeller. This means that DEA efficiency blueprints have been empirically measured on farms rather than being the product of theoretically possible calculations (Farrell, 1957).

Fried *et al.* (2008) defined productivity as a ratio of aggregated outputs to aggregated inputs and efficiency as the ratio of measured productivity to potential productivity. Figure 1 illustrates how efficiency is calculated in the BEEFMARK model. The 'best observed practice' farms exhibit an efficiency score of one and the efficiency frontier created by joining their production functions 'envelops' farms below the frontier which have an efficiency score of less than one (Farms A and E). Efficiency models can be either output or input oriented. BEEFMARK efficiency scores are output oriented because inputs such as land and labour on most farms are essentially fixed and therefore model results prescribing changes of such input variables would be largely impractical

(Tauer, 1993; Newman and Matthews, 2007). Output oriented efficiency scores give the farmer an indication of how output can be increased by more judicious and efficient management of the existing farm inputs.

2.1. The benchmark dataset

Data from the Teagasc National Farm survey (NFS; Hennessey *et al.*, 2012) for 2009 and 2010 were used as the benchmark dataset for the initial development of BEEFMARK. The NFS is an

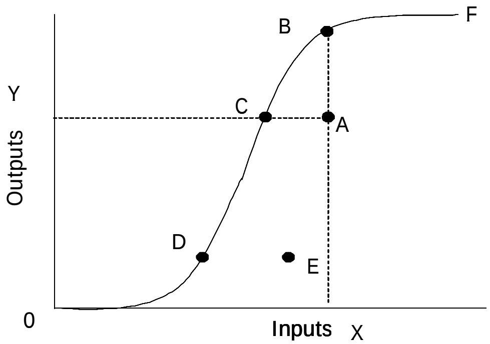

Figure 1. Illustration of efficiency calculation and efficient peers

annual voluntary survey of approximately 1,100 farms, representative of over 100,000 farms in Ireland, providing data to the Farm Accountancy Data Network (FADN). The modelled farms were categorised as either ‘cattle rearing’ (CR) or ‘cattle other’ (CO) within this dataset. Cattle rearing farms are primarily suckler farms while CO farms are primarily beef finishing farms.

2.2. BEEFMARK model inputs and outputs

The eight model inputs were land area farmed (ha), number of livestock units (LU), total labour units employed (paid and unpaid), concentrate feed expenditure, fertiliser expenditure, other variable input costs, overhead costs and total direct payment subsidies; all annual, whole-farm values. Whole-farm output was annual net income; nominally family farm income (FFI measured in €/farm). FFI includes income from subsidiary farm enterprises, market derived income from cattle and farm direct payments.

2.3. Bootstrapping

To address sampling bias BEEFMARK employed a bootstrapping re-sampling procedure to all sample farms as described by Simar and Wilson (1998). Sampling bias is a problem inherent in all DEA models (Latruffe *et al.*, 2005). The bootstrap involved 10,000 random Monte Carlo re-samples. This procedure produced a distribution of efficiency scores and a bootstrap bias term for each sample farm. The bootstrap bias term (essentially a sampling error term) was deducted from the deterministic efficiency score (ES) to give the bias-corrected efficiency score. Income efficiency (IES) and scale efficiency (SES) scores referred to throughout this article are bias-corrected efficiency scores.

2.4. Efficient peers

Efficient peers (EP) act as commercial blueprint farms for similarly structured, but less efficient farms. Each sample farm in the BEEFMARK model which is classed as inefficient has an EP. This EP represents the closest farm on the best-practice frontier and indicates the shortest radial route for the inefficient farm to achieve efficiency. In Figure 1, farm B is the EP for inefficient farm A and farm D is the EP for farm E. The farm acting as EP for the greatest number of inefficient farms was identified as the "most common efficient peer". The most common efficient peer shared more common characteristics than the other efficient farms with the inefficient farms in the sample. By observing the characteristics which differed between the inefficient farms and their most common efficient peer, pathways to increased efficiency could be deduced.

2.5. BEEFMARK operation

The BEEFMARK model was run in four discrete steps:

1. Scale and income efficiency scores were calculated using "FEAR" in the R language (Wilson, 2009).
2. All sample farms were assigned to top, middle and bottom thirds ranked in order of bias-corrected efficiency score. To identify determinants of efficiency, explanatory management, environmental and demographic variables were then compared across these thirds using a Mann-Whitney test for difference of means (Table 4). This procedure was repeated for scale efficiency.
3. Efficient peers were identified using "DEAP" (Coelli, 2005).
4. Because DEAP identified peers based on deterministic efficiency scores, the most common efficient peers were ranked on bias-corrected efficiency scores (stage 1 output). An EP was only identified as such by BEEFMARK if it was in the top 20% of its respective sample both in terms of income and scale efficiency.

2.6. BEEFMARK dataset comparison

The consistency of BEEFMARK was qualitatively assessed using an independent dataset of Irish beef farms. The independent dataset comprised approximately 500 beef farms which recorded farm production and financial data using the Teagasc web-enabled profit analysis program, the "eProfit Monitor" (ePM), over the years 2009 and 2010. Model input and output variables were equivalent to those used for the analysis of NFS farm data described above. Comparative analysis results were compared between the datasets to assess the performance of BEEFMARK under differing beef farm samples.

3. Results and discussion

3.1. Mean efficiency scores and comparative analysis of explanatory variables

Table 1 details the mean efficiency scores and proportion of farms operating at increasing and decreasing returns to scale and scale efficiency for the benchmark (NFS) and the independent (ePM) datasets for 2009 and 2010.

Tables 2 and 3 show the comparative analysis results for the NFS and ePM datasets, respectively, with farms ranked on IES. Higher concentrate and overhead expenditure per LU were consistently associated with lower income efficiency. Lower efficiency NFS farms were more fragmented (results not shown). Stocking rate, farmer age, and off farm employment had no

Table 1. Mean efficiency scores and percentage of farms operating at scale efficiency, increasing and decreasing returns to scale for the benchmark (NFS) sample and the independent (ePM) sample of Irish beef farms

Dataset	Farm Sample	Year	Bias	IES	SES	IRS %	SE %	DRS %
Benchmark dataset	Cattle Rearing	2009	0.06	0.80	0.67	1	2	96
		2010	0.10	0.71	0.73	4	2	94
	Cattle Other	2009	0.12	0.66	0.60	0	13	87
		2010	0.12	0.64	0.57	0	12	88
Independent dataset	Cattle Rearing	2009	0.10	0.61	0.54	0	6	94
		2010	0.07	0.73	0.36	0	2	97
	Cattle Other	2009	0.15	0.67	0.55	0	15	85
		2010	0.09	0.78	0.41	6	2	92
Overall mean			0.10	0.70	0.55	2	7	92
Benchmark dataset mean			0.10	0.70	0.64	1	7	91
Independent dataset mean			0.10	0.70	0.46	2	6	92
2009 mean			0.11	0.69	0.59	0	9	91
2010 mean			0.09	0.71	0.52	3	4	93
Cattle Rearing mean			0.08	0.71	0.57	1	3	95
Cattle Other mean			0.12	0.69	0.53	2	10	88

Bias = sampling bias calculated by 10,000 bootstrap re-samples. IES = Income efficiency score. SES = Scale efficiency score. IRS = increasing returns to scale. SE = Scale efficient. DRS = Decreasing returns to scale

Table 2. Characteristics of top and bottom 1/3 of National Farm Survey beef farms ranked on bias corrected income efficiency score

		Cattle Rearing						Cattle Other					
Year		2009			2010			2009			2010		
Scale efficiency tercile		Top 1/3	Bottom 1/3		Top 1/3	Bottom 1/3		Top 1/3	Bottom 1/3		Top 1/3	Bottom 1/3	
Income efficiency score		0.89	0.69	***	0.84	0.57	***	0.82	0.50	***	0.79	0.47	***
Scale efficiency score		0.58	0.51	***	0.65	0.58	***	0.56	0.59	NS	0.50	0.57	NS
Cattle numbers	LU	44	46	NS	43	46	**	52	54	NS	56	52	NS
Land farmed	ha	42	45	*	47	44	NS	42	44	NS	46	47	NS
Farm gross output	€	40,600	35,129	NS	41,745	38,508	NS	48,263	42,041	NS	54,545	41,712	NS
Farm direct payments	€	21,057	18,565	***	21,224	18,230	***	21,754	20,366	NS	22,943	18,774	NS
Stocking rate	LU/ha	1.24	1.21	NS	1.11	1.23	NS	1.34	1.33	NS	1.35	1.23	*
Overhead costs	€/LU	285	438	***	329	430	***	275	337	***	296	454	***
Concentrates fed	€/LU	74	123	***	82	125	***	103	123	*	143	181	NS
AI expenditure	€/cow[1]	8	7	NS	6	8	NS	-	-		-	-	
Gross output	€/LU	978	772	***	1,058	864	***	918	790	**	992	976	*
Family farm income	€/ha	230	194	NS	232	205	NS	265	290	NS	338	278	NS

[1] per cow or in-calf heifer. Signif levels: *** P < 0.01; *** P < 0.05; * P < 0.10

Table 3. Characteristics of top and bottom 1/3 ePM beef farms ranked on bias corrected income efficiency

		Cattle Rearing						Cattle Other					
Year		2009			2010			2009			2010		
Scale efficiency tercile		Top 1/3	Bottom 1/3		Top 1/3	Bottom 1/3		Top 1/3	Bottom 1/3		Top 1/3	Bottom 1/3	
Income efficiency score		0.77	0.45	***	0.86	0.59	***	0.83	0.49	***	0.90	0.63	***
Scale efficiency score		0.56	0.51	**	0.42	0.32	***	0.54	0.62	NS	0.37	0.46	NS
Cattle numbers	LU	86	83	NS	79	100	***	71	80	NS	67	97	NS
Land farmed	ha	52	51	NS	49	59	***	45	54	NS	43	62	NS
Farm gross output	€	82,372	67,960	NS	76,359	84,497	*	75,710	70,994	NS	74,799	84,079	NS
Farm direct payments	€	35,205	31,288	NS	31,312	34,106	NS	31,022	30,306	NS	31,605	32,135	NS
Stocking rate	LU/ha	1.66	1.67	NS	1.61	1.70	***	1.65	1.45	NS	1.63	1.45	NS
Overhead costs	€/LU	272	384	***	251	375	***	249	416	***	273	422	**
Concentrates fed	€/LU	168	190	NS	144	206	***	258	263	NS	226	283	NS
AI expenditure	€/cow[1]	8	16	NS	8	18	*	-	-		-	-	
Gross output	€/LU	992	822	***	981	857	***	1,066	927	**	1,099	927	**
Family farm income	€/ha	704	137	***	709	194	***	752	163	***	814	133	***

[1] per cow or in-calf heifer. Signif levels: *** P < 0.01; *** P < 0.05; * P < 0.10

significant effect on IES. The observed positive relationship of market gross output per LU with efficiency is indicative of either greater genetic merit of cattle or an improved productivity due to superior management relative to the mean. These results were discussed more thoroughly in Finneran and Crosson (2012) and Finneran and Crosson, (2013).

3.2. Comparison of the datasets

A number of sample by year interactions were observed. For example, in the 2010 cattle rearing ePM farm sample, land area farmed was significantly greater on the low IES farms. Farm direct payments were significantly greater on the NFS high IES cattle rearing farms but this was not observed on the ePM farms. However, apart from these exceptions the relationships between the explanatory variables and income efficiency were consistent across the data-sets. This suggests that despite differences in size and sampling procedure (ePM - farmer voluntary unbalanced sample; NFS - a nationally representative balanced sample) the bootstrapping procedure in BEEFMARK generally dealt well with sampling bias.

3.3. Analysis of efficient peers

The most common efficient cattle rearing peer on ePM farms in both 2009 and 2010 was identified and designated “Farm X”. Table 5 details the characteristics of Farm X relative to the sample mean and the mean of the inefficient farms in the sample for which Farm X was a peer. It is evident that for most variables Farm X is more similar to the peer mean than the cattle rearing sample mean, as one would expect. However, the variables for which Farm X is different to the peer mean may indicate determinants of efficiency on Farm X. While Farm X is similar to its peers in terms of land area (ha), stock numbers (LU) and stocking rate (LU/ha), it achieved a market gross output (€/LU) three times greater than its inefficient peers. Similarly, Farm X incurred 25% less concentrate feed costs and 50% less overhead costs per LU than its peers. In addition, Farm X included no rental land in contrast with the 18% peer mean.

These efficiency drivers highlighted by the peer analysis had all been previously observed in the whole-sample comparative analysis results (Finneran and Crosson, 2012; Finneran and Crosson, 2013). However, as discussed by Fraser and Cortina (1999), identifying “real world” efficient best-practice farms gives much more weight to the comparative analysis learning experience for farmers than analysis of means of anonymous samples.

Table 5. Characteristics of Farm X, an efficient cattle rearing peer in 2009 relative to the cattle rearing sample mean and the mean of Farm X’s inefficient peers

	Farm X	Sample Mean	Difference to sample mean %	Peer Mean	Difference to peer mean %
Income efficiency score	0.79	0.62	+17	0.61	+18
Ha	39	52	-24	35	+13
LU	72	86	-17	61	+16
Stocking rate LU/ha	1.82	1.68	+8	1.78	+2
Gross output €/LU	1108	902	+23	899	+23
Market Gross output €/LU	625	478	+31	447	+40
Gross margin €/ha	666	235	+184	166	+301
Family Farm Income €/ha	1355	437	+210	426	+218
Concentrate feed €/LU	150	180	-17	208	-28
Fertiliser €/LU	44	70	-37	70	-36
Other variable costs €/LU	139	180	-23	179	-22
Overhead costs €/LU	152	315	-52	304	-50
Proportion of land rented	0.00	0.15		0.18	

Ha = hectares, LU = livestock units (1 unit is equivalent to 1 dairy cow)

4. Conclusions

Greater efficiency on Irish beef farms was found to be associated with greater production from pasture and less purchased concentrate feed inputs. This provides a challenge for expanding beef output, given the limited availability of pasture and the decreasing returns to scale observed on larger farms. Market derived gross output (€/LU) was positively associated with farm efficiency while greater overhead and concentrate feed expenditure was negatively associated with income and scale efficiency. The BEEFMARK efficient peer procedure enables efficiency drivers to be observed at the individual farm level and could provide a valuable learning tool for farmers and extension practitioners within beef discussion groups.

5. References

Central Statistics Office, 2012. Labour market report - 2012. CSO, Cork, Ireland.http://www.cso.ie/en/media/csoie/releasespublications/documents/labourmarket/2012/qnhs_q22012.pdf

Charnes A., Cooper W.W., Rhodes E., 1978 Measuring the efficiency of decision making units. *European Journal of Operational Research,* 2**,** 429-444.

Farrell M.J., 1957. The Measurement of Productive Efficiency. *Journal of the Royal Statistical Society. Series A (General),* 120**,** 253-290.

Finneran E., Crosson P., 2012. Identifying determinants of efficiency using Data Envelopment Analysis for Irish suckler beef farms. IN STEAD, D. (Ed.) *Agricultural Economics Society of Ireland Annual Meeting.* RDS, Dublin, Ireland.

Finneran E., Crosson P., 2013. Benchmarking scale efficiency of Irish beef farms. IN DISKIN, M. (Ed.) *Agricultural Research Forum.* Tullamore, Ireland, Teagasc.

Fleming E., Farrell T., Villano R., Fleming P., 2006. Is farm benchmarking the new acceptable face of comparative analysis? *Australasian Agribusiness Review,* 14.

Fraser I,. Cordina D., 1999. An application of data envelopment analysis to irrigated dairy farms in Northern Victoria, Australia. *Agricultural Systems,* 59**,** 267-282.

Fried H.O., Lovell C.A.K., Schmidt S.S., 2008. *The measurement of productive efficiency and productivity growth,* New York, Oxford University Press, USA.

Hennessy T., Kinsella A., Moran B., Quinlan G., 2012. National Farm Survey 2011. Teagasc, Athenry, Ireland.

Latruffe L., Balcombe K., Davidova S., Zawalinska K., 2005. Technical and scale efficiency of crop and livestock farms in Poland: does specialization matter? *Agricultural Economics,* 32**,** 281-296.

McCall D.G., Clark D.A., 1999. Optimized dairy grazing systems in the northeast United States and New Zealand. II. System analysis. *J Dairy Sci,* 82**,** 1808-16.

Millar J., Curtis A., 1997. Moving farmer knowledge beyond the farm gate: An Australian study of farmer knowledge in group learning. *European Journal of Agricultural Education and Extension,* 4**,** 133-142.

Newman C., Matthews A., 2007. Evaluating the Productivity Performance of Agricultural Enterprises in Ireland using a Multiple Output Distance Function Approach. *Journal of Agricultural Economics,* 58**,** 128-151.

Rakipova A.N., Gillespie J.M., Franke D.E., 2003. Determinants of Technical Efficiency in Louisiana Beef Cattle Production. *Journal of the American Society of farm managers and rural appraisers,* 66**,** 99-107.

Shadbolt N.M. 2012. Competitive strategy analysis of NZ pastoral dairy farming systems. *International Journal of Agricultural Management,* 1**,** 19-27.

Sheehy S.J., McAlexander R.H., 1965. Selection of Representative Benchmark Farms for Supply Estimation. *Journal of Farm Economics,* 47**,** 681-695.

Simar L., Wilson P.W., 1998. Sensitivity Analysis of Efficiency Scores: How to Bootstrap in Nonparametric Frontier Models. *Management Science,* 44**,** 49-61.

Tauer L.W., 1993. Short-run and long-run efficiencies of New York dairy farms. *Agricultural and Resource Economics Review,* 22**,** 1-9.

Wilson P.W., 2009. FEAR 1.12 User's Guide. Clemson University, USA.

FACTORS AFFECTING RICE ADOPTION IN THE SOLOMON ISLANDS: A CASE STUDY OF FIU VILLAGE, MALAITA PROVINCE

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Abstract

In 2006, the Solomon Islands (SI) Government implemented the National Rural Rice Development Programme (NRRDP) aiming to promote rice growing in SI. However, the low level of rice adoption raised questions relating to the successful implementation of this programme. The aim of this paper is to identify the factors that contributed to farmers' decision to adopt or not to adopt rice growing. The data collected was analysed using the qualitative data analysis. This study found several key factors that influenced the farmers' decision to adopt rice technology. These factors were separated into three broad categories: characteristics of technology, internal factors and external factors. Several characteristics of the technology such as: relative advantage, compatibility, complexity and risk were identified by the adopters. The internal factors were: personal characteristics, on-farm factors, cultural factors and leadership. The external factors that influenced adoption decision were: government policy, infrastructure, agro-climatic condition, access to extension services and markets. However, it was found that poor policy implementation, poor leadership by the community leaders and poor delivery of extension service were the key factors that affected the adopters' decision to discontinue the use of the technology in 2010. This study also showed that the majority of farmers in Fiu village did not adopt the technology due to the negative attributes of the rice technology such as: complexity, lack of compatibility with traditional practices, resource requirements and risk of crop failure. For the project to be successful, funds needed to be made available so that the Ministry of Agriculture and Livestock could provide the capital and variable inputs and the labour subsidy in a timely fashion to the community group. This would have reduced the lack of trust that the farmers had in the governments' ability to deliver on programmes and help ensure high crop yields, whilst minimising the risk of crop failure. Furthermore, the selection of community group leaders with the right attitudes, technical and group management skills was critical for the successful implementation of the project.

Keywords: farmer adoption, rice adoption, Malaiata Province, Solomon Islands

1. Introduction

For decades, the people of the Solomon Islands (SI) have depended on traditional staple crops, such as sweet potato, cassava, taro and yam for their dietary energy (SIG, 2008). However, this trend has slowly changed over the past 50 years, as the population has developed a taste for rice and rice is now third most important crop after sweet potato and cassava. Rice was first introduced into the SI in 1942 by American soldiers during World War II (McGregor, 2006; Warner, 2007; SIG, 2009). However, 16 years after the war, the taste for rice had grown and this resulted in the first importation of rice in 1961. Rice imports increased from 2,700 tons in 1961, to 3,322 tons in 1970. The price of rice also increased from US$144/ton in 1961, to US$ 201/ton in 1970 (FAO Statistic, 2010).

The increase in the price of rice imports over the period 1961-1970, led the SI Government to intervene by implementing a food policy during the 1960s. The aim of this policy was to limit food imports and increase local food production. In 1966 the government leased 4,235 ha of land to a privately owned Australian commercial company "Guadalcanal Plain Limited" (GPL) for rice production (Barrett 1970). In 1967, the GPL planted 599 ha of rice and this allowed the SI to become self-sufficient for the first time (Barrett, 1970; Fleming, 1996). In 1975, GPL formed a joint venture with the SI Brewers Solomon Associates (BSA) a local based subsidiary of C. Brewer Corporation (a Hawaiian-based agribusiness firm) to form the Sol-rice Company. This company increased the rice area from 599 ha in 1975 to 2,512 ha in 1978 and allowed SI to become an exporter of rice to Australia, New Zealand and Fiji. When exports peaked at almost USD$5 million in 1980, rice had become the fifth most valuable export and the third most valuable agricultural export crop after copra and palm oil (Fleming, 1996).

Rice exports declined through the early 1980s and in 1986, BSA withdrew from the joint venture, after four years of experiencing successive losses due to serious insect problems, a drop in world rice prices and the high costs associated with mechanised production practices. In 1986, the rice plantations suffered serious infrastructure damage due to cyclone Namu. As a result, the Sol-Rice Company ceased rice production and exports (Fleming, 1996).

Despite the liquidation of the Sol-Rice Company, the rice consumption per head increased from 37 kg in 1987 to 72 kg in 2007 (Figure1). This was due to a combination of population growth (2.8% p.a.), rapid urbanization and change of consumption patterns (SIG, 2009). The rice imports also increased from over 10,000 tons in 1987 to over 35,000 tons in 2007 (Figure 1).

From 1987 the world price of rice has been increasing (Figure 2) and in 2008, the world price of rice spiked to US$1,664/ton (FAO, 2010). As a consequence, per capita rice consumption in 2008 dropped to a record low of 26kg/head (Figure 1).

The cost of rice imports and increased rice consumption were a major concern for the SI government. To reduce rice imports, improve food security and increase local rice production, the Ministry of Agriculture and Livestock (MAL) initiated a National Rural Rice Development Programme (NRRDP) in 2006 (SIG, 2008). A Rice Section was established to implement the programme and encourage local farmers to adopt rice growing. The Rice Section employed a community group approach because of the high labour requirements of rice growing. They also

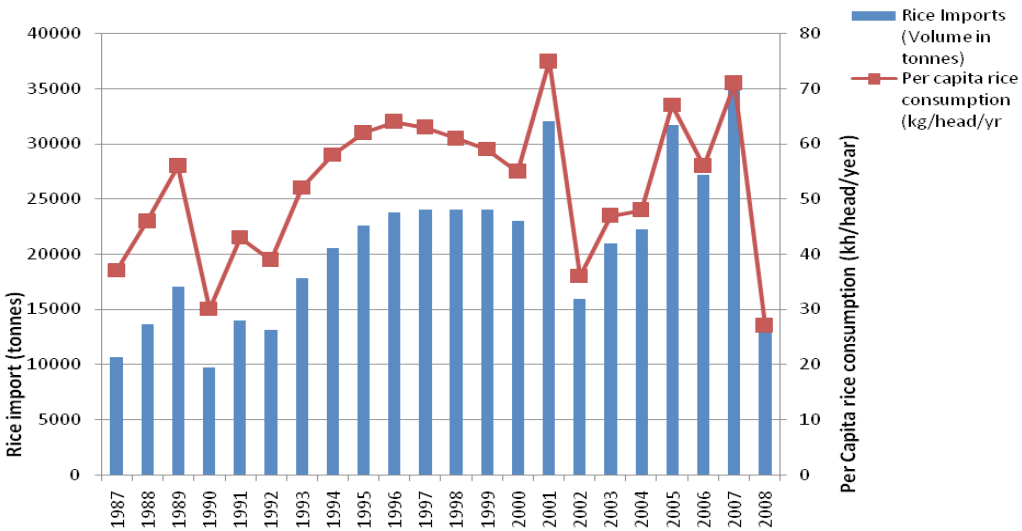

Figure 1. Rice consumption pattern in the Solomon Islands (1987-2008)
Source: FAO, 2010

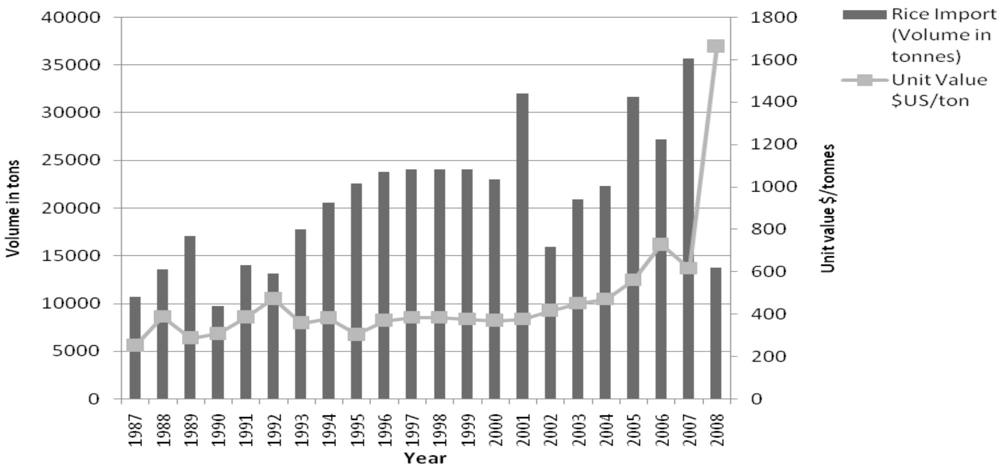

Figure 2. Rice imports into the Solomon Islands (1987-2008)
Source: FAO, 2010

planned to provide farmers with assistance in the form of extension advice, labour subsidies, capital (e.g. tractors, fuel) and variable inputs (e.g. fertilizer, seeds). These incentives were to be provided for three years, to allow the rice farms to become viable and able to continue to produce without government assistance after the third year of operation (SIG, 2009).

Since the inception of the programme in 2006, the government spent approximately USD$1.73 million over a three year period (SIG, 2009). Additional funds were invested in 2008, when the government provided an extra US$4.1 million (SIG, 2009b). In early 2010, a further USD$1.6 million was allocated from the government's budget, to assist with the rice programme (SIG, 2010).

Despite the significant investment in this programme over the past five years, only a limited number of farmers have joined it (SIG, 2009a). NRRDP had only managed to establish 323 ha of rice in 5 years of operation, compared to their target of 3,000 ha (SIG, 2008). This paper reports on a study that was undertaken to investigate why farmers adopted or did not adopt the rice growing technology promoted by the SI government.

2. Research methodology

A single–case study approach was chosen for this research. The Fiu community Rice Project in the Central Kwara'ae Constituency of the Malaita Province was selected as case for three reasons: 1) it was the only rice project in Malaita province of the SI that was still functioning when the primary data collection was organised; 2) it was located in an area that was safe for the researcher to collect data, and 3) it was accessible, with respect to contacts and the existence of roads and transport to the study site.

The government officers involved in the rice programme and the Fiu rice committee members were the first respondents identified by the researcher. The farmers who adopted the rice technology were selected using a snowball sampling technique. In this case, the researcher used the committee members as a strategic starting point for the identification of information-rich respondents. A purposive sampling was used for the farmers who did not adopted the rice to capture a diversity of opinions and views of the members of the Fiu community.

The data collection for this research was carried out between June and July 2010. A total of 24 respondents were interviewed. The respondents included: two government officers (national & provincial levels); two Fiu project committee members; ten farmers in Fiu village who adopted rice technology; and eight farmers in Fiu village who did not adopt the rice technology.

Primary and secondary sources of data were used in gathering relevant information. The primary data was collected through semi-structured interviews that were tape recorded and later transcribed. Secondary information and relevant documents/reports were also collected from the governmental, regional and local offices relating to the Rice Development Programme as well as the Fiu community.

A qualitative data analysis technique developed by Dey (1993) was used to analyse the data. This is a three step iterative process comprising description, classification and connection. The data was transcribed, summarised and categorised to look for connections and relationships.

2.1. Classification of the case

The case studied is located in Fiu village in the Central Kwara'ae Constituency of Malaita province of the Solomon Islands. The age of farmers ranged between 20 to 65 years (Table 1). There was a low level of literacy amongst the farmers in the community. Most of the farmers had previous experience in growing rice as part of a community group in the 1990s. The main source of livelihood for the majority of people in the community was agriculture. They generated additional revenues from other activities such as fishing, pig rearing, and basket weaving. The Fiu Community Rice Project (FCRP) was situated close to Fiu village. The land on which the community rice project was located, was owned by the Church of Melanesia (COM) and leased to the community by the government for rice development. Because of this arrangement, tenure of land was therefore secure from disputes. The land area set aside for rice development was approximately 20 ha.

The case was a community project which required farmers to form a community group in order to grow rice (Table 2). The establishment of the community group was facilitated by local extension officers. Membership was open to all community members of Fiu village. The community rice

Table 1. Farmer and farm characteristics

Characteristics	Case study classification
Age of farmers (years)	20 - 65 years
Gender equality	Men usually make household decisions
Education	The majority of farmers have predominantly primary with limited secondary education. Literacy rates are low.
Experience with the technology (rice growing)	The majority of farmers had some experience with rice growing within a community project
Homogeneity	Four different tribes with four chiefs representing each tribe. The tribes share the same religion
Wealth	99% are termed as poor and only 1% are rich
Livelihood situation	Subsistence agriculture and also gain income from fishing, pig rearing, and basket weaving.
Location of the rice farm	Close to farmers homes
Land tenure	The land is not in dispute
Farm size	20 hectares

project had 30 farmer members including six committee members. The main role of the committee was to plan and develop a work programme for rice production. There was no official constitution developed by the committee that set out formal rules to guide the project's operations. The decisions were made by the project committee with minimal consultation with group members.

The government provided support under the NRRDP for the Fiu community to grow rice. The support that the government had planned to provide to the Fiu Community Rice Project included the provision of capital and variable inputs, a labour subsidy, and the provision of rice information and technical advice from extension officers.

Table 2. Community group characteristics

Characteristics	Case study classification
Nature of group	Formed by local extension officers
Membership	Open
Group size	30 farmers
Written constitution	No
Level of participation in decision making	Decisions were made by the leadership with minimal consultation with group members
Leadership capacity: Group management Rice production	 Poor Poor

3. Results and discussion

The research findings revealed that there were several factors that influenced the farmers' initial decision to adopt or not adopt at the inception of the project in 2007. These factors could be separated into three categories: 1) characteristics of technology, 2) internal factors, and 3) external factors. These are discussed in the following section.

3.1. Characteristics of the rice technology

The study identified six characteristics of technology to have influenced the farmers' decision to adopt the technology. The first four factors were consistent with Rogers (1995; 2003) adoption model. These are: relative advantage, compatibility, complexity and observability. Trialibility was not important because the rice technology requires 10 - 20 ha of land to be grown immediately, and therefore trialling it in a small scale was not possible. The other two characteristics of the technology that were identified related to resource use and risk.

The perceived relative advantages of rice that influenced adoption decision of farmers were: improved food security, improved income, early maturity of rice crop, improved palatability and convenience. The study revealed that flooding is the main threat to local staple production in the area. Therefore, farmers thought that because rice crop had much better storage characteristics than local staples crops, it would provide the source of food during this flooding period. The farmers also suggested that they would improve income through the sale of surplus rice and from the wages that they could receive through labour subsidy payments.

This research also revealed that adopters decided to grow rice rather than local staples because it only took three months to reach maturity, whereas the local staples took 6-11 months to mature. This meant that farmers could grow two crops of rice in the time it took to grow one staple crop which in turn could improve both their food security and income. This finding is consistent with the work of Feder et al. (1993).

Because of a combination of poor group leadership and failure by the government to provide capital and variable inputs, many of these relative advantages did not eventuate and after two years of crop failure, the farmers decided to discontinue the project in late 2010. The result also revealed that farmers who had joined the community project and adopted rice were worse off in terms of food security and income than those that did not adopt. Azilah (2007) also reported that farmers may discontinue the use of a technology after being dissatisfied with the performance of the new idea.

In contrast to the 30 adopters, the majority of the community did not adopt the rice technology in 2007 because they believed that they would be better off in terms of food and income by growing their traditional staple crops, fishing and rearing pigs.

The rice was more complex to grow than the local staple crops. Despite this, thirty farmers adopted the rice technology because they had previous experience in rice growing and expected to receive extension support. Many of the non-adopters also had previous experience, but they did not trust the government to provide the necessary support, nor the leadership to manage the project effectively. Ogunlana (2004) and Rogers (2003) stressed that the greater the complexity of a technology the more negatively farmers may view it and that this may lead to its non-adoption.

Observability did not influence the farmers' initial decision in 2007 to adopt the rice technology because there were no similar projects within the vicinity to be observed. However, when the project was implemented during the period from 2007 to 2010, the non-adopters observed the project being poorly implemented and this confirmed that their initial decision not to adopt the rice technology was correct.

In this study, the resource use characteristics of the rice technology were capital and variable input intensive, labour intensive and land-using and had an important influence on the farmers' adoption decision. Although the adopters were aware of these negative resource-use characteristics, they believed that the government had put in place actions to overcome them. Sunding and Zilberman (2001) found that resource use characteristics often acted as barriers to adoption if they were not overcome.

In 2007, the non-adopters' perceived rice technology to be input intensive particularly when compared to their staple crops and this influenced their decision not to adopt, results consistent with the work of Khanna (2001). The non-adopters also perceived rice growing as labour intensive, involving multiple activities and required a large labour force. They also did not adopt the technology because they also perceived rice growing as land-using compared to local crops.

The risk associated with the production of rice also influenced the farmers' adoption decision. Feder and Umali (1993) and Pannell et al. (2006) identified the risk associated with a new technology as an important factor that influenced the adoption decision of farmers. Although the adopters were aware that rice was susceptible to pests and diseases, it did not deter them from adopting the rice technology due to the available governmental support in terms of fertilisers, pesticides, and fungicide and extension support. However, when these inputs were not fully provided by the government, the rice crop was attacked by pests and diseases, and this in turn lead to crop failure.

3.2. Internal factors

Four internal factors that influenced the farmers' initial decision to adopt the rice growing technology were identified. These were: personal characteristic, on-farm factors, cultural factors and the leadership characteristics of the community group. Although other studies (Doss & Morris, 2001; Deressa et al., 2009) have identified gender, level of education, and training as important determinants of the adoption decision of farmers, these factors did not influence the adoption decision of farmers in this study.

Age has been reported to positively influence the adoption decision of farmers (Deressa et al., 2009). However, in this study, the results were less clear cut. Age and the labour intensive nature of the crop influenced the oldest farmer not to adopt. The majority of farmers in this study had previous experience in rice growing and community groups in the 1990's, which influenced their decision to adopt the technology. Khanna (2001) and Hassan & Nhemachena (2008) reported that previous experience with agricultural technologies had a positive influence on the adoption decisions of farmers. However, the non-adopters found that the rice programme in the 1990's did not work well and this influenced their decision not to adopt. Despite many of the adopters having negative experiences in relation to the previous rice project and other government programmes, they still adopted the technology because they believed that the government would put in place mechanisms that would overcome the problems experienced in the past.

The on-farm characteristics that were identified to have influenced the farmers' initial adoption decision included: proximity of the rice farm to farmers' home, land free from land-dispute and location of the farm close to the water source. The proximity of the rice field to the farmers' homes reduced the time and effort required to travel to the farm. In the SI, land is increasingly a subject of conflict, where tribes argue with each other over which development projects they will undertake on their land. The location of the farm on a piece of land free of dispute influenced the farmers' decision to adopt the rice growing. The location of the farm close to an available water source also affected the farmers' decision to adopt rice. Despite a number of positive on-farm characteristics, the majority of the farmers in the village did not adopt the technology.

The cultural practices of the local community also influenced the farmers' decision to adopt rice growing and showed two contrasting perspectives. Rice played an important role as the main food source during local feasts, ceremonies and other traditional village activities. Herbig and Miller (1991) and Stanley et al. (2000) reported that farmers will only adopt a technology which is compatible to their norms and cultural practices. In contrast, the non-adopters stated that one of their reasons for not adopting the technology was because it was labour intensive and that this would limit the time they had available to attend cultural activities.

Leadership characteristics of the project leaders did not influence the decision of farmers who adopted the rice technology. Both, the adopters and non-adopters perceived that the leaders of the community group had limited technical skills and knowledge in rice growing, lacked both technical and management skills and had poor attitudes. Similar leadership characteristics were identified in the literature (Damanpour & Schneider, 2008). The non-adopters stated that the leaders did not put the interests of the community group ahead of their own. They showed a lack of respect towards some group members, even though they had considerable experience in rice production.

3.3. External factors

This research identified five external factors that influenced the farmers' decision to adopt the rice growing. These were: government policy, infrastructure development, agro-climatic condition, access to extension services, and access to markets. Similar external factors have been identified in the literature (Zeller et al., 1998; Granner and Sharpe, 2004; Akpabio and Inyang, 2007; Langyintuo and Mungoma, 2008).

This study found that government policy was one of the most important factors that influenced the farmers' initial decision to grow rice. Government policy provided several incentives: provision of capital and variable inputs, provision of a labour subsidy, adoption of a community group approach, leasing of suitable land, and provision of advice through the extension organisation. The key element of the policy that influenced the farmers' initial decision to adopt the rice technology was the community group approach. The adopters perceived the community group approach as positive because it increased the opportunity for group members to acquire new knowledge and skills from experts within the group. Other studies (Meinzen-Dick, 2002; Granner & Sharpe, 2004) also reported that a community group approach has the potential for pooling the abilities, expertise and resources of people in the group. The farmers also perceived that working in a community group would allow them to share the work load.

Poor implementation of the policy influenced the adopters to discontinue the rice technology in 2010. Only three of the policy elements (leased land, labour subsidies and provision of advice) were implemented, and the labour subsidy was only implemented partially. The government had failed to deliver the capital and variable inputs such as: tractor, rice processing equipment, fertilisers, pesticides and fungicides to the farmers as promised. This led to crop failures and discouraged the farmers from continuing the project.

The village had a good road and transport system. Access to processing equipment was also found to influence the farmers' decision to adopt the rice technology. It was found that the village had rice processing equipment and as such farmers compared this situation to the 1990's, when rice was harvested and sent to Honiara for processing, which was expensive.

The agro-climatic conditions of the area also influenced the farmers' decision to adopt the rice technology. Favourable agro-climatic factors such as: soil quality, rainfall sunshine hours and temperature were perceived by farmers to contribute to high rice yields and, therefore, it was expected that this would lead to improved food security and income.

Although the infrastructure and agro-climatic conditions were good the majority of farmers did not adopt rice. They mentioned that the quality of the road and transportation system in the area had greatly reduced the cost of transporting local produce to market.

Access to extension services was one of the factors that influenced the farmers' initial decision to adopt the rice growing. The farmers perceived that since they were located close to the provincial capital Auki, they would have good access to extension services. When the project was implemented post-2007, the extension officers provided advice on rice growing, but they did not provide the capital and variable inputs. Despite the provision of good advice on rice cultivation, failure to provide critical inputs resulted in crop failure and as a result, farmers discontinued growing rice in 2010.

Market access was an important external factor that influenced the farmers' decision to adopt rice. The Fiu Rice Project was located close to three expanding markets: Fiu village, Aligegeo School and Auki. The price for rice in these markets was also increasing due to the expanding population. Other studies (Zeller et al., 1998; Ransom et al., 2003; Akpabio & Inyang, 2007) also reported that good access to markets positively influenced the adoption decision of farmers. In contrast, the non-adopters did not adopt rice because of access to the three markets. In this case, there was also a growing market for local staples and the non-adopters saw this as a better source of additional income.

4. Conclusions

The Rice Section of the MAL encouraged and promoted rice growing to farmers in the SI in order to be able to reduce the country's rice imports and improve food security in rural areas. The study identified that the decision related to the adoption of rice as a new crop was different to most other studies in two distinct ways. First, the new crop was to be grown by a community group as opposed to individual farmers. This meant that issues such as the management and leadership of the community group were important factors that are not relevant when an individual farmer grows a new crop on his own land. Second, where the adoption of a new crop is concerned, farmers tend to consider this as a substitution problem. That is, they consider if they are better off substituting a hectare of the new crop for a hectare of their old crop. In this instance, the substitution did not occur through land use, but rather through the substitution of labour.

The factors that influenced the adoption of rice growing could be classified into the characteristics of the technology, internal and external factors. However, the influence of these factors on the adoption decision of the farmers was context dependent. As such, a factor might be important to one farmer, but irrelevant to another from within the same community. This suggests that viewing adoption from a "factor" perspective is too simplistic and that future work should investigate adoption in a more systemic manner.

The case was interesting because the technology had a number of positive attributes and the government had gone to some lengths to counter the negative attributes. Rice growing provided a number of relative advantages over the existing crops, it suited the agro-climatic conditions, the crop was valued by the community and played an important role in cultural events, and the infrastructure in terms of processing, transport, markets and access to extension support was good. Against this, the negative attributes were the complexity, lack of compatibility with traditional practices, the resource requirements of the crop and the risk of crop failure. To counter these problems, the government developed a policy that would provide extension support, capital and variable inputs, a labour subsidy, undisputed land and a community group approach. Despite this, only 30 out of 1152 farmers in the village adopted rice growing.

The major constraint to adoption was the farmers' distrust of government programmes which have failed to deliver in the past. They also distrusted the leadership of the community group because they lacked technical and group management skills and put their own interests before that of the community. The farmers that adopted rice believed that the government would provide the promised support and that the extension service would develop the capability of the leadership such that the project would succeed. Unfortunately, the government failed to deliver key inputs which resulted in crop failure and the leadership of the community group proved inept in their management of the project.

For the project to be successful, funds needed to be made available so that the MAL could provide the capital and variable inputs and the labour subsidy in a timely fashion to the community group. This would have reduced the lack of trust that the farmers had in the governments' ability to deliver on programmes and help ensure high crop yields, whilst minimising the risk of crop failure. Furthermore, the selection of community group leaders with the right attitudes, technical and group management skills was critical for the successful implementation of the project.

5. References

Akpabio I.A., Inyang E.B., 2007. Major constraints affecting aquaculture development in Akwa Ibom State, Nigeria. African Journal of Aquatic Science, 32(1), 45-50.

Azilah M.E., 2007. Adoption of Cassava Technology for Sustainable Livelihoods: A Thesis Presented in Partial Fulfilment of the Requirements for the Degree of Master of Applied Science in Rural Development at Massey University, New Zealand. Massey University, Palmerston North.

Damanpour F., Schneider M., 2009. Characteristics of innovation and innovation adoption in public organizations: Assessing the role of managers. Journal of public administration research and theory, 19(3), 495.

Deressa T.T., Hassan R.M., Ringler C., Alemu T., Yesuf M., 2009. Determinants of farmers' choice of adaptation methods to climate change in the Nile Basin of Ethiopia. Global Environmental Change, 19(2), 248-255.

Dey I., 1993. Qualitative data analysis: A user friendly guide for social scientists. London: Routledge

Doss C.R., Morris M.L., 2000. How does gender affect the adoption of agricultural innovations? Agricultural Economics, 25(1), 27-39.

FAO, 2010. Statistical database – FAOSTAT. FAO, Rome.www.faostat.org

Feder G., Umali D.L., 1993. The adoption of agricultural innovations: A review. Technological forecasting and social change, 43(3-4), 215-239.

Granner M., Sharpe P., 2004. Evaluating community coalition characteristics and functioning: a summary of measurement tools. Health Education Research, 19(5), 514.

Hassan R., Nhemachena C., 2008. Determinants of African farmers' strategies for adapting to climate change: Multinomial choice analysis. African Journal of Agricultural and Resource Economics, 2(1), 83-104.

Herbig P.A., Miller J.C., 1991. The Effect of Culture upon Innovativeness. Journal of International Consumer Marketing, 3(3), 7-53.

Khanna M., 2001. Sequential adoption of site-specific technologies and its implications for nitrogen productivity: A double selectivity model. American Journal of Agricultural Economics, 83(1), 35-51.

Langyintuo A., Mungoma C., 2008. The effect of household wealth on the adoption of improved maize varities in Zambia. Food Policy, 33 (6), 550-559.

McGregor A., 2006. Solomon Islands Smallholder Agriculture Study, Volume 3: Market and marketing Issues. AusAID, Canberra, Australia [www document].URL. http://w.w.w.ausaid.gov.au/publication/pdf/solomon_study_vol 3.pdf.

Meinzen-Dick K., 2002. What affects organization and collective action for managing resources? Evidence from canal irrigation systems in India. World Development, 30(4), 649-666.

Ogunlana E.A., 2004. The technology adoption behavior of women farmers: The case of alley farming in Nigeria. Renewable Agriculture and Food Systems, 19(01), 57-65.

Pannell D.J., Marshall G.R., Barr N., Curtis A., Vanclay F., Wilkinson R., 2006. Understanding and promoting adoption of conservation practices by rural landholders. Australian Journal of Experimental Agriculture, 46(11), 1407-1424.

Ransom J., Paudyal K., Adhikari K., 2003. Adoption of improved maize varieties in the hills of Nepal. Agricultural Economics, 29(3), 299-305.

Rogers E.M., 2003. Diffusion of innovations. New York: Free Press.

Rogers E.M., 1995. Diffusion of innovations. New York: Free Press.

Solomon Islands Government (SIG), 2007a.Ministry of Agriculture and Livestock Annual Report, MAL, Honiara, Solomon Islands.

Solomon Islands Government (SIG), 2007b. Solomon Islands Agriculture and Rural Development Strategy, Ministry of Development Planning and Aid Coordination, SI

Solomon Islands Government (SIG), 2008.Ministry of Agriculture and Livestock: Annual Report 2008, MAL, Honiara, Solomon Islands.

Solomon Islands Government (SIG), 2009a. Ministry of Agriculture and Livestock: Annual Report 2009, MAL, Honiara, Solomon Islands.

Solomon Islands Government (SIG), 2009b. Ministry of Agriculture and Livestock: Agriculture Corporate Plan 2009-2010, MAL, Honiara, Solomon Islands.

Solomon Islands Government (SIG), 2010. Ministry of Agriculture and Livestock (National Rice Sector Policy: (2010-2015), MAL, Honiara, Solomon Islands.

Stanley J., Clouston B., Baker R., 2000. Understanding land manager constraints to the adoption of changed practices or technological innovations: Literature review. Case Studies in Increasing the Adoption of Sustainable Resource Management Practices. Land and Water Resources Research and Development Corporation (LWRRDC), Canberra, ACT.

Sunding D., Zilberman D., 2001. The agricultural innovation process: research and technology adoption in a changing agricultural sector. Handbook of agricultural economics, 1, 207-261.

Warner B., 2007. Smallholders and rural growth in Solomon Islands: Prepared for: Economics workshop on Pacific Agriculture, Lae, Papua New Guinea.

Zeller M., Diagne A., Mataya C., Consumption I.F.P.R.I.F., Division N., 1998. Market access by smallholder farmers in Malawi: Implications for technology adoption, agricultural productivity and crop income. Agricultural Economics, 19 (1-2), 219-222.

TRANSFORMING COMMUNITIES THROUGH AGRICULTURE: DEMONSTRATION PLOT SEEDCANE MODEL IMPROVES THE LIVELIHOODS OF SMALL-SCALE SUGARCANE GROWERS

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Abstract

The small-scale farms in the communal areas of Noodsberg mill supply area, KwaZulu-Natal Province, South Africa, were not productive for many reasons, including a lack of resources, knowledge and access to finance and high food insecurity. An innovative extension approach was required to uplift communities and ensure the success of agricultural projects at a small grower level. Thus the "Demonstration Plot Seedcane Model" was initiated and developed. The project was a multi-stakeholder, private-public approach which aimed to improve the agronomic knowledge and skills of small growers while raising awareness of the high potential of the area's natural resources for sugarcane production. Through this extension methodology, growers could become aware of the value of scientific research for their livelihoods. Key agronomic skills and knowledge transfer would include understanding differences in varieties; the importance of soil sampling, approved, locally available seed cane and pest and disease monitoring. In addition, environmental sustainability and good farming practices form the basis of the extension and technology transfer activities and promotes improved farmer co-operation and community coherence. The "Demonstration Plot Seedcane Model" allows for highly scientific information to be transferred and adopted in an accessible manner. The project, spanning 11 years, has resulted in vastly improved yields, increased area under sugarcane and improved livelihoods in the community. The contribution to the local economy is significant as is the increased stability of sugarcane supply to the local mill. This has, in turn, created job opportunities and reduced poverty at both household and community level. The model is repeatable in other regions, can be extended to other commodities and results in improved skills adoption, income generation and job creation.

Keywords: extension, rural development, sugarcane small growers

1. Introduction

Smallholder farms represent more than 95% of Sub-Saharan Africa's agriculture. However, with foreign aid and investment in Africa declining due to the global economic crisis, it is more critical than ever to assist small farmers to become economically successful and sustainable. Historically, small grower projects are viewed as a poor investment and have generally not remained sustainable once investment and support is withdrawn. Extensive investment capital has previously been channelled into KwaZulu-Natal (KZN) Province, South Africa small grower projects with little or no long term success. Several reasons for these failures have been identified, including a lack of capital, resources and technology, poor natural resource management and complex issues of land tenure and security. A lack of understanding of local socio-economic conditions and cultures has also been a challenge. The South African sugar industry is under pressure to stabilize the supply of sugarcane to the mills and some mills are currently operating below capacity. In addition, commercial grower production levels are beginning to plateau due to a loss of agricultural land to non-agricultural development such as residential estates, industry and mining, expansion onto marginal land and increases in production inputs. Land available for significant future expansion for sugarcane production exists primarily within communally owned areas where large tracts of high value land are underutilized. Small scale growers number about 48 000 and currently produce 12% of the total South African sugarcane supply (SACGA, 2005), with farm sizes of 30 hectares or less. Sugarcane as an industry offers a unique opportunity for rural development, job creation for unskilled and skilled labour and income generation. The industry currently employs 11% of South Africa's agricultural labour force and has been shown to accelerate social and infrastructural development in rural KZN, as well as developing emerging farmers and supporting land reform initiatives (Blom, 2011).

To improve production in communal areas, an extension methodology is required that addresses the numerous constraints and challenges, develops skills and builds financial independence. Such a methodology must result in effective and sustainable improvement in sugarcane yields of small grower farmers. In the study area, Noodsberg, KZN Province, South Africa, much of the land available to small growers is highly suited to the production of sugarcane but lies fallow due to many challenges that face small growers. However, the sugar industry is well organized to accept and support new growers in that the local mill is able to accept additional cane, contractors are available to assist growers with land preparation, planting, harvesting and transport, the price per ton is guaranteed and no marketing is required. This presents a unique opportunity for these new entrants to the industry to become successful.

2. Background

Prior to 1999, the communities of Noodsberg communal area were involved in mixed farming including small plots of maize, sugarcane, household vegetables and livestock. In 1999, funds were released by government departments to assist the small sugar growers with planting two sugarcane demonstration plots to show the viability of sugarcane as a commodity, offer agronomic training and showcase the high potential of the natural resources. Agricultural development in these areas was challenging as homesteads traversed the landscape for thousands of hectares, land parcels were small and soil conservation management such as contours and waterways were difficult to implement due to scattered settlements, informal road networks and gravesites. Sugarcane production was decreasing, growers displayed a low level of technical knowledge and there appeared to be no structured system of knowledge transfer. In addition, growers lacked resources such finance for inputs, fertilizer, seedcane, transport and other equipment and struggled with ineffective and/or insufficient extension support and guidance. Most small growers depend on contractors for harvesting and transport since very few own or have access to equipment and machinery. However, many of the contractors offer poor service quality (Meyer & Nothard, 2005) and pricing is not standardised. Other complex issues such as political infighting, land tenure and security remained stumbling blocks to agricultural productivity. Thus, the small growers remained trapped in economically non-viable activities, were food insecure and highly vulnerable to risk. Sugarcane was not viewed as a viable economic alternative as income levels were low due to poor production practices, ageing ratoons (regrowth after harvesting) and a lack of access to low cost disease free seedcane (vegetative plant material).

In the Noodsberg Mill supply area, a lack of access to finance for suitable seedcane was an important limitation to sustainability and the potential of the communally owned areas was not being realized. The use of demonstration plots for training, technology transfer, evaluating varieties under local conditions and as seedcane nurseries, needed to be expanded. Since small growers were reluctant to replant fields due to the expense of purchasing and transporting seedcane long distances, the demonstration plots offered a practical opportunity to close the seedcane gap and introduce new varieties to local growers.

While the demonstration plots were very successful for showing the economic viability of sugarcane in the region, as well as the high potential land resources the communities resided upon, expansion remained stagnant. In 2002, an additional demonstration plot was implemented which also produced high yields under local conditions, but crop losses, fires and a lack of security led to no income being realised until 2005, even though the traditional leadership was very supportive and allocated land for new plantings. Detailed natural resource surveys undertaken in 2005 by extension staff finally raised awareness of the extremely high potential of the area for all forms of agriculture.

The Noodsberg area falls into the top 1% of South Africa's land potential categories ie. deep, apedal, well-drained humic soils, high rainfall, moderate temperatures, wind and frost free and gently sloping terrain. Additionally, the area was in close proximity to the local mill, local contractors were available to harvest, plant and transport sugarcane, there was a guaranteed market and good road infrastructure and most dwellings had access to potable water and electricity. Another advantage of the area was that growers were well organized with grower group representatives. An innovative approach was needed to ensure the successful adoption, implementation and sustainability of this development project; a methodology which would capacitate growers and extension officers and increase the involvement of the local mill and other roleplayers in the project. If this could be achieved, the project would become a vehicle for rural development, job creation and income generation for the communities as well as remaining self-sustaining into the future.

3. Methodology

A new methodology, developed to address the above mentioned issues, was implemented in 2005 in the Noodsberg communal area (KZN Province, South Africa) (Figure 1).

This methodology offered a structured and highly organized approach which insisted on commitment from relevant roleplayers including financiers, millers, research organizations, extension support, cooperatives and contractors with clearly outlined tasks and responsibilities for each organization and/or individual. Previous projects had failed where the growers, in particular, were not involved in the planning process, a factor that had been recognized by Hart (2001). It is important that the planning stages are participatory and that the roleplayers were in agreement and had committed resources to the project, the newly developed methodology followed a stepwise process outlined below for each additional demonstration plot planted:

1. Community consultation with growers and leadership to select a co-operator (successful grower) who will become a seedcane merchant for the next two crops.
2. Acquire finance for the project.
3. Selection of land with suitable land potential (Camp, 2001) which is of uniform and representative soil type for the area, accessible by car, weed free, approximately two hectares in size and fenced.
4. Regular (monthly), monitored field training days and meetings (Bembridge, 1997) were organized according to the agronomic calendar which covered all aspects of sugarcane agronomy from soil classification, soil fertility, land use planning, runoff control, weedicides, herbicides, choice of variety, planting, pest and disease control, fertilization, harvesting etc. As each training day progressed through the growing season, the relevant action was implemented on

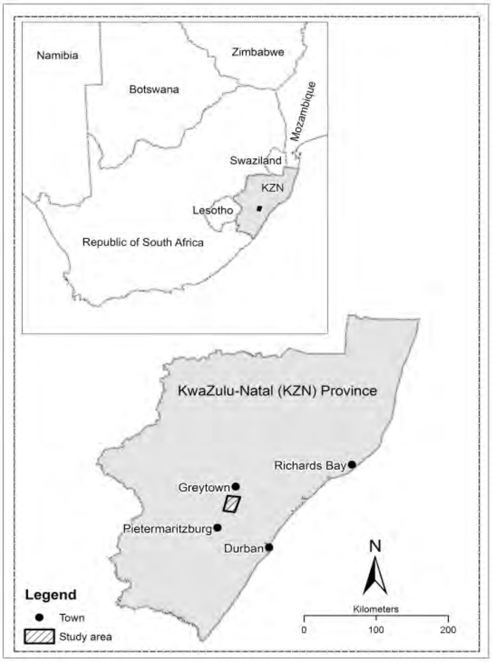

Figure 1. The locality of the Study Area of Noodsberg, KZN Province, South Africa

or before that day eg hand planting of sugarcane (the norm for small scale growers) would be demonstrated on an already prepared field and then undertaken by the attending growers under the supervision and direction of the extension officer and/or field scientists.

5. Land use planning surveys were undertaken to ensure correct land use management and compliance with legislation ie waterways, contours, sugarcane extraction routes, soil sampling for fertility correction. A detailed natural resources survey and data sheet must be completed with the grower and roleplayers at which the link between the soil type, yield potential and potential income is explained and quantified.
6. Arrange for inputs to be supplied and delivered timeously (seedcane, transport, land preparation, planting).
7. Agricultural Extension Officer (AEO) and the grower agree to a site management plan (weed control, topdressing, firebreaks, fencing) and sign an agreement which commits both to undertaking various responsibilities throughout the life of the project. This includes detailed record keeping for each plot by the grower and AEO. The co-operator agrees to allow unrestricted access to the plot by roleplayers, make available its use for training and undertakes the on-going management of the plot.
8. The AEO's work programme must include two critical areas: the annual planting of additional demonstration plots and issuing and pricing of seedcane. The AEO must also ensure an increase in the number of local growers, the number of hectares planted and technology transfer on e.g. good agricultural practices, business skills, forward planning, environmental stability (Gillespie & Mitchell, 2006 & 2009).

9. The selected site will only be used as a seedcane nursery for the plant and first ratoon crop in accordance with pest and disease control regulations, after which it reverts to commercial cane. A higher profit can be realised for seedcane sold locally to neighbouring growers since transport costs are lower. From the second ratoon crop, the grower will then be paid by the mill for subsequent crops, as it can no longer be used for seedcane. Growers in the area are not allowed to buy seed cane from their neighbours unless the seed cane has been approved by the local Pest & Disease and Variety Control Committee.
10. A new seedcane merchant is identified each year so as to continue the growth of the industry and sustain the demand for seedcane due to expansion.

4. Results and discussion

4.1. Growth in demonstration plots and knowledge transfer

To date 20 demonstration plots have been planted varying in size from 1 to 2 ha and totalling an area of 24.6 hectares. From these demonstration plots, the Noodsberg communities have adopted new technologies, converted their fields to more suitable higher yielding varieties and improved the sustainability and productivity of their crops. Since 2006, 105 field training days were arranged to which all growers were invited. Attendance at these training days was never fewer than 13 but often exceeded 70 people. This is indicative of the renewed interest in sugarcane as a cropping option since the start of this project in the area.

4.2. Resource optimization

This extension methodology has exposed the high potential of natural resources in Noodsberg communal areas and the economic viability of sugarcane as a crop. The communal area planted to sugarcane and supplying Noodsberg Mill has increased by 87% since 2006, expanding from 537.2 hectares to more than 1026 hectares in 2013. A further 8000 ha remains available for future expansion. The total tons sugarcane delivered to the mill per year has increased by 158% from 16466 tons in 2006 to 42600 tons for 2013 (Figure 2). This indicates that the Noodsberg small growers have embraced sugarcane as a viable cropping enterprise and have become successful technically competent growers.

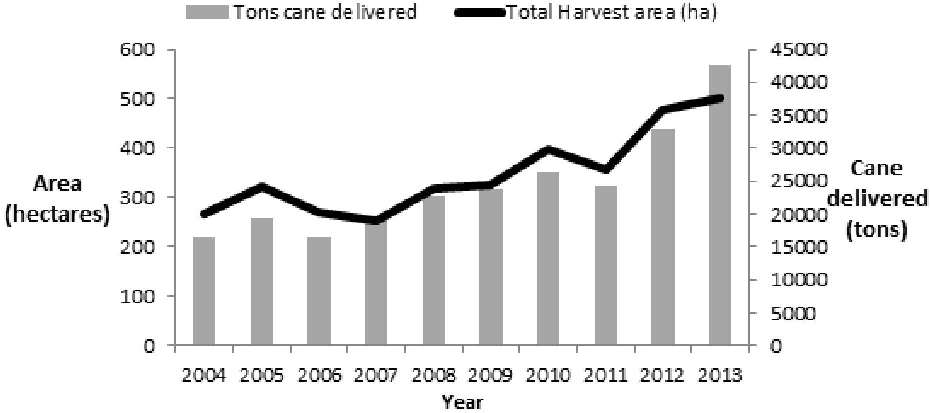

Figure 2. Increase in small grower sugarcane yield and area planted in Noodsberg, South Africa

4.3. Income generation

With the success of this methodology, funding and investment has become increasingly available in recent years to plant additional areas to sugarcane, which has further stabilized supply to the local mill and resulted in job creation and significant income generation within the area. Individual growers have amalgamated into group farming systems (cooperatives) which enables greater control, bargaining power for reduced input costs and more effective management. The project currently has 9 trained and capacitated seedcane merchants who can meet the needs of future growers by supplying locally accessible seedcane. The yields on the demonstration plots are excellent with some achieving in excess of 150 tons per hectare, representing an income of R37 750 per hectare to the seedcane merchant. The number of growers delivering to the mill has more than doubled in 7 years, from 231 (2006) to 477 (2013). Due to improved production and technology transfer, average yields have increased dramatically from 61 tons per hectare (2006) to commercially comparable levels of 85 tons per hectare (2013). This improved production relates to a direct increase in income generation. Total revenue (at current price per ton) to the community has almost tripled: in 2006 gross income was R6.497 million, while in 2013, gross income had risen to R16.819 million (Figure 3).

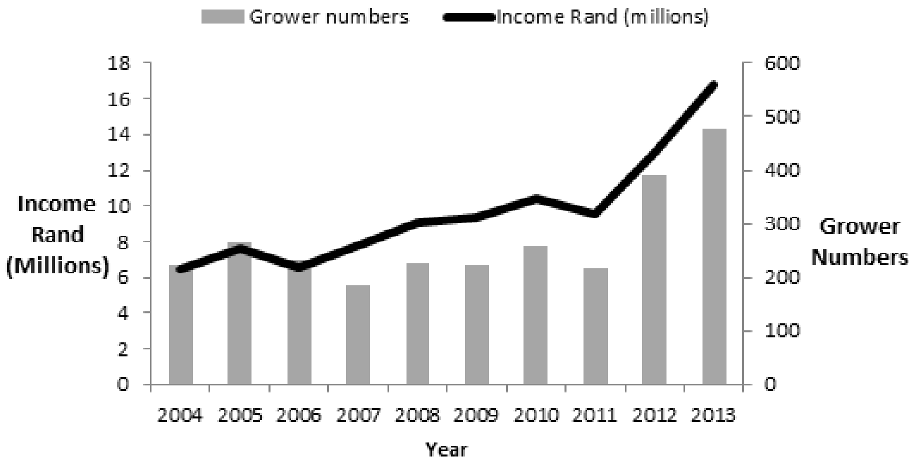

Figure 3. Project impact in terms of increase in small grower numbers and income in Noodsberg, South Africa

4.4. Adoption of new technologies

The link between growers, extension services and research scientists is critical yet is often tenuous. This methodology allowed complex scientific concepts to be related at an appropriate level and in the relevant language. Scientific research results were delivered through on-site training to growers who adopted new technologies within land use planning, soil fertility, production potential, site/soil specific varieties and good agricultural practices to achieve commercial level yields. Three new varieties have been planted in Noodsberg and are being assessed in terms of their productivity in the area when compared to older varieties. Land use planning has been implemented throughout the project area and payment for services such as laboratory testing for fertilizer recommendations and pest and disease monitoring has been adopted. The value of continuous weed control and the use of herbicides have been accepted. These technologies have enabled growers to realise higher yields and income. The link between good site management, yield, area and income has been clearly recognized.

5. Conclusions

Land resource assessments have had significant value in identifying and optimizing natural resource potential in Noodsberg Mill supply area. Demonstration plots planted as seedcane nurseries have motivated small growers to adopt better farming practices, offered greater access to cheaper disease-free seedcane and have resulted in significant increases in sugarcane supply to the mill. The plots have resulted in an awareness and adoption of new varieties and served as a technical training facility. Relationships between local growers, technicians and the miller, as well as the link to scientific research, have been strengthened. Growers have learnt valuable business skills and have learned to be more cost-effective in their management and production activities. The demonstration plots have acted as a catalyst for development, job creation and higher economic returns, resulting in sustainable and improved livelihoods. The methodology has been documented in a detailed manual for use by extension staff and other development agencies. Growers in the Noodsberg area have participated and benefitted from this project methodology, resulting in improved yields, increased income, food security and levels of knowledge that lead to sustainability of the growers themselves, making them less dependent on support. This methodology can be easily repeated in other areas, and can be applied to other commodities.

6. References

Bembridge TJ., 1997. Agricultural publication in small-scale farmer extension. *South African Journal of Agricultural Extension* Vol. 26:1-11.

Blom N., 2011. Sugar Industry can help to kill several birds with one stone. *Agricultural Commentary. Business Day Newspaper*, Johannesburg, South Africa. November 2011.

Camp K.G.T., Mitchell F.J., Bennett R.G., Whitwell P.P., 2001. Unlocking Agricultural Potential: The KwaZulu Natal Bioresource Programme. *Proceedings of 35th South African Society for Agricultural Extension Congress*, Upington, South African.

Gillespie W.A., Mitchell F.J., 2006. A successful methodology for the establishment of an extension programme in a small grower area. *Proceedings of the 80th South African Sugar Technologists Association Congress:* 80:188-89.

Gillespie W.A., Mitchell F.J., Way M., Webster T., 2009. Demonstration Plots Double as Seedcane Nurseries for Small Scale Growers in the Noodsberg Areas. 83rd South African Sugar Technologists Association Congress Proceedings.

Hart T., 2001. Participatory Project Planning as a Means for Improving Research and Extension Management: Some Theories and Recent Experiences. Proceedings of 35th South African Society for Agricultural Extension Congress, Upington, South African.

Meyer E., Nothard B.W., 2005. Logistics and Challenges in Delivering Small-Scale Grower Sugarcane in KwaZulu-Natal. South African Sugar Research Institute Internal Publication, Mount Edgecombe, South Africa.

SACGA, 2005. Statistical Data G/215/2005, 1995/96 – 2004/5. South African Cane Growers Association Publication, Mount Edgecombe, South Africa.

INTERNATIONAL ORGANIZATIONS AND AGRICULTURAL DEVELOPMENT IN NIGERIA: AN ANALYSIS OF RICE AGRIBUSINESS UNDER THE WORLD BANK ASSISTED SECOND NATIONAL FADAMA DEVELOPMENT PROJECT (NFDP II) IN ADAMAWA STATE, NIGERIA

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Abstract

Declining Agricultural Productivity in Nigeria has necessitates implementation of various programmes and projects. Some of these projects/programmes were supported, funded or co-founded by International Organizations and Agencies. Recently, the World Bank (WB) and African Development Bank (ADB) implemented the Second National Fadama Development Project (NFDP II) during the year 2004-2010 in eighteen (18) States of Nigeria. Twelve (12) States including Adamawa State were supported by the World Bank while the remaining six (6) States by the African Development Bank. This study evaluates the performance of Rice Agri-business via comparison of Fadama II participating and Non-Fadama II Rice Actors in the study area, with a view to ascertain and validate Fadama documents which reported success of the project. Primary data were collected through the use of questionnaire administered to a total of three hundred and forty six (346) randomly selected respondents comprising of 202 Fadama II and 144 Non- Fadama II Actors. Socio-economic analysis of the respondents shows that Fadama II Rice Actors were better educated, younger and more productive than the Non- Fadama II Rice Actors. Profitability analysis also revealed that Fadama II Rice Actors were making more profit than the Non- Fadama II Rice Actors. It is therefore concluded that, the World Bank Assisted Second National Fadama Development Project had impacted positively on Rice sector and hence Agricultural Development in Adamawa State. It is therefore recommended that, similar projects should be put in place by various International Organizations and Agencies in Nigeria.

Keywords: Fadama,international organizations, agencies, rice, agri-business and development

1. Introduction

The World Conference on Agrarian Reform and Rural Development (WCARRD) held in 1979 agreed on primary objective of Agricultural and Rural Development Projects to be eradication of Poverty, Hunger, and Malnutrition. Also, essential contributory objectives include growth with Equity, National Self- reliance, Ecological harmony and the Conservation of natural resources (Arene, 2008). Different Countries of the World have had to execute several projects targeted at improving Agricultural Production, and provision of social infrastructure in the rural areas (UN- ACC, 1994). The World Bank and the African Development Bank recently supported the Second National Fadama Development Project (NFDP II) in Nigeria with US$ 100 million and US$ 30 million respectively. Out of the 18 States that participated in Fadama II project, twelve (12) of them were assisted by the World Bank and include Adamawa, Bauchi, Gombe, FCT, Imo, Kaduna, Kebbi, Lagos, Niger, Ogun, Oyo and Taraba (NFDO, 2007) while the remaining six (6) by the ADB. Fadama II was designed to operate for six years (2004- 2010) with a goal of contributing to Poverty reduction in Nigeria. However, actual implementation did not begin until September, 2005.

NFDP II was targeted as a follow up to Fadama1 that was adjudged successful. Its approach was Community Driven Development (CDD) with emphasis on social inclusiveness and empowerment of the rural people to take charge of their development agenda. The main objective of the project is to sustainably increase the incomes of the Fadama users through expansion of Farm and Non- Farm activities with high value added output (PCU- NFDO, 2005).

Rice Agri-business comprises Input suppliers, Producers, Processors, Traders/Marketers and Consumers (Rujis, *et. al.,* 2001). The ban imposed in Nigeria on rice importation in 1985 was due to the colossal amount of money being expended to import large quantity of the commodity resulting from high demand and low domestic supply. The policy objectives were to encourage domestic production and since then available statistics has indicates improvement in the hectares and quantity of rice produced domestically. However, even though the quantity is not enough to meet domestic requirement but have encouraged proliferations of more rice farmers, processors, produce and inputs marketers in the Country and Adamawa State in particular. Therefore, it provided employment opportunities to many stakeholders along the rice value chain. Accordingly, any meaningful approach to improving domestic rice sector should consider the entire chain. In line with this development, the researcher embarked on enterprise by enterprise analysis of the rice sub – sector specifically under a particular project with the hope of understanding how far the project has achieve for better planning.

2. Objectives

The main objective of the study was to compare the performances of Fadama II and Non-Fadama II rice actors in the study area. Specific objective include to:

a) describe the socio-economic characteristics of Fadama II and Non- Fadama II rice actors in the study area; and
b) estimate cost and returns of rice actors under Fadama II and Non- Fadama II in the study area.

3. Methodology

3.1. The study area

The study area is Adamawa State (latitudes 8^o and 11^o North and longitudes 11.5^{oo} and 13.75^o East) with land area of 39,742.12 sq. km which is about 4.4 percent of the land area in Nigeria (Kornoma *et al.,* 2002 ,Adamawa State Diary, 2005). The State had a population of 3,178,950 according to National Population Census (NPC, 2006) (80% reside in rural areas and engaged in Agricultural Production) and is divided into 21 Local Government Areas (Kormowa et. al., 2002, Adamawa State Diary, 2005).

The State has about 4.2 million hectares of land out of which 2.9 million are arable but only 0.232 million hectares (i.e. 8%) are under cultivation annually. The mean farm size per farming household in 2001 was 0.73 hectares which indicate that majority are small scale farmers. However, there are few medium and large scale farmers with farm holdings exceeding 5 hectares (Kormowa et al., 2002). The rainy season commences in April and ends in October. Average rainfall for the State is 700 mm in the northern parts and 1600 mm in the southern parts which is a good range for rice cultivation (Adebayo, 1999).

3.2. Sampling technique and sample size

Multi-stage Sampling Technique was used. First stage involved purposive selection of ten (10) Local Government Areas (L.G.As) out of the twenty one (21) L.G.As that participated in Fadama II project in the State which comprised Mubi- North, Michika, Gombi, Song, Fufore, Yola- South, Yola- North, Lamorde, Guyuk,and Ganye.

Second stage involved purposive selection of all the Rice Fadama User Groups (FUGs) and it members including Input sellers (68), Rice Producers (120), Mill Operators (96), and Rice Marketers (120) which gave a total of four hundred and four (404) that constituted the target population.

Third stage involved random selection of fifty Percent (50%) of each of the category of the target population that is Input sellers 48, Rice Producer's 60, Mill Operators 48, and Rice Marketers 60 which gave a total of two hundred and two (202) sampled respondents. For the Non-Fadama II participants (the list of rice interest groups were collected from their associations) within the 10 Fadama II participating LGAs and includes Input sellers 60, Rice Producers 102, Mill Operators 66 and Rice Marketers 60 which gave a total population of two hundred and eighty eight (288). Fifty percent (50%) of the population from each of the rice economic interest groups were randomly selected and includes Input sellers 30, Rice Producers 51, Mill Operators 33 and Rice Marketers 30 that gave a total of 114 sampled respondents.

3.3. Data collection procedure

Data for this study was collected from both primary and secondary sources. Primary data were collected from samples of the respondents. Sources of primary data were Fadama II and Non-Fadama II Rice Actors. The actors considered for the study were Input- sellers, Rice producers, Rice millers and Rice marketers.

4. Data analysis

4.1. Socio-economic analysis (objective I)

Frequency, percentage and mean distribution were used to describe the socio-economic characteristics of Fadama II and Non- Fadama II Rice Actors in the study area.

4.2. Profitability analysis (objective II)

Nuru et al., (2006) used profitability analysis of processing crude honey to estimate profitability of crude honey at farm gate, local markets of the study area were considered. Dejene (2008) also studied the profitability of extension package inputs for Wheat and Barley in Ethiopia. He used simple calculation of value – cost – ratio and the unit of analysis was hectare of land. This study adopted the concept of gross margin and gross profit analysis to analyze the profitability of Fadama II and Non-Fadama II rice actors in the study area. The models were specified as follows:

$$Gross\ Profit = V - C = PQ - \sum_{i}^{n} p_i\, q_i$$

Where:

P = Price of the produce;

p_i = price of the input I;

q_i = quantity of input I;
Q = Total production per hectare;
V = Value of production; and
C = Total cost of production

Gross Margin Analysis was used to measure profit objective 2 of the study. Mathematically, the Gross Margin is expressed as follows:

$$GM = GR - TVC$$

Where:
GM = gross margin per unit of output (N);
GR = gross revenue per unit of output (N); and
TVC = total variable costs per unit of output (N).

5. Results and discussions

5.1. Socio-economic characteristics

Gender of the respondent

Results shows that all (100%) of the Fadama II and Non- Fadama II inputs sellers were Males while majority (90 and 72.7%) of the Rice Producers were Females. Also, all (100%) of the Fadama II and Non- Fadama II Mill Operators were Males. The result further reveals that majority (81.7 and 83.3%) of the Fadama II and Non- Fadama II Rice Marketers were Females. The result implied that females were engaged only on rice production and marketing while rice milling operation and inputs selling were entirely male activities.

Age distribution of the respondents

Results reveals that (88.2 and 36.7%) of the Fadama II and Non- Fadama II Inputs Sellers were within the age brackets of 21-30 years while (78.3 and 36.45%) of the Fadama II and Non- Fadama II Rice Producers were also within the age limit of 21-30 years. It also reveals that 52.1 and 40 % of the Mill Operators under Fadama II and Non- Fadama II were within the age limit of 21-30 years. Majority (75 and 50%) of the Rice Marketers under Fadama II and Non- Fadama II were within the age bracket of 21-30 years respectively. The result is contrary with the findings of Yusuf et al. (2009) in Zamfara State who found that 37% of the rice marketers were at the average age of 35 and 36 years while those youths between 20-30 years constitute the minority. It clearly shows that all the actors under the rice supply chain were at their active and productive age. Ogundele and Okoruwa (2006) also reported that, as age of actors increase, productivity will continue to fall owing to their declining strength. Hence, he suggested that the occupation needed injection of young able people.

5.2. Marital status of the respondents

Results on the marital status of the respondents show that 91.2 and 73.3% of the Fadama II and Non- Fadama II Input- sellers were married. The result also shows that 78.3% of the Fadama II rice producers were married, while 42.4% of the Non- Fadama II were single.

For the Mill Operators, it shows that 75 and 56.7% of Fadama II and Non-Fadama II were married. The result further reveals that 65 and 63.3% of the Fadama II and Non-Fadama II rice marketers were married .The result implied that rice actors in the area were matured and hence their decision making capability and ability is expected to be developed. This could also mean they can discharge their responsibilities diligently.

Family size of the respondents

Result of family size of the respondent shows that both Fadama II and Non-Fadama II Rice Actors had an average of six (6) members in their households. The result implied that respondents need to hire labor because family labor constitutes the bulk labor in small- scale farm operations in Nigeria since they don't have large members in their households more particularly when considering expanding the business. Ogundele and Okoruwa (2006) supported this by reporting that labor constitutes the most important input into small-holder Agricultural production in Nigeria, they further asserts that, labor input can be sourced from within the family (Family Labour), from commercial pool in the labor market (Hired Labour), and from among other farmers (Group Labour). However, family labour constituted the major proportion of the aggregate labour use in Nigerian Agriculture. The report also lamented that, the amount of man -days of family labour that can be engaged by rice farmers will depend on the house hold size, structure of the household and primary occupation of the household members.

The foregoing has clearly indicated the importance of family size. Large family could mean availability of labour for economic activities. It could also mean that, the income generation will be high; hence, there is tendency for savings and investment in better facilities which can improve the quality of the products and income of the actors. However, on one side large family could also mean so many mouths to feed and many people to take care.

Educational status of the respondents

Result on the educational background of the respondents shows that (70.6 and 47.7%) of Fadama II Inputs Sellers and Producers had primary education while (46.7 and 48.5%) of Non-Fadama II input – sellers and producers did not have formal education. For the Mill Operators, 52.1 and 40% under Fadama II and Non- Fadama II had primary education.

Similarly, majority (66.7 and 56.7%) of the Fadama II and Non-Fadama II Rice Marketers had primary education. The results revealed that Fadama II Rice Actors were more educated than the Non- Fadama II Rice Actors. However, both cases had low educational status. This agrees with the National Rice Development Strategy (2006) which reported that low level of education and other players in the rice value chain impacts negatively on local rice production. Ogundele and Okoruwa (2006) also reported that, education plays a significant role in skills acquisition and technology transfer. It enhances technology adoption and the ability of farmers to plan and take risk. Actors with higher levels of education are likely to be more efficient in the use of inputs than their counterparts with little or no education. Therefore, this low educational background of the actors under rice supply chain in the study area is a serious problem and deserves immediate attention and intervention.

Membership of co-operative society

Results on the membership of cooperative societies shows that all (100%) of the input- sellers, Rice Producers, Mill Operators and Rice Marketers under Fadama II belong to Co-operative Societies while only half (53.5%) of the actors under Non- Fadama II belongs to Co-operative Societies. The reason why all Fadama II rice actors belongs to co-operative group is that, it was mandatory to register as co-operative under a particular Economic Interest Group (EIG) before participating in Fadama II project.

The results implied that rice actors under Fadama II Project were more co-operated than the Non- Fadama II Rice Actors. And by extension, since co-operative serve as a prelude to capital mobilization and business formation, it is a powerful tool for Empowerment and Poverty Alleviation. This could mean that Fadama II Rice Actors were alleviated from Poverty and therefore better off than Non- Fadama II Rice Actors. Also it might means that they were more exposed and have better opportunities to pursue their common social as well as economic goals within and outside (such as assistance from Local, National and International Agencies).

Agri-business experience of respondents

Results on the years of experience of Fadama II and Non- Fadama II Rice Actors in the area shows that 47.1% of the input – sellers under Fadama II had less than five years experience while 53.3% of the Input – sellers under Non – Fadama II had five to ten years experience on the enterprise.

It reveals that 36.7 and 36.4% of the farmers under Fadama II and Non- Fadama II had put eleven to twenty years on farming. Also, 43.8% of the Fadama II Mill Operators and 53.3% of the Non-Fadama II Mill Operators has put in less than five to ten years in milling business respectively. Further, it shows that 46.7% of the rice marketers under Fadama II have put 5-10 years on the business while 50% of the rice marketers under Non- Fadama II had less than five years experience.

This result implied that Non- Fadama II rice actors have put more years on the business than the Fadama II Actor. Putting many years on the business might not be the only determinant of efficiency; other factors play a role. Ogundele and Okoruwa (2006) reported that, experience is the best teacher. Thus the longer a person stays on a job, the more likely he becomes an expert. Further, they asserted that Agri-business involves a lot of risk and uncertainties; hence to be competent enough to handle the vagaries associated with Agri-business, actors must have stayed on the farm for quite some time. Since in both cases, they have moderate years of experience on the business, with more emphasis on training, their know-how, skills and capabilities can be enhanced and promoted for better performance.

Consequently this result also implied that, rice milling is an infant industry in the area since majority (78 and 70%) of the millers under Fadama II and Non- Fadama II had less than twenty years experience. This shows that rice milling business received a boost only after the ban of rice import by the Federal Government of Nigeria in 1985 that is nearly three (3) decades ago. This means that, the ban on rice imports has increased rice output, productivity and post harvest activities (milling and trading) in the area.

Net- capital for Fadama II and Non- Fadama II rice actors

Table 1 presents results on the Net- capital of Fadama II and Non- Fadama II Rice Actors. It shows that Fadama II input sellers at the inception of the project (2005-2006) had a mean of ₦1,277,353 but this amount dropped by 15% to a mean of ₦1,087,059 during the period (2007-2008) and increased by 8.3% to ₦1,177,353 during the period (2009-2010). The reason for the dropped during the 2007-2008 could be due to the payment of counterpart funds which stood at 30% of the total requirement for acquisition of pilot assets which have not been supplied. While the Non- Fadama II input sellers had a mean of ₦663,333.3 at inception (2005-2006). However the mean increased by 25% to ₦830,333.3 during the period (2007-2008) and rise by 30% to ₦1,080,333.3. This reveals a steady increase.

The result further indicated that, rice producers under Fadama II at inception (2005-2006) had a mean capital of ₦100,566.7, increased by 35.5% to ₦136,250 during the (2007-2008) period and by (2009-2010), the mean had increased by 36.3% to ₦185,700. Similarly, Non-Fadama II rice producers had a mean of ₦83,030.30 at inception (2005-2006) increased by 25.5% during the period (2007-2008) to ₦104,242.4 and by (2009-2010), the amount increased by 38.1% to ₦143,939.4.

Furthermore, the result revealed that, Fadama II Mill Operators had a mean capital of ₦170,565.0 at inception (2005-2006). The amount increased by 30.9% to ₦223,333.3 during the period (2007-2008), it then increased by 23.3% to ₦275,416.7 during the (2009-2010) period. The Non- Fadama II Mill Operators at inception (2005-2006) had a mean of ₦147,833.3, the amount increased by 27.8% to ₦189,000.0 during the (2007-2008) period, then increased by 17.1% to ₦221,333.0 during the period (2009-2010).

The result also showed that Fadama II rice marketers had a mean capital of ₦97,166.67 at inception (2005-2006), the value increased by 0.2% to ₦97,333.33 during the period (2007-2008), and then increased by 37.3% to ₦133,550.0 during the (2009-2010) period. Similarly, the Non- Fadama II rice marketers had a mean of ₦109,000 at inception (2005-2006), this amount increased by 50.2% to ₦163,666.7 during the (2007-2008) period and then dropped by 5.9% to ₦154,000 during the (2009-2010) period.

Table 1. Net-Capital of Fadama II and Non-Fadama II Rice Actor before, during and after the project

REIGs (Rice Economic Interest Groups)	Observation (n)	Before (2005-2006)	During (2007-2008)	After (2009-2010)
		Mean N		
Input supplier F	(34)	1,277,353	1,087,059 (-15%)	1,177,353 (+8.3%)
Input supplier NF	(30)	663,333	830,333 (+25%)	1,080,333 (+30%)
Rice producers F	(60)	100,566	36,250 (+35.5%)	185,700 (+36.3%)
Rice producers NF	(33)	83,030	104,242 (+25.5%)	143,939 (+38.1%)
Mill operators F	(34)	170,565	223,333 (+30.9%)	275,416 (+23.3%)
Mill operator NF	(30)	147,833	189,000 (+27.8%)	221,333 (+17.1%)
Rice Marketers F	(60)	97,166	97,333 (+0.2%)	133,550 (37.2%)
Rice Marketers NF	(30)	109,000	163,666 (+50.2%)	154,000 (-5.9%)

(%) = values in brackets are changes in F = Fadama II, NF = Non- Fadama II
Source: Survey data, 2012

5.3. Profitability analysis

Gross Margin/ Net Marketing Income For Fadama II and Non-Fadama II Input Sellers

Table 2 present's results on Gross margin of Fadama II and Non-Fadama II inputs marketers. It shows that Fadama II *Input* - marketers were making an average returns and Gross margin of ₦544,117.65 and ₦201,470.59 while the Non-Fadama II rice marketers were making an average returns and gross margin of ₦455,666.67 and ₦112,333.33 respectively.

The results implied that Fadama II inputs marketers were making more money as returns than their Non- Fadama II input marketers. This could be attributed to improvement in marketing infrastructures, training and advices received by the Fadama II input marketers. Improvements in infrastructures were in areas of market shades, stores, and transport facilities. These offered the potentials of cutting down expenses significantly. The variable costs include the followings: Transportation cost, communication, loading and off- loading, security, market assistants, tax and revenues. The fixed cost includes depreciation on Buildings, Stores and Vehicles.

Gross Margin/ Net Production Income For Fadama II and Non-Fadama II Rice Producers

Table 2 present's results on Gross margin/ Net Production income for Fadama II and Non-Fadama II rice producers. It revealed that Fadama II rice producers were making an average returns and Gross Margin of ₦423,340.80 and ₦135,001.05 respectively while the Non- Fadama II Rice Producers were making an average returns and gross margin of ₦340,909.09 and ₦104,545.45 respectively. The above results implied that Fadama II rice producers were performing better than the Non- Fadama II rice producers. This could be as results of improved investment in farm assets, access to genuine farm inputs, and capacity building training received by the Fadama II Rice Actors which translate to increased output and income.

The variable cost include costs of the followings; Seed, Fertilizer, Herbicides, Labour, Transportation. Fixed costs were depreciation on Land, Buildings and Machinery. The Annual income from Fadama II and Non-Fadama II Rice Producers is however lower than the findings of Agom et al.,(2009) who found that majority (50%) of upland rice farmers in Imo State earned an annual income of ₦201,000 and above with an annual mean of ₦205,021.43 within the research period. This suggested that there is still need for improvement among the Fadama II and Non- Fadama II Rice Farmers. Idowu et al., (2009) in a study on profitability level of upland rice production in Ilaro Agricultural Zone of Ogun State, Nigeria used budgetary techniques (cost and returns) to estimate the profit of rice production. They reported a gross margin and net income that accrued to each upland rice farmer per production season on the average to be ₦194,094.88 and ₦185,409.53 respectively. This amount was also higher than what was obtained both under Fadama II and Non – Fadama II rice production in Adamawa State.

Gross Margin/ Net Production Income for Fadama II And Non-Fadama II Rice Mill Operators

Table 2 present's results on Gross Margin/Net Milling Income of Fadama II and Non-Fadama II Rice Mill Operators. It revealed that Fadama II rice mill operators were making an average returns and Gross Margin of ₦176,479.99 and ₦53,479.99 respectively while the Non- Fadama II Rice Mill Operators were making an average returns and gross margin of ₦150,400.30 and ₦38,200.30 respectively.

The results above implied that Rice Mill Operators under Fadama II had more returns that the Non- Fadama II. Similarly the Gross Margin of ₦53,479.99 for the Fadama II Mill Operators was greater than that of Non- Fadama II Mill Operators which stood at ₦36,350.00. The reason for this difference could be explained as result of increased/expansion in milling facilities and improved milling capacity acquired through capacity training offered by the Fadama II project. The variable costs include, cost of diesel/electricity, labor, servicing, tax and revenue, rent and security. The fixed costs were depreciation on building and machine.

Gross Margin/Net Marketing Income for Fadama II and Non-Fadama II Rice Marketers

Table 2 present's results on Gross margin/Net marketing income of Fadama II and Non- Fadama II rice marketers. It revealed that Fadama II rice marketers were making an average returns and gross margin of ₦352,759.98 and ₦62,609.98 respectively while the Non- Fadama II rice Mill Operators were making an average returns and gross margin of ₦290,500.50 and ₦45,500.5 respectively. The above results implied that Fadama II rice marketers had an average returns and gross margin that were greater than the Non-Fadama II Rice Marketers. This could as results of

Table 2. Costs and Returns (Gross Margin/Net Marketing Income) For Fadama II and Non-Fadama II Rice Actors

Item	Fadama II (n = 34)		Non-Fadama II (n = 30)	
	average N	total N	average N	total N
Input- Sellers				
(i). Returns	544,117.65	18,500,000.00	455,666.67	13,670,000.00
(ii). VC	342,647.06	11,650,000.00	343,333.33	10,300,000.00
(iii). FC	5,273.00	179,282.00	4,181.67	125,450.00
(iv). GM	201,470.59	6,850,000.00	112,333.33	3,370,000.00
(v). NMI	196,197.59	6,670,718.00	108,151.67	3,244,550.00
Rice Producers				
(i). Returns	423,340.80	25,400,450.00	340,909.09	11,250,000.00
(ii). VC	288,339.79	17,300,387.50	236,363.64	7,800,000.00
(iii). FC	8,335.74	500,144.20	6,969.70	230,000.00
(iv). GM	135,001.05	8,100,063.00	104,545.45	3,450,000.00
(v). NFI	126,665.31	7,599,918.80	97,575.76	3,220,000.00
Mill Operators				
(i). Returns	176,479.99	6,000,319.70	150,400.30	4,512,009.00
(ii). VC	123,000.00	4,182,000.00	112,200.00	3,366,000.00
(iii). FC	3,400.00	115,600.00	1,850.30	55,509.00
(iv). GM	53,479.99	1,818,319.66	38,200.30	1,146,009.00
(v). NMI	50,079.99	1,702,719.66	36,350.00	1,090,500.00
Rice Marketers				
(i). Returns	352,759.98	21,165,598.80	290,500.50	8,715,015.00
(ii). VC	290,150.00	17,409,000.00	245,000.00	7,350,000.00
(iii). FC	3,050.00	183,000.00	2,400.60	72,018.00
(iv). GM	62,609.98	3,756,598.80	45,500.50	1,365,015.00
(v). NMI	59,559.98	3,573,598.80	43,099.90	1,292,997.00

VC = variable cost; FC = fixed cost; GM = gross margin; NFI/NMI = Net farming income/Net marketing income

Source: Survey Data, 2012

improvement in parboiling skills and marketing strategies. The variable costs include cost of purchasing paddy, milling cost, parboiling cost, transportation and communication, loading and off-loading, tax and revenue, rent and security. The fixed cost were depreciation on items like drums, bowls, buckets wheel barrows, vehicles and trampoline.

6. Conclusions

The findings of this research revealed that Fadama II Rice Actors were younger, better educated and more productive than the Non-Fadama II. Also Fadama II actors have more capital and were making more profit than the Non-Fadama II actors in the area. It is therefore concluded that the Second National Fadama Development Project (NFDP II) had Impacted positively on the Income and livelihood of the rice actors and hence reduce poverty across the gender in the study area. This therefore is in agreement with Fadama II reports and objectives.

7. Recommendations

The following recommendations were made based on the finding of the research:

1. The Non-Fadama II Rice Actors should form viable co-operative groups so that they can benefits from government and Non- Governmental Agencies.
2. Youth should be encouraged to venture into Agri-business as a source of livelihood.
3. Agri-business should be promoted as veritable tool for Poverty Alleviation and Food Security.
4. Appropriate technology should be promoted due to expensive nature for foreign machines and equipments.
5. The skills and know-how of rice actors should be enhanced through reliable training (capacity building).
6. Basic infrastructures should be provided in rural and urban areas to facilitate transportation and exchange function.
7. Prices of basic inputs and outputs should be monitored on win – win basis.
8. Credit facilities for agribusiness operators should be made accessible and affordable.
9. More donor agencies should be advocated to come to the aid of agribusiness operators in Nigeria.

8. References

ADADP, 2002. Adamawa State Agricultural Development Programme Diary.

ADSG, 2005. Adamawa State Government Official Diary

Adebayo A.A., 1999. "Climate 1"*In*: Adebayo, A.A. and Tukur, A.L. (eds.) Adamawa State in Maps, Paracletes Publishers, and Yola, Nigeria. Pp. 20-22.

Agom D. I., Ohen S. B., Idiong I.C., Oji R., 2009. Production function Analysis of upland Rice Farmers in Imo State Nigeria. Proceedings of the 23rd Annual National Conference of Farm Management Society of Nigeria, 14 – 17th December, 2009. Usman Danfodio University, Sokoto, Nigeria.

Arene C. J., 2008. Economic Analysis of Agricultural and Rural Development Projects. Snaap press Limited, Enugu, Nigeria.

Dejene L., 2008. Profitability of extension Package inputs for Wheat and Barley in Ethiopia. The case of Limuna Bilbilo Wareda (Arsi Zone). Rural Development and Environment in Ethiopia; prospects and challenges. Proceedings of the 10th Annual Conference of Agricultural Economics Society of Ethiopia. Addis Ababa, Ethiopia.

FRN, 2009. National Rice Development Strategy (NRDS), A Federal Republic of Nigeria Document, Prepared for the Coalition for African Rice Development (CARD) May, 2009.

Idowu A.O., Ojiako I., Akerele E.O., 2009. Profitability Level of Upland Rice Production in Ilaro Agricultural Zone of Ogun State, Nigeria. Proceedings of the 23rd Annual National Conference of Farm Management Society of Nigeria, 14 – 17th December, 2009.

Kormawa P.M., Ega L., Olukosi J.O., 2002. Needs Assessment Study for Markets – Driven Agricultural Technology Transfer and commercialization in Adamawa State, Nigeria, USAID, Abuja, Nigeria.

National Rice Development Strategy, 2009. Federal Government of Nigeria Document. Prepared for the coalition for African Rice Development (CARD) .

Nuru A., Eddosa N., Sebsibe Z., 2006. Profitability of processing crude honey. Reversing Rural Poverty in Ethiopia; Dilemmas and Critical Issues. Proceedings of the 9th Annual Conference of Agricultural Society of Ethiopia, Addis Ababa. Ethiopia. PP. 133.

Ogundele O.O., Okoruwa V. O., 2006. Technical efficiency differentials in Rice production technology in Nigeria, AERC Research Paper 154, African Economic Research Consortium, Nairobi.

Oladele O.I., Abisoye B.S, 2008. Technology and Extension Gaps Among Rice Farmers in Ogun State, Nigeria, Agricultural Tropical et Sub Tropical Vol.4, pp.160-164.

Olayide S.O., 1980. "Agricultural technology and Nigerian small farmers". In: S.O. Olayide, J. A. Eweka and V.E. Bello- Osagie, eds., Nigerian Small Farmers: Problems and Prospects in Integrated Rural development. Centre for Agricultural Research and Development (CARD). University of Ibadan, Nigeria.

PCU-NFDO, 2005. "Poverty Reduction and increased Productivity through Empowerment". National Fadama Development Project.

Rujis A., Schweigman C., Lutz C., Sirpe G., 2001. In: Benjamin O., Damian I., Simon I., Paul O., 2008. *Making Rice Agribusiness Work in Sub-humid Tropic of Nigeria: The Commodity Value Chain Development Approach: African Journal of Agricultural Research* Vol.3, No.1, pp.779-786.

Second National Fadama Development Office NFDP II, 2007. Poverty Reduction through Empowerment. A publication of PCU – NFDO, Abuja, Nigeria.

Takele A., 2010. Analysis of Rice Profitability and marketing chain: the case of Fogera Woreda, south Gondar zone, Amhara national Regional state, Ethiopia. A thesis submitted to the college of Agriculture Department of Agricultural Economics, School of Graduate Studies, Haramaya University.

Yusuf B. I., Baba K.M., Mohammed I., Dogon Daji S.D., 2009. Determinants of Rice Production: A Guide for Food Security Policy in Nigeria. Proceedings of the 23rd Annual National Conference of Farm Management Society of Nigeria, 14 – 17th December, 2009. Usman Danfodio University, Sokoto, Nigeria.

National Population Commission, 2006. National Population Census.

FINANCIAL MEASUREMENTS TO RANK FARMS IN THE NORTHERN CAPE, SOUTH AFRICA, USING DATA ENVELOPMENT ANALYSIS

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Abstract

Producers use financial benchmarking in agriculture to compare financial performance across production years and to compare competitors in the industry. This study determined whether Data Envelopment Analysis could be used to divide farms in the Northern Cape (South Africa) into different performance groups using financial measurements. Three enterprise groups (crop, mixed, and livestock) were benchmarked using Data Envelopment Analysis and subsequently divided into efficient or inefficient groups according to operating efficiency. Efficient farms had an operating efficiency score of one and inefficient farms less than one. Results indicated that Data Envelopment Analysis could be applied to determine efficient and inefficient farms according to financial results. An alternative benchmarking tool to compare the operating efficiency of one farm relative to similar farms included in the data set was thus provided. It is recommended that the Data Envelopment Analysis benchmarking model be used in conjunction with other models or established norms to provide accurate information and a comprehensive overview of financial performance.

Key words: farm management, Data Envelopment Analysis, financial benchmarking, financial measurements

1. Introduction

An effective method for executing and monitoring strategic and operational plans on a farm is very important to ensure success. These plans, which include the financial structure of the farm, provide a clear sense of the producer's objectives. To ensure the financial objective of the farm is met, producers must constantly evaluate and monitor the financial performance of the farm (Boehlje *et al.*, 1999*)*. Financial ratio analysis is considered to be a standard approach for evaluating financial performance (Ozcan & McCue, 1996). There are some useful financial measurements that when used collectively over time can provide much information about the financial performance of a farm (Ferris & Malcolm, 1999).

The Farm Financial Standards Council, U.S.A., developed financial guidelines for agricultural producers. These measurements are divided into five categories: liquidity, solvency, profitability, repayment capacity and financial efficiency. In each of these categories there are measurements that are referred to as the "Sweet 16" financial measurements (Crane, 2004). Blocker et al., (2003) illustrated the use of the "sweet 16" measurements to obtain norms for the measures where farm performance is divided into three groups, the top -, midpoint - and bottom performance groups to benchmark a farm's financial performance.

Benchmarking is an important tool that can assist farm managers to improve the performance of a business. Benchmarking is defined by Wilson et al., (2004) as a performance indicator that identifies a specific level of performance, which includes best practice performance. Benchmarking with financial measurements provide the performance measurements of the different financial categories of a farm. The measurements can then be compared with the performance measurements of other farms (Wilson et al., 2004). Benchmarking provides information that can be compared to past performances of the farm and can also be compared to other farms (Blocker et al., 2003). Financial benchmarking can be done by dividing the farms into two or more groups on the basis of their performance. In order to divide the farms into performance groups, norms and boundaries have to be established.

A linear mathematical method, the Data Envelopment Analysis (DEA), uses financial measurements of farms to benchmark performance. The DEA method is a nonparametric mathematical model that evaluates the relative efficiency of a group of decision makers based on their input use to produce outputs (Al-Shammari & Salimi, 1998). The DEA uses a linear programming technique to find a set of weights for each farm so that the efficiency score is maximised, but does not exceed a score higher than one (Sarafidis, 2002). Since the development of the original DEA model by Charnes et al., (1978), several extensions have been made. The Charnes et al., (1978) model assumed constant returns to scale, thus assumed a proportional increase in input use would result in a proportional increase in output. The first adjustment to this original model was made by Banker et al., (1984) who accommodated for variable returns to scale. Thus the assumption is that a proportional increase in input use would result in a less or more than proportional change in outputs. Although most of the application of DEA models focus on the use of absolute number variables there are however cases where researchers needed to use ratio variables as input data especially when the aim is to evaluate producers financial performance. This led to the development of a non-parametric model for financial ratios by Fernandez-Castro and Smith (1994), and has since been used by Al-Shammari and Salimi (1998), Feng and Wang (2000), Scheraga (2004), and Ablanedo Rosas (2010) to evaluate relative efficiencies using financial ratios.

This study used the financially based DEA model to evaluate the financial performance of agricultural producers from the Northern Cape, South Africa. The financially based DEA model was used to benchmark the producers based on their financial performance. To evaluate the usefulness of the financially based DEA model the DEA results were compared to results from Henning (2011). Henning divided farms from the cooperative area of ‘Griekwaland Wes Korporatief Limited’ (GWK) into three groups in order to determine their financial performance.

2. Literature review

Financial measurements highlight many factors that can cause unacceptable farm financial performances. Of these factors, some are not in the producer’s control (Boehlje et al., 1999). The producer has several options to improve financial performance; the usefulness of these options will be reflected in the financial measurements.

2.1. Data Envelopment Analysis

Data Envelopment Analysis was used to determine the efficiency of ports and shipping industries by Tongzon (2001). Lin et al., (2005) used DEA to measure the efficiency of selected Australian and other international ports and a performance efficiency evaluation of the Taiwan’s shipping industry. Results of Lin et al., (2005) indicated that performance evaluation for shipping industries can be more comprehensive if financial ratios are used. An innovative adopted version of DEA was used by Ablanedo-Rosas et al., (2010) to study the relative efficiency of Chinese ports. This study made use of a financial ratio based DEA approach and results indicated that the higher a port's efficiency ratio in relation to the corresponding ratio of other ports, the higher the efficiency of this specific port. Apart from shipping examples, DEA was also used as a financial performance index for hospitals (Ozcan & McCue, 1996). Al Shammari and Salimi (1998) and Avkiran (2011) applied DEA to determine the operating efficiency of banks. Both studies used financial ratios to determine the operating efficiency of banks. Min-Feng and Wang (2000) evaluated the performance of airlines and found that performance evaluation was more comprehensive if financial ratios were considered.

The DEA is a method that is widely used in agriculture for a variety of reasons. Fraser and Cordina (1999) used DEA to assess the technical efficiency of dairy farms in Northern Victoria, Australia. Rouse et al., (2007) also used DEA to benchmark the performance of dairy farms. These authors illustrated how DEA can be a useful tool for benchmarking in the dairy industry and how to examine the impact of environmental factors on farm efficiency.

2.2. Benchmarking

Benchmarking is a long-standing, highly developed practice that is used in the agricultural sector (Jack, 2009). Flemming et al., (2006), mention that benchmarking was developed as a farm management tool to detect areas where producers could increase their profit or performance by adopting the methods of their more successful peers. Benchmarking is a powerful management tool that can be used by agricultural producers to manage their risks and improve their profitability (Craven et al., 2011). According to Ferris and Malcolm (1999), benchmarking has a valuable role to play in the improvement of farm productivity and plays a role in farm standards to help identify weaknesses.

There are two types of benchmarking that can be used to analyse and interpret financial records. With historical benchmarking, producers must focus on the improvement of their own financial measurements and the discovery of possible problems (Blocker et al., 2003). The other type of benchmarking compares a farm to other similar farms. The best farm analysis must include accounting guidelines and both of the benchmarking options, namely historical data and similar farm benchmark (Blocker et al., 2003).

Accurate and complete information is needed when a benchmarking system is developed. Another important factor is the amount of information collected over a number of years that will adequately reflect the producer's situation. Yeager and Langemeier (2007) used a sample of Kansas farms and concluded that five years of data are necessary to benchmark similar production enterprise farms.

3. Methodology

The data used in the study was obtained from GWK agribusiness head office in Douglas, South Africa. GWK has a study group of producers in their Northern Cape trading area[1]. The financial statements from the study groups for the years 2004 to 2009 totalled between 76 and 85 farms. Data obtained from GWK included balance sheets and income statements. Only 38 farms were identified to have complete financial statements for the period 2005 to 2009 (5 years). The farms (identified by a number) were divided into three enterprise groups: livestock (9), crop producers (17) and mixed enterprise (12) as shown in Table 1.

[1] Barkley West, Douglas, Hopetown, Marydale, Modderrivier, Niekerkshoop and Prieska.

Table 1. Farm identification numbers, organised per enterprise (n = 38)

Mixed enterprise	Cop enterprise	Livestock enterprise
farm number		
2	4	30
3	5	32
6	8	34
7	9	40
15	13	43
18	14	45
22	16	49
25	17	50
31	20	54
33	21	---
35	23	---
61	24	---
---	27	---
---	29	---
---	38	---
---	44	---
---	69	---

The balance sheet and income statements provided enough information for analysis using the "Sweet 16" financial measurements as identified by the Farm Financial Standards Council (Hoag, 2009). For this study 14 of the "sweet 16" financial ratios were used to analyse the farms and are shown in Table 2 with border ratios for three performance groups as identified by Blocker et al., (2003). Only 14[2] of the 16 measurements were included in the study because information on depreciation was not included in the data set obtained from GWK.

A financial ratio based DEA model was used to rank the farms according to their operating efficiency. Every farm is seen as a decision-making unit (DEA). The DEA model combines multiple financial measurements, as indicated in Table 2, into a single measurement of operating efficiency. The output orientated financial ratio based DEA model with variable returns to scale is defined as follows:

$$\text{Maximise} \quad Z_0$$

$$\text{Subject to:} \sum_{n=1}^{N} \lambda_n r_{in} \geq z_0 r_{i0} \qquad i=1,\ldots,m$$

$$\sum_{n=1}^{N} \lambda_n = 1$$

$$Z_0 \geq 0; \;\; \lambda_n \geq 0 \; (n = 1, \ldots \ldots, N)$$

Where *Z0* indicates the ratio enlargement rate for *DMU0*, λ_n represents the multiplier weights that is used to determine the efficiency frontier. While *ri0* represents the observed measurement for *DMU0*. *N* refers to the total number of DMU's that is appraised on *m* financial measurements (Al-Shammari & Salimi, 1998).

The mathematical model is solved for every farm, and in this manner the relative operating efficiency is determined for each DMU in question (Ablanedo-Rosas *et al.*, 2010). The higher the estimated ratio enlargement rate (Z_0) the lower the level of efficiency. However, interpretation of the estimated Z_0 value can be confusing, therefore an easily interpretable efficiency score (α) was estimated as:

$$\alpha = 1/Z0 \qquad 1 \geq \alpha \geq 0$$

This efficiency score or α allows the ranking of the current DMU's (DMU0), where an efficiency score of one is considerd as efficient and any score less than one (α < 1) is inefficient (Ablanedo-Rosas et al., 2010). The optimisation model used to estimate the DMU's efficiencies was built in the General Algebraic Modelling System (GAMS). The optimisation model was

2 Depreciation was omitted because different methods exist to calculate depreciation debt repayment ratio was not reliable and only a monetary value showing debt repayment capacity was included.

Table 2. Financial measurements used for estimation of the DEA, formulas to estimate financial measures border ratios for the top, mid and bottom performance groups

Liquidity	Formules	Borders		
		Top	Mid	Bottom
Current ratio	Current assets ÷ Current liabilities	>2>	2-1	>1>
Working Capital	Current assets - Current liabilities	?		?
Solvability				
Debt against assets	Total Liabilities ÷ Total assets	<30%<	30%-60%	<60%<
Equity against assets	Total equity ÷ Total Liabilities	>70%>	70%-40%	>40%>
Debt against equity	Total Liabilities ÷ Total Equity	<43%<	43%-150%	<150%<
Pofitability				
Return on Assets	NFI ÷ Total assets	>10%>	10%-5%	>5%>
Return on Equity	NFI ÷ Total equity	>5>	5%-1%	>1%>
Operating profit margin	NFI ÷ gross revenue	>35%>	35%-20%	>20%
Net farm income	Net farm income	?		?
Debt Repayment Capacity				
Capital debt repayment capacity	NFI from operations ± Miscellaneous revenue/expenses + non farm income - income tax + interest	?		?
Financial Efficiency				
Asset turnover ratio	Gross revenue ÷ Total assets	>40%>	40%-20%	>20%>
Operating expense ratio	Total operating expenses ÷ gross revenue	<60%<	60%-80%	<80%<
Interest expense ratio	Interest expense ÷ Gross revenue	<10%<	10%-20%	<20%<
Net income ratio	NFI ÷ Gross revenue	>20%>	20%-10%	>10%>

Source: FFSC, 2008; Blocker et al., 2003

solved 15 times, solving the model for three enterprise groups, once for every year over the five years. This provided data results for the five years to determine changes in performance for each of the farms. An operational efficiency comparison can be made between efficient and inefficient farms of the same enterprise. To compare the results from the financial ratio based DEA to the border measurements from Henning (2011) the percentage of measurements that were in the top third performance for each farm were calculated.

4. Results and discussion

One of the important factors to remember when using DEA was that the farms were compared relative to one another. A farm identified as inefficient or efficient was seen in context to the other farms in the same enterprise category. Farms were benchmarked according to the performance of overall measurements with other similar enterprise farms. An inefficient score did not always indicate that the farm was in danger of bankruptcy, but was just an indication that other farms had a more efficient financial performance. There will always be farms in the bottom, mid-point and top performance group as determined by the border measurements by Henning (2011). The reason for this is because the data is analysed over five years to determine the border values for each measurements.

4.1. Crop enterprise farms

The DEA results for crop enterprise farms are given in Table 3. Farms 13, 14 and 16 were identified as the most efficient over five years. Farms 14 and 16 had more than 50% of their measurements in the top performance groups over the five years. Farm 13 was in the top performance group only once (2007/08) during the five year period. Farm 20 was efficient for four of the five years with a score of 0.998 for 2004/05. The same results were found with Henning's (2011) benchmarking border measurements as indicated by the percentage of measurements in the top performance group. However during the 2004/05 year the percentage of measurement recorded is 28%. During 2004/05, the owner's withdrawals as a percentage of farm profit were very high and that led to decreased measurements. Farm 24 was considered inefficient during the first two years, however, this rating changed to efficient from 2006/07. The border measurement indicated an improvement from only 28% in 2004/05 to a 100% in 2007/08. There was once again a decrease

Table 3. DEA results for crop enterprise farms from 2004 to 2009 (n = 17) and percentage of measurements in the top performance group calculated from Henning (2011)

Farm No.	DEA Results					Percentage of measurements in top performance group				
	2004/05	2005/06	2006/07	2007/08	2008/09	2004/05	2005/06	2006/07	2007/08	2008/09
4	0.983	0.97	0.982	0.984	0.992	28.6%	35.7%	42.9%	42.9%	50.0%
5	0.99	0.917	0.937	1	0.878	28.6%	14.3%	28.6%	42.9%	35.7%
8	0.951	0.947	0.944	0.976	0.956	7.1%	7.1%	14.3%	50.0%	14.3%
9	0.981	0.901	0.895	0.921	0.956	35.7%	14.3%	14.3%	21.4%	35.7%
13	1	1	1	1	1	28.6%	35.7%	35.7%	78.6%	35.7%
14	1	1	1	1	1	64.3%	71.4%	85.7%	100.0%	71.4%
16	1	1	1	1	1	57.1%	50.0%	92.9%	71.4%	78.6%
17	0.819	1	0.993	0.966	0.986	0.0%	7.1%	42.9%	42.9%	28.6%
20	0.998	1	1	1	1	28.6%	78.6%	78.6%	71.4%	78.6%
21	0.885	0.891	0.937	0.981	1	0.0%	14.3%	0.0%	57.1%	42.9%
23	1	0.955	0.961	0.981	1	50.0%	28.6%	28.6%	64.3%	64.3%
24	0.986	0.997	1	1	1	28.6%	42.9%	78.6%	100.0%	92.9%
27	1	0.947	0.961	1	0.997	42.9%	28.6%	21.4%	57.1%	50.0%
29	1	0.947	0.984	0.982	0.983	7.1%	21.4%	57.1%	85.7%	64.3%
38	0.954	0.963	0.894	1	0.902	7.1%	28.6%	21.4%	50.0%	21.4%
44	0.961	0.943	0.96	0.941	0.908	14.3%	7.1%	35.7%	35.7%	21.4%
69	0.709	1	1	0.982	1	0.0%	57.1%	57.1%	14.3%	78.6%

in the number of measurements in the top performance group for the last year but the percentage still remained very high with 93% in this group.

Farms 4, 8, 9 and 44 were inefficient. Using Henning's (2011) technique these farms scored at the bottom or mid-point for each year. When the efficient scores were compared to Henning's (2011) benchmarking measurements most of the scores for farms 4, 8, 9 and 44 were at the bottom or bottom half of the mid-point performance groups. Not one of these farms had more than 50% of their measurements in the top performance group over the five years. When farm measurements were divided into their respective performance groups, the results could be compared to that of the DEA model. The farms identified as efficient by the DEA model were also the farms with the most measurements in the top performance groups or at least in the mid performance group.

4.2. Mixed enterprise farms

The DEA results for the mixed enterprise farms are given in Table 4. Only one mixed enterprise farm (25) was identified as efficient over the five years. Farm 25 was in a very good position when the analysis of each financial measurement was compared to the norms for the GWK mixed farms by Henning (2011). The percentage of measurements in the top performance group indicated the same results with more than 70% of measurements in the top performance group in all years except for 2004/05. Farms 7, 35, and 61 performed well during four production years, there were years when the number of measurements for these farms were lower and performed in the midpoint performance group.

There was only one farm (Farm 2) that never had a DEA efficiency score of one. When comparing the differences in farms that showed an efficient financial performance measure in one or two years to an efficiency in four or five years, the differences were clear. The farms identified as efficient over all five years were the top performers, or at the top of the midpoint performance group according to the cut-off measurements calculated by Henning (2011). There were years

Table 4. Efficiency score of the mixed enterprise farms from 2004 to 2009 (n = 12) and percentage of measurements in the top performance group calculated from Henning (2011)

Farm No.	DEA Results					Percentage of measurements in top performance group				
	2004/05	2005/06	2006/07	2007/08	2008/09	2004/05	2005/06	2006/07	2007/08	2008/09
2	0.959	0.994	0.909	0.946	0.917	7.1%	0.0%	0.0%	14.3%	7.0%
3	0.986	1	0.949	0.998	0.957	28.6%	28.6%	14.3%	35.7%	14.0%
6	0.959	1	1	1	0.978	14.3%	50.0%	64.3%	35.7%	21.0%
7	1	1	0.996	1	1	78.6%	50.0%	57.1%	71.4%	57.0%
15	0.935	0.952	0.944	0.996	1	21.4%	21.4%	35.7%	35.7%	36.0%
18	1	0.984	0.976	1	0.968	28.6%	28.6%	21.4%	85.7%	21.0%
22	1	1	0.962	1	0.988	28.6%	85.7%	14.3%	71.4%	43.0%
25	1	1	1	1	1	42.9%	78.6%	85.7%	78.6%	71.0%
31	1	1	0.971	1	0.942	42.9%	78.6%	21.4%	42.9%	43.0%
33	0.98	0.974	0.979	0.978	1	28.6%	28.6%	35.7%	28.6%	57.0%
35	0.992	1	1	1	1	28.6%	57.1%	71.4%	71.4%	57.0%
61	1	0.998	1	1	1	28.6%	28.6%	64.3%	35.7%	64.0%

where some farms showed a decline in efficiency, however they still remained in a very good performance position relative to the other mixed enterprise farms. This could also be seen in the number of years where the percentage of measurements was in the top performance group. The remaining farms were mostly in the midpoint or bottom performance groups. These farms were not in the top third of the mixed enterprise farm performance groups in the GWK trading region and would have to improve their performance to enter the top third.

4.3. Livestock enterprise farms

The DEA results for livestock enterprise farms are shown in Table 5. There were only nine livestock enterprise farms that were analysed of which four were efficient over all five years. All farms were efficient for at least one of the five years. Results for the livestock enterprise farms could be interpreted the same as for the crop and mixed enterprise groups. With the high number of efficient farms over all five years there were certain farms that had no measurements in the top performance group for certain years.

The farms that had an efficiency score of one in three years or less were in the bottom of the midpoint and bottom performance groups. These farms could still have measurements that were in the top performance group in any specific year, but most of the performance measurements were in the bottom performances of the enterprise group. There were variations in the percentages of measurements in the top performance group (number of top performance measurements), but the farms that were identified as being efficient performed better than those that had an inefficiency score from the DEA results.

Table 5. Efficiency scores of the Livestock enterprise farms from 2004 to 2009 (n = 9) and percentage of measurements in the top performance group calculated from Henning (2011)

Farm No.	DEA Results					Percentage of measurements in top performance group				
	2004/05	2005/06	2006/07	2007/08	2008/09	2004/05	2005/06	2006/07	2007/08	2008/09
30	1	1	1	1	1	64.3%	35.7%	57.1%	14.3%	43.0%
32	1	0.979	0.968	0.978	0.957	35.7%	21.4%	0.0%	21.4%	7.0%
34	1	0.963	0.966	1	0.991	64.3%	0.0%	35.7%	78.6%	29.0%
40	0.91	0.842	1	0.965	0.897	21.4%	0.0%	50.0%	42.9%	14.0%
43	1	1	1	1	1	28.6%	57.1%	64.3%	42.9%	36.0%
45	1	1	1	1	1	28.6%	42.9%	57.1%	35.7%	36.0%
49	1	1	1	1	1	35.7%	92.9%	100.0%	78.6%	71.0%
50	1	1	1	0.995	1	35.7%	78.6%	85.7%	42.9%	57.0%
54	0.976	1	0.969	0.957	1	35.7%	21.4%	0.0%	0.0%	57.0%

4.4. Differences between inefficient and efficient farms

The question arose as to why some farms were more efficient than others. The average financial ratios for debt against assets, equity against assets, asset turnover ratio and net income ratio, over the five years, for efficient and inefficient crop-, mix- and livestock enterprise farms are shown in Table 6. The difference in performance was explained by the financial factors: capital structure (leverage), efficiency (asset turnover ratio) and net income. Thus, the financial structures of the farms differed.

Table 6. Average financial ratios for debt against assets, equity against assets, asset turnover ratio and net income ratio for efficient and inefficient crop-, mix- and livestock enterprise farms

Financial status	Crop farms (n = 17)		Mixed farms (n = 12)		Livestock farms (n = 9)	
	Efficient	Inefficient	Efficient	Inefficient	Efficient	Inefficient
Debt against asset	22%	29%	22%	29%	3%	16%
Debt against equity	30%	87%	30%	48%	4%	20%
Asset turnover	62%	51%	58%	44%	28%	24%
Net income ratio	43%	33%	40%	36%	73%	57%

The capital structure between efficient (22%) and inefficient (29%) crop enterprise farms was compared (Table 6) and the efficient farms were less reliant on borrowed capital

Asset turnover ratio indicated how effective assets had been used to generate income. The difference between the farms that were efficient and those that were inefficient were 62 against 51%. Another ratio that indicated the difference between the efficient and inefficient farms was the net income ratio, which indicated how much of the gross value of production was left after all farm expenses had been paid. The difference in average net income ratio for the efficient and inefficient farms was 10 percentage-points, with a 43% average for efficient farms and 33% for inefficient farms.

Differences between efficient and inefficient mixed enterprise farms were similar to those of crop enterprise farms. The difference in capital structure was, as shown in Table 6, viewed as the average debt against assets, debt against equity, asset turnover ratio and net income ratio. The results shown in Table 6 indicated that the efficient farms had more equity than borrowed capital in their capital structures, with borrowed capital being half the value of equity (efficient farms: 30%, inefficient farms: 48%). The efficient farms (58%) also used their assets more effectively with higher asset turnover ratios, which reflected in the net income ratios difference between the efficient (40%), and inefficient farms (36%).

The capital structure of livestock enterprise farms varied from crop and mixed enterprise farms (Table 6). This confirmed that different enterprises should not be compared, because results could be based and lead to mistakes during decision-making. The borrowed capital, debt against assets for efficient (3%) and inefficient (16%) livestock farms was lower than for the other enterprise farms. The difference in capital structures was also seen in the average values of efficient and inefficient farms, with debt against assets and debt against equity values much lower than those of crop and mixed enterprise farms.

The income that was generated by efficient farms were higher than for other farms, and this was reflected by the higher net income ratios (efficient farms: 73% and inefficient farms: 57%).

5. Conclusion and recommendations

The financial ratio based DEA model was applied to the South African agricultural sector, specifically the producers of the GWK trading region, Northern Cape to benchmark the financial performance. The DEA model was applied to three different enterprise groups over a period of five years and results indicated that the DEA model could be used successfully to benchmark agricultural producers.

In comparison the DEA model presented similar results to the performance groups determined by Henning (2011). Farms that were identified as being efficient by the ratio based DEA model was also the farms that had a high percentage of Henning's (2011) measurements in the top performance group. There were instances were measurements was not in the top performance group but in the mid-point performance group. Farms classified as DEA inefficient were in the bottom performance and the bottom half of the midpoint performance groups. These results indicated that the DEA model could be used as a financial measurement benchmarking tool to analyse the financial performance of farms. The methods of benchmarking could be used by producers to improve their decision-making and to identify specific regions of their financial structures that must improve.

The financial ratio based DEA and Henning's (2011) benchmark measurement should not be viewed as substitute benchmarking techniques but rather as supplement techniques. Henning's (2011) benchmark measurement technique compares the various financial measures to the financial norms whereas the DEA compares the financial measures of producers and determines the actual benchmark as represented by the best producers.

Producers within the same enterprises and not in different enterprises must be compared. The financial structures between the enterprises are different, making comparisons between the enterprises inappropriate.

6. References

Ablanedo-Rosas J.H., Gao H., Zheng X., Alidaee B., Wang H., 2010. A Study of the Relative Efficiency of Chinese Ports: a Financial Ratio-based Data Envelopment Analysis Approach. Expert Systems 27(5), 349-362.

Al-Shammari M., Salimi A., 1998. Modeling the Operating Efficiency of Banks: a Nonparametric Methodology. Logistics Information Management 11(1), 5-17.

Avkiran N.K., 2011. Association of DEA Super-efficiency Estimates with Financial Ratios: Investigating the Case of Chinese Banks. Omega 39, 323-334.

Banker R.D., Charnes A., Cooper W.W., 1984. Some Models for Estimating Technical and Scale Inefficiencies in Data Envelopment Analysis. Management Science 30, 1078-1092.

Blocker A., Ibendahl G., Anderson J., 2003. Interpreting Farm Financial Ratios. Mississippi State University. [online] accessed 25 February 2010 from http://www.cottoninc.com/FarmFinance/Interpreting_Farm_Financial_Ratios/Interpreting_Farm_Financial_Ratios.pdf

Boehlje M., Dobbins C., Miller A., Miller D., Barnard F., 1999. Farm Business Management for the 21st Century: Measuring and Analyzing Farm Financial Performance (EC-712). Purdue University Cooperative Extension Service, Department Agriculture Economics, West Lafayette, IN.

Charnes A., Cooper W.W., Rhodes E., 1978. Measuring the Efficiency of Decision Making Units. European Journal of Operational Research 2, 429-444.

Crane L.M., 2004. Measuring Financial Performance: A Critical Key to Managing Risk. AoE FIELD CROPS TEAM. [online] accessed 14 March 2010 from http://fieldcrop.msu.edu/documents/Meauring%20Financial%20Performance.pdf

Craven R., Nordquist D., Klair K., 2011. The benefits of Financial Benchmarking to farmers in the United States. Congress Procedings - Non peer reviewed papers and posters, (pp. 268-275). Christchurch, New Zealand.

Emrouznejad A., Amin G.R., 2009. DEA Models for Ratio Data: Convexity Consideration. Applied Mathematical Modelling 33, 486-498.

Farm Financial Standards Council, 2008. Financial Guidelines for Agricultural Producers. Farm Financial Standards Council, United States of America.

Feng C.-M., Wang R.-T., 2000. Performance Evaluation for Airlines Including the Consideration of Financial Ratios. Journal of Air Transport Management 6, 133-142.

Fernandez-Castro A., Smith P., 1994. Towards a General Non-parametric Model of Corporate Performance. Omega 22(3), 237-249.

Ferris A., Malcolm B., 1999. Sense and Nonsense in Dairy Farm Management Economic Analysis. University of Melbourne, Department of Food Science and Agribusness, Australasian Agribusiness Perspectives, Melbourne.

Flemming E., Farrell T., Villano R., Flemming P., 2006. Is Farm Benchmarking the New Acceptable Face of Comparative Analysis? Australasian Agribusiness Review 14(12).

Fraser I., Cordina D., 1999. An Application of Data Envelopment Analysis to Irrigated Dairy Farms in Northern Victoria, Australia. Agricultural Systems 59,267-282.

Henning J.I.F., 2011. Financial Benchmarking Analysis: Northern Cape Farmers. M.Com Thesis, University of the Free State, Bloemfontein, South Africa.

Henning J.I.F., Strydom D.B., Willemse B.J., 2011. Developing a Financial Ratio Benchmarking System for GWK District Farmers in South Africa. Paper presented at the 18th International Farm Management Association Congress, Methven, Canterbury, New Zealand, March 2011.

Hoag D.L., 2009. Applied Risk Management in Agriculture (1st Edition). CRC Press, Boca Raton.

Jack L., 2009. Benchmarking in Food and Farming: Creating Sustainable Change. Gower Publishing Company, Farnham.

Jolly R.W., Vontalge A., 1995. Financial Troubleshooting. Iowa State University Extension Publication, Ames.

Lin W., Liu C., Chu C., 2005. Performance Efficiency Evaluation of the Taiwan's Shipping Industry: an Application of Data Envelopment Analysis. Proceedings of the Eastern Asia Society for Transportation Studies 5, 467-476.

Min-Feng C., Wang R.S., 2000. Performance evaluation for airlines including the consideration of financial ratios. Journal of Air Transport Management 6, 133 – 142.

Ozcan Y.A., McCue M.J., 1996. Development of a Financial Performance Index for Hospitals: DEA Approach. Journal of Operational Research Society 47, 18-26.

Rouse P., Chen L., Harrison J.A., 2007. Benchmarking the Performance of Dairy Farms Using Data Envelopment Analysis. University of Auckland, New Zealand.

Sarafidis V., 2002. An Assessment of Comparative Efficiency Measurement Techniques. Occasional Paper 2, Europe Economics, London.

Scheraga C.A., 2004. Operational Efficiency Versus Financial Mobility in the Global Airline Industry: a Data Envelopment and Tobit Analysis. Transportation Research Part A: Policy and Practice 38, 383-340.

Tongzon J.L., 2001. Efficiency Measurement of Selected Austrailan and Other International Ports using Data Envelopment Analysis Transportation Research Part A 35, 107-122.

Wilson R.H., Charry A.A., Kemp D.R., 2004. Performance Indicators and Benchmarking in Australian Agriculture: Synthesis and Perspectives. Extension Farming Systems 1(1), 45-57.

Yeager E., Langemeier M., 2009. Benchmarking Recommendations using a Sample of Kansas Farms. Paper presented at the International Farm Management Association Conference, July 19-24 2009, Bloomington, Illinois.

Zwiegers W., Kluge A., 2011. Personal interview regarding GWK financial study groups. 22 July 2011.

POLICY IMPACT ANALYSIS OF PENALTY AND REWARD SCENARIOS TO PROMOTE FLOWER STRIPS USING A BUSINESS SIMULATION GAME

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Abstract

In germany the cultivation of silage maize has risen due to the increasing number of biogas plants and the good qualities of maize as biogas substrate. But, various reasons speak for the limitation of maize. So the policy may be promoting alternative biogas substrates. A currently much discussed biogas substrate is the use of a special floral seed blend. A business simulation game is used to investigate whether the implementation of a reward and a penalty policy will improve the uptake of flower strips in the production program of farmers. The results indicate that the implementation of these policy measures have a promoting effect on the cultivation area of flower strips. The penalty policy leads to a stronger increase in the growing area of flower strips than the reward policy, although the policies have the same income effect.

Keywords: policy impact analysis, flower strips, experimental economics, business simulation game

1. Introduction

Fossil energy sources are finite resources and contribute significantly to anthropogenic global warming by the release of CO_2 emissions. Therefore, the German government has resolved to promote the expansion of renewable energy sources with the "Act on granting priority to renewable energy sources" (Deutscher Bundestag 2011). This governs the remuneration of electricity from renewable energy sources and was last adjusted in 2012. Its goal is to realize a 35% share of renewable energy in total electricity generation by 2020 and 85% by 2050 in Germany.

Due to the increased remuneration for power derived from renewable energy sources, many farmers have invested in biogas plants. The electricity production from biomass, with a share of 26.7%, is the second most important source of renewable energy behind wind power with a share of 33.3% (Statistisches Bundesamt 2012). The importance of renewable raw materials is also reflected in the strong expansion of biogas plants. From 2001 to 2011, the number of biogas plants increased from 1,300 to 7,320 with a total installed capacity of 2,997 megawatts throughout Germany (Fachverband Biogas e.V. 2012). Because of this, the cultivation of energy crops such as maize and whole crop silage increased sharply. In 2012, energy crops for fermentation in biogas were grown on a surface of 962,000 ha. This consisted mostly of energy maize with 800,000 ha (Fachagentur Nachwachsende Rohstoffe e.V. 2012).

The expansion of energy production from biomass however is not necessarily viewed positively and is attracting increasing public criticism. "The creation of maize deserts" is a catchword which falls within this context (Bosch and Peyke 2011; Steinhäußer 2012). However, due to its high conversion of dry matter to energy, maize is the preferred crop for biogas. A conflict of interest has arisen between parts of the public that demand the cultivation of less maize, and farmers that require cultivation to be profitable (Steinhäußer 2012).

For the subsequent development of electricity production from biomass, it is essential to reconcile the interests of farmers and the public. An initial step in policy is to cap off the use of energy maize and grain, including corn-crop mix, grain maize, and ground ear maize in biogas plants to 60 mass percent, which is anchored in the "Act on granting priority to renewable energy sources" and became effective on 01.01.2012 (Deutscher Bundestag 2011). A variety of alternative biogas substrates such as cup plant, sudan grass, and sorghum are discussed. In addition, the fermentation of flower strips in biogas plants is being explored. Initial results show that flower strips are well suited. Further advantages include low input, the creation of habitats for wildlife, and also the increasing acceptance shown by the positive public response to fields that are surrounded by flower strips (Vollrath et al. 2010).

For the aforementioned reasons, a policy aim could be the integration of flower strips cultivation into the production program of farmers. But, the introduction of a new policy is accompanied by high costs. Therefore, prior to the introduction, a policy impact analysis is essential to evaluate whether a policy measure is effective or an unintended effect occurs. Human behavior can be characterized by a range of goals, such as making profit, risk aversion, traditions, recreational activities, or social recognition (Benz 2009). In addition, decision-makers act in many cases bounded rational (Selten 1990) and rely on heuristics to decide (Kahneman and Tversky 1979). Rational choice models for policy impact analysis often assume a rational behaving homo economicus (Veetil 2011). Therefore, behavior often does not correspond to the identified expectations. Because of this, rational choice models can reflect the consequences of policy implementation distorted. Experiments and in particular business simulation games offer the opportunity to address this limitation with an appropriate design. In both laboratory experiments and in business simulation game situations it is possible to set incentives to motivate participants to make "good" decisions (Hertwig and Ortmann 2001). Furthermore, the realistic design of the decision-making situation in business simulation games (Levitt and List 2007) is an important advantage compared to classical lab experiments. For these reasons, business simulation games in particular seem to be suitable for policy impact analysis.

This paper shall explicitly examine the reaction of farmers to the approach of policies for increasing the share of flower strips in the agricultural landscape. For this purpose, the developed multi-period, single-person business simulation game is arranged in a way that the farmers are in a realistic farming situation. Furthermore, they will be confronted with different policy measures. The following questions will be addressed:

1. Has the implementation of reward and penalty policies an impact on the proportion of flower strips in the production program of the farmers?
2. Is a reward or a penalty policy more effective?
3. Does the policy change leads to cultivation of flower strips as a biogas substrate?

The novelty of this paper is that the policy impact analysis is geared towards implementing flower strips in the production program of real farmers. Scientists have increasingly concerned themselves in recent years with flower strips and their environmental benefits. Primarily research has considered the nature conservation concept and impacts on biodiversity (Haenke et al. 2009; Haaland and Gyllin 2010). To our knowledge, there are no publications that address the individual effect of policies to increase the quantity of flower strips in the agricultural landscape. Furthermore, a new aspect is that a business simulation game conducted with real farmers is used for the policy impact analysis.

The article is structured as follows: First, the behavioral theoretical hypotheses are derived (section 2). Sections 3 and 4 explain the experimental design and sample characteristics. Afterwards, the results are presented (section 5). The article ends with a summary and future prospect (section 6).

2. Hypothesis generation

Human behavior is controlled primarily through incentives or penalties. Incentive and penalty strategies lead the human behavior to comply with rules and laws and establish in this way a social order (Tyler 1990). Penalty payments pursue a strategy of deterrence to prevent that rules are broken, whereas rewards represent incentives to direct human behavior in a desired direction (Tyler and Blader 2005). Therefore, there is the assumption that a reward or penalty strategy of the policy can direct the behavior of farmers to extend the cultivation of flower strips. This yields the following hypothesis:

- H1: Regardless of whether the policy introduces a reward for growing flower strips or a penalty for not growing flower strips, the share of flower strips in the production program of farmers will increase.

In the economic literature there are hints that policy approaches which will be implemented by penalties differ with regard to policies with incentive schemes (Tyler 1990). With experiments Kahneman and Tversky (1979) and Kahneman et al. (1991) have proven "Loss Aversion" which states that people weight a monetary loss more heavily than an equally high profit. Concerning the reward and penalty policy, which have the same income effect, it means that the loss of the penalty payment is higher weighted than the reward payment. Even the "Opportunity Cost Effect" supports the assumption that reward and penalty policies differ in their effect. Out of pocket costs like penalty payments are given a higher weight than opportunity costs, which correspond to a loss of reward payments (Kahneman et al. 1991). The following hypothesis can be derived:

- H2: The penalty policy changes the cultivation behavior of farmers regarding the scope of flower strips stronger than the economic equivalent of a reward policy.

Flower strips can be cultivated as nature conservation measure (Hartmann et al. 2006) or as biogas substrate for energy production (Vollrath et al. 2010). The implementation of policy measures to increase the share of flower strips directs the assumption that the cultivation of flower strips can complement the production of a biogas substrate. Thus the following hypothesis is derived:

- H3: The establishment of reward and penalty policies would promote that flower strips are grown as a biogas substrate.

3. Design of the experiment

The experiment is divided into three sections. In the first part of the experiment, the incentive compatible, multi-period, one-person business simulation game is conducted. Subsequently, a Holt-and-Laury lottery (Holt and Laury 2002) takes place to examine the risk attitude of the participants. As a third part, socio-demographic and socio-economic information of the participants are collected.

In the following parts, the general structure of the business game will be explained and the policy measures will be described. The Holt-and-Laury lottery is not discussed further because no changes were made to the methodology presented by Holt and Laury (2002). Furthermore, this method is already established in agricultural economics (Brick et al. 2012).

3.1. Fundamental structure of the business simulation game

The structure of the business simulation game follows a "Framed Field Experiment" (Harrison and List 2004). In the business simulation game, participants put themselves in the situation of the manager of a farm. The yield and price level of production activities correspond to real conditions, where as the price developments and weather risks are reflected as uncertainties. The design is to put the participants into a realistic business situation which results in realistic decisions (Harrison und List 2004). In the business simulation game documented decision behavior is the basis for studying the effect of various policy measures.

Within the framework of the simulation the participants manage a farm with 100 hectares of arable land for twelve production periods. For all participants, the given objective is to attain the maximum profit. Each game turn is a production period and requires the following basic decisions of the participants:

1. Production program decision: The configuration of the production program for the cultivation of the farm land with the production activities wheat, silage maize, sorghum and flower strips.
2. Contract decision: Acceptance of a substrate delivery contract for an adjacent biogas plant for about 0 t, 1,500 t, 3,000 t and 4,500 t of fresh matter. For fulfillment silage maize, sorghum and flower strips can be used.

In the business simulation game (1) deterministic and (2) stochastic parameters are given.

Ad 1). The deterministic parameters apply to all participants and do not change randomly. They are communicated at the beginning of the game. When the simulation starts, each attendant has a starting capital of € 100,000. In each production period, withdrawals in the amount of € 30,000 are made to cover the costs of living. Furthermore, each participant receives after each completed period of production a transfer payment of € 300 per hectare. At the same time, they are informed that amendments may occur during the playing time. A production period is complete when the participants have set their production program and made their contract decisions. All production activities can be grown in a maximum circumference of 70 hectares. Note that the entire farm land must be cultivated with the four crops. There is no possibility to let land lie idle. Winter wheat is only used for selling on the market, while maize is for fulfilling the delivery contract, and also for marketing. The cultivation of sorghum is solely for the production of biogas substrate. Flower strips, in contrast, have two useful alternatives; they can be grown as a substrate for biogas plants or they may remain unused for ecological reasons to create habitat for animals and thus potentially increase biodiversity.

Ad 2). The stochastic parameters change randomly from production period to production period and, therefore, vary between the participants. The market prices for winter wheat and silage maize are volatile. The prices follow an arithmetic Brownian motion starting with an identical starting value for all participants. The market prices decrease or increase, starting with the current price in any production period with a probability of 50% by € 20/t for winter wheat and by € 1.50/t for maize silage. The contracted substrate delivery is remunerated at € 35/t, regardless of whether the biomass is provided with maize silage, sorghum, or flower strips. The delivery contract has to be 100% fulfilled. If this is not the case, then the missing substrate amount of maize has to be bought from the market for twice the current market price of silage maize. Weather conditions will affect yield and, therefore, gross margins. There is a distinction between above-average, average, and below-average weather conditions. The periods of good and bad weather occur each with a probability of 20%. Average weather is expected with a probability of 60%. Above-average weather has the consequence that the yield per hectare of all cultures achieves its maximum, whereas below-average weather leads to a yield drop to the minimum. Both the probabilities and the yields per hectare are communicated at the beginning of the simulation.

Since there are no storage possibilities for crops, all goods are sold at the end of each period at the current market prices. The current prices and the weather conditions of the previous period are communicated at the beginning of each new production interval. Furthermore the participants receive further information about the profit of the production program, contract decisions of the previous production periods, and the observed prices. These observed prices are the starting point for the price changes in the next production period.

3.2. Changes in the policy framework

At the beginning of the simulation, participants are randomly assigned to one of three policy scenarios. During the first six production periods of the simulation, the design is identical for the three policy scenarios. In subsequent production periods 7 to 12, the following policy changes for the three scenarios occur:

- **Scenario 1** (reference scenario): The policy framework remains unchanged over the entire duration of the simulation.
- **Scenario 2** (reward scenario): The participants are informed that the transfer payment decreases by 10% to € 270 per hectare. Simultaneously, the policy introduces an additional premium of € 300 per hectare for sustainable agriculture and promotes acceptance by growing flower strips. The state pays a maximum amount of € 3,000 per farm and in this way subsidizes a maximum cultivation of 10 hectare flower strips.
- **Scenario 3** (penalty scenario): The policy punishes all participants who use less than 10% of their farm land for the cultivation of flower strips. Each hectare lacking to fulfill the growing requirement will incur a penalty of € 300.

Scenarios 2 and 3 do not differ in their profit impact. To compare the scenarios, always three different farmers play the simulation with the same price and weather trends but operate in different policy scenarios.

3.3. Incentives

To achieve incentive compatibility, monetary incentives for “good” decisions are set. A total of two cash prizes are raffled among the planned 120 participants to four farmers. The first cash prize totaling € 1,620 is raffled to three farmers in the business simulation game. Goal for all participants is to maximize their business success. Therefore, the profit depends on the business success. With purely rational behavior, the monetary gain totals to a maximum of € 540 per cash prize. Winners receive the share of the maximum monetary gain that corresponds to their business success. The second cash prize is played in the Holt-and-Laury lottery. In this part of the experiment the participants are aware of the cash prize they could win, that depends on their own decisions. When raffle the trophy, one participant is drawn randomly, and the lottery is carried out. The participant will receive a cash prize ranging from € 10 to € 385, which conforms to his risk attitude.

4. Description of the sample

The experiment was performed at the agricultural exhibition “EuroTier” from the 13th to the 16th of November 2012 in Hanover. Nine hundred and forty-six visitors to the exhibition were contacted directly and invited to participate in the simulation. In total, 123 farmers (13% of those contacted) successfully completed the experiment, with 41 farmers playing in each policy scenario. In average 43 minutes were need to complete the experiment. The socio-demographic and socio-economic characteristics of the participants are shown in table 1.

On average, the participants were 29 years old, with the youngest participant 16 years, and the oldest 62 years old. Thirty-four percent of the farmers managed a farm of their own. The arable land of the agricultural enterprises is on average 245 ha in size. The largest farm has 3,000 ha of arable land. Fourteen percent of agricultural businesses are run as farms farmed on a parttime basis. The sample consists of 12% female participants. The average HLL-value of

5.4 indicates that the participants are slightly risk averse. With the H-test, according to Kruskal and Wallis, it can be shown that the socio-demographic and socio-economic characteristics of the participants in the three policy scenarios do not significantly differ in age (p-value = 0.140), years of education (p-value = 0.961), the HLL-value (p-value = 0.228), and the farmland (p-value = 0.759). In addition, a chi-square test, indicates that there were no significant differences between the participant groups in the percentage of female participants (p-value = 0.800), farm managers (p-value = 0.855), and parttime farms (p-value = 0.273).

Table 1. Socio-demographic and socio-economic characteristics of the participants (N = 123)

Characteristics	Policy scenario 1		Policy scenario 2		Policy scenario 3	
	mean	SD	mean	SD	mean	SD
Age	31.8	12.7	28.8	10.3	27.7	9.4
Percent of female participants	12.2%	-	14.6%	-	9.8%	-
Years of education	13.6	3.3	13.7	3.5	13.8	3.2
HLL-value [(a)]	5.9	2.0	5.2	2.2	5.1	1.6
Farm manager	39.0%	-	34.1%	-	29.3%	-
Farms farmed on a parttime basis	19.5%	-	7.3%	-	14.6%	-
Farmland in ha	225.5	392.3	196.9	220.4	312.5	617.4

(a) 1-3 = risk seeking, 4 = risk neutral, 5-9 = risk averse

5. Behavioral control impacts of different policy measures on farmers

In the first six production periods, all participants use the same basic conditions. On this basis, one can analyze how the cultivation area of flower strips change when the three policy scenarios appear. The average growing area of flower strips is represented in table 2 for the production periods 1 to 6 and 7 to 12 for each of the three policy scenarios.

Table 2: Growing area of flower strips in the business game (41 participants in each policy scenario)

Policy scenario	Area of flower strips periods 1-6	Area of flower strips periods 7-12
1	10.21 ha	9.88 ha
2	7.92 ha	10.01 ha
3	8.22 ha	12.73 ha
Average	8.78 ha	10.87 ha

The paired t-test shows for scenario 1 (reference scenario), that the growing area in the first six periods does not significantly differ from the growing area in periods 7 to 12 (p-value = 0.732). In contrast, the cultivation area changed significantly with the introduction of a reward (scenario 2) or penalty policy (scenario 3) (p-value = 0.080 and p-value = 0.001 respectively).

There are four initial situations: The cropping areas of flower strips for all three policy scenarios for the first six periods represent the reference situation. The policy scenarios 1 to 3, which occur at the seventh production period, reflect the policy implementation effects. They are referred to in table 3 as dummy scenario 1 to 3 and refer in to the baseline of the first six production periods in the estimated models. Model 1 reflects the effects of the independent variables on the total cropping area of flower strips. Furthermore, models 2 and 3 highlight the effects separately for the cultivation of flower strips for biogas production or nature conservation purposes.

Hypothesis H1 can be seen as being confirmed: Both in reward and in the penalty scenarios, the share of flower strips increase significantly (see Table 3, Model 1). Participants who are con-

Table 3. Pooled regression to declare the growing of flower strips (N = 1.476), robust standard errors

	Model 1 dependent variable: flower strips cumulative		Model 2 dependent variable: flower strips biogas plant		Model 3 dependent variable: flower strips nature conservation	
	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic
constant	26.294	5.084***	10.936	4.024***	15.358	3.802***
Dummy scenario 1	1.204	0.992	0.283	0.336	0.921	1.322
Dummy scenario 2	2.230	1.701*	0.599	0.676	1.631	1.733*
Dummy scenario 3	5.276	4.326***	2.866	3.111***	2.411	2.546**
Profit differencial(b)	-1.483	-1.848*	-0.797	-1.321	-0.686	-1.074
Risk attitude(c)	0.205	0.658	0.164	0.839	0.041	0.170
Additional purchase costs(b)	0.052	2.414**	0.004	0.398	0.048	2.852***
Substrate delivery amount(b)	-1.556	-3.680***	0.123	0.488	-1.679	-4.976***
Age	-0.087	-1.337	-0.076	-2.074**	-0.010	-0.239
Gender(d)	5.485	2.886***	2.686	2.690***	2.796	1.901*
Years of education	-0.585	-2.398**	-0.279	-2.092**	-0.305	-1.897*
Earning power(e)	-7.200	-3.169***	-2.975	-2.406**	-4.225	-2.621***
Profit flower strips(f)	3.805	2.546**	1.358	1.619	2.447	2.362**
F-value	24.060 ***		9.188 ***		23.466 ***	
R^2	0.165		0.070		0.161	

(a) * = p-value < 0.1; ** = p-value < 0.05; *** = p-value < 0.01.
(b) in 1,000 € or 1,000 t.
(c) 1-3 = risk seeking, 4 = risk neutral, 5-9 = risk averse.
(d) 1 = female, 0 = male.
(e) 1 = mainstay farm, 0 = parttime farms.
(f) Do you think it is possible to earn money by growing flower strips? 1 = yes, 0 = no.

fronted with the reward policy grow on average 2.230 hectares more flower strips in comparison to the reference periods 1 to 6. Participants who are confronted with the penalty policy increase their share of flower strips on average by 5.276 hectares. No significant change occurs in the periods 7 to 12 in the reference scenario in comparison to the reference situation of periods 1 to 6. Consequently, the deterrence strategy of the penalty policy and the incentive strategy of the reward policy have effected a change in participant's behavior regarding the growing of flower strips.

Hypothesis H2 can be seen as being confirmed: The implementation of a penalty policy leads to a stronger increase in the growing area of flower strips than implementation of a reward policy (see Table 3, Model 1). A linear restriction reveals that the effects of the reward and the penalty policy differ on a significance level of 10% from each other suggesting that when estimating policy consequences, the "loss aversion" and the "Opportunity Cost Effect" have to be taken into account because these effects influence the awareness of reward and penalty scenarios.

Hypothesis H3 can partly be seen as being confirmed: A penalty policy results in an increase in cultivation of flower strips to produce biogas substrate by 2.866 ha (see Table 3, Model 2). In contrast, the introduction of a reward policy has no significant effect on the cultivation of flower strips for biogas plants. Despite having the same income effect of the policy scenarios 2 and 3, only the penalty policy (scenario 3) achieved a significant increase in the growing of flower strips to produce biogas substrate.

6. Conclusion and outlook

The German government aims the sustainable development of renewable energy. One policy goal can to promote the cultivation of alternative biogas substrates is. Business simulation games are a suitable method for policy impact analysis. The realistic design of the business situation may result in realistic decisions. Therefore, the aim of the paper is to analyze the behavior of the target group "farmers" regarding the implementation of reward and penalty policies to promote flower strips. The participants manage a fictional farm and have to determine in each of the twelve production periods cultivation and contract decisions. During the simulation, they are confronted with the policy measures, which do not differ in terms of their income effect.

The results indicate that both reward and penalty policies lead to an increase of cultivating flower strips. Furthermore, the implementation of a penalty policy affects the behavior stronger than the implementation of a reward policy. The reward policy acts on the cultivation of flower strips for nature conservation, and has no effect on flower strips used as biogas substrate. Therefore, with equal high costs of policy implementation a penalty policy should be implemented. Furthermore, the introduction of a penalty policy achieves that flower strips are used as biogas substrate.

Further research is needed to investigate the influence of socio-demographic effects on cultivation decisions. This could improve the effectiveness of policy implementations. Of interest, however, is the broader question how to design behavior-controlling policies that farmers grow increasingly flower strips as biogas substrate in order to guarantee the sustainable energy production from biogas plants. Further initial points for research could relate to contract design, which can be investigated with business simulations games.

7. References

Benz M., 2009. Entrepreneurship as a non-profit-seeking activity. In: International Entrepreneurship and Management Journal 5 (1), S. 23-44.

Bosch S., Peyke G., 2011. Gegenwind für die Erneuerbaren – Räumliche Neuorientierung der Wind-, Solar- und Bioenergie vor dem Hintergrund einer verringerten Akzeptanz sowie zunehmender Flächennutzungskonflikte im ländlichen Raum. In: Raumforschung und Raumordnung 69 (2), S. 105-118.

Brick K., Visser M., Burns J., 2012. Risk Aversion: Experimental Evidence from South African Fishing Communities. In: American Journal of Agricultural Economics 94 (1), S. 133-152.

Buttel F.H., Gillespie G.W., Larson III O.W., Harris C.K., 1981. The Social Bases of Agrarian Environmentalism: A Comparative Analysis of New York and Michigan Farm Operators. In: Rural Sociology 46 (3), S. 391–410.

Carr S., Tait J., 1991. Differences in the Attitudes of Farmers and Conservationists and their Implications. In: Journal of Environmental Management 32, S. 281-294.

Deutscher Bundestag, 28.11.2011. Gesetz zur Neuregelung des Rechtsrahmens für die Förderung der Stromerzeugung aus erneuerbaren Energien. Fundstelle: Bundesgesetzblatt. In: Bundesgesetzblatt. Online verfügbar unter http://www.bgbl.de/Xaver/start.xav?startbk=Bundesanzeiger_BGBl.

Fachverband Biogas e.V., 2012. Branchenzahlen 2011 und Branchenentwicklung 2012/2013. Entwicklung der Anzahl Biogasanlagen und der gesamten installierten elektrischen Leistung in Megawatt [MW]. Freising. Online verfügbar unter http://www.biogas.org/edcom/webfvb.nsf/id/DE_Branchenzahlen/$file/12-11-29_Biogas%20Branchenzahlen%202011-2012-2013.pdf (26.02.2013).

Fachagentur Nachwachsende Rohstoffe e.V., 2012. Cultivation of Renewable Resources in Germany 2012. Online verfügbar unter http://mediathek.fnr.de/media/downloadable/files/samples/r/l/rl_fnr4_0184_grafik_nawaro_.jpg (26.02.2013).

Haaland C., Gyllin M., 2010. Butterflies and bumblebees in greenways and sown wildflower strips in southern Sweden. In: Journal of Insect Conservation 14 (2), S. 125-132.

Haenke S., Scheid B., Schaefer M., Tscharntke T., Thies C., 2009. Increasing syrphid fly diversity and density in sown flower strips within simple vs. complex landscapes. In: Journal of Applied Ecology 46 (5), S. 1106-1114.

Harrison G.W., List J.A., 2004. Field Experiments. In: Journal of Economic Literature 42 (4), S. 1009-1055.

Hertwig R., Ortmann A., 2001. Experimental practices in economics: A methodological challenge for psychologists? In: Behavioral and Brain Sciences 24 (3), S. 383-451.

Holt C.A., Laury S.K., 2002. Risk Aversion and Incentive Effects. In: The American Economic Review 92 (5), S. 1644-1655.

Kahneman D., Tversky A., 1979. Prospect Theory: An Analysis of Decision under Risk. In: Econometrica 47 (2), S. 263-292.

Kahneman D., Knetsch J.L., Thaler R.H., 1991. Anomalies. The Endowment Effect, Loss Aversion, and Status Quo Bias. In: Journal of Economic Perspectives 5 (1), S. 193-206.

Levitt S.D., List J.A., 2007. What Do Laboratory Experiments Measuring Social Preferences Reveal About the Real World? In: Journal of Economic Perspectives 21 (2), S. 153-174.

Lütz M., Bastian O., 2002. Implementation of landscape planning ant nature conservation in the agricultural landscape - a case study from Saxony. In: Agriculture, Ecosystems and Environment 92, S. 159-170.

Olli E., Grendstad G., Wollebaek D., 2001. Correlates of Environmental Behaviors: Bringing Back Social Context. In: Environment and Behavior 33 (2), S. 181-208.

Schultz P.W., Oskamp S., Mainieri T., 1995. Who Recycles and When? A Review of Personal and Situational Factors. In: Journal of Environmental Psychology (15), S. 105-121.

Selten R., 1990. Bounded Rationality. In: Journal of Institutional and Theoretical Economics 146 (4), S. 649-658.

Statistisches Bundesamt, 2012. Erzeugung: Bruttostromerzeugung in Deutschland für 2010 bis 2012. Online verfügbar unter https://www.destatis.de/DE/ZahlenFakten/Wirtschaftsbereiche/Energie/Erzeugung/Tabellen/Bruttostromerzeugung.html (26.02.2013).

Steinhäußer R., 2012. Aktuelle Änderungen im Erneuerbare-Energien-Gesetz (EEG) und die geplante Reform der Gemeinsamen Agrarpolitik der Europäischen Union (GAP): Konsequenzen für die umweltgerechte Bereitstellung von Bioenergie. In: Natur und Recht 34 (7), S. 441-448.

Tyler T.R., 1990. Why people obey the law. New Haven: Yale University Press.

Tyler T.R., Blader S.L., 2005. Can Businesses Effectively Regulate Employee Conduct? The Antecedents of Rule following in Work Settings. In: The Academy of Management Journal 48 (6), S. 1143-1158.

Veetil V.P., 2011. Conceptions of rationality in law and economics. In: European Journal of Law and Economics 31 (2), S. 199–228.

Vollrath B., Kuhn W., Werner A., 2010. “Wild” statt “Mono” – neue Wege für die Biogaserzeugung. Bayerische Landesanstalt für Weinbau und Gartenbau. Online verfügbar unter http://www.lebensraum-brache.de/_downloads/poster_und_veroeffentlichungen/WildstattMono_LandinForm.pdf (28.08.2012).

ARE THE MOST PROFITABLE FARMS CONSISTENTLY THE MOST PROFITABLE

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Abstract

Every year, some farmers will do better than other farmers. Whether by luck, better management, more rainfall, a different enterprise mix, etc., a subset of farmers will be more profitable than another subset of farmers. However, over a period of years, is there consistency among the population of farmers for who is the most profitable. That is, are the most profitable farms in any given year also the most profitable farms over a long-term time horizon? This paper investigates a 15-year panel data set of similar farm from Kansas to determine if the most profitable farms are consistent across time. We accomplish this by ranking farms by decile each year and then averaging these yearly rankings. If luck and weather are the main drivers of differences in yearly net farm income, then over time a farm's yearly ranking would vary and the overall average ranking for that farm should approach 5.5. Conversely, if management is more of a factor determining differences in net farm income, then a farm should consistently place in the same decile ranking year in and year out. Thus the overall 15-year average rankings of farms should be very widely distributed. That is there would be no more farms ranked at the mean (5.5) than at the extremes. We find that both management and weather/luck contribute to overall profitability. Even though the bottom decile of farmers consistently have negative net farm income each year, the 15-year average of net farm income only has 4 percent of farms with a negative average.

Keywords: profitability, ranking, consistency

1. Introduction

Every year, some farmers will do better than other farmers. Whether by luck, better management, more rainfall, a different enterprise mix, etc., a subset of farmers will be more profitable than another subset of farmers. This is even after accounting for farm type and farm size. However, over a period of years, is there consistency among the population of farmers for who is the most profitable. That is, are the most profitable farms in any given year also the most profitable farms over a long-term time horizon? This paper investigates a 15-year panel data set of similar farm from Kansas to determine if the most profitable farms are consistent across time. This paper should help show if there are such farms or if luck and weather variability have more to do with farm profitability than does management. If there is a consistent set of more profitable farms, then these farms can be examined in more detail to determine why they are more profitable.

Weather is certainly a major contribute for determining profitability in a given year. Rainfall can vary tremendously across a region resulting in higher yields for some farms and lower yields for others. However, over a period of years, these rainfall variations should tend to equal out. Thus, if a farmer is consistently more profitable than another across time, it is unlikely this profit difference is caused by weather or luck. This assumes of course that farms from similar geographical regions are compared. If there are more profitable farms consistently across time, then this difference can be attributed to some factor of management. Management could include the enterprise choice, the level of debt, the choice and amount of inputs, etc.

2. Data and methods

This paper uses a panel data set of 626 Kansas farms for the years 1997 through 2011. Complete whole farm financial data is available for these farms as well as the location of the farm and the type classification of the farm (i.e., livestock vs. crop). For each year of the data set, the farms were divided into 10 groups based on accrual net farm income. Each of these deciles contained either 62 or 63 farms. The top 10 percent of net farm income farms were assigned a value of "1", the next group of farms based on net farm income were assigned a value of "2" etc. Thus, all the farms in a given year had a ranking from 1 to 10 and given each group was the same size, this procedure resulted in a uniform distribution of farm rankings in a given year.

This same procedure of ranking farms was applied to the other years. The years were considered to be independent so that a farm's ranking one year had no effect on the next year. Thus, each farm ended up with 15 farm ranks over the 15 years of the data set. Since the yearly ranking produced a uniform distribution from 1 to 10, the average farm ranking in a given year was 5.5.

The next step was to average, for each farm, the yearly farm rankings. This gave a single average farm ranking for a particular farm. If weather or luck was totally accounting for the yearly variation in farm rankings, we would expect that over 15 years the farm ranking would average toward the mean (5.5). In fact, if weather or luck was the only factor affecting farm profitability, then all the farms should end up with an average ranking of 5.5. There would be no variation.

However, if management (or possibly farm size, farm type, or soil productivity) was a factor in the yearly ranking of net farm income, then some farms should have a higher 15-year average than other farms. If management was the only factor affecting the variation in yearly net farm income, then the top 10 percent of farms should be the same every year. The other ranking groups would be the same across time as well. The 15-year average of farm rankings would have 10 percent of the farms ranked as one, 10 percent ranked as two, etc. The overall average would still be a 5.5 but the overall average distribution would resemble an individual year distribution.

By examining the actual distribution of 15-year farm ranking averages, we can determine how much of the net farm income variation in any year is due to management. The flatter the distribution, the more likely management is to be a factor. In other words, if the actual distribution of average returns approaches the theoretical uniform distribution when management is the only factor, then management is more important. Conversely, the steeper the distribution, the more likely that luck or weather is a bigger factor in the variation in yearly net farm income. In this case, all the farms would converge to an average rating of 5.5 after 15 years.

Another way of examining the influence of management on net farm income is to count the number of farms that have an average rating either one standard deviation above or one standard deviation below the overall farm rating average (5.5 average rating for all farms). Because the farms are forced into a discrete uniform distribution each year, farms that have an average rating below 2.623 would be considered to be above average farms. Farms that have a rating above 8.372 would be considered to be below average farms.

If weather and luck were the only factors affecting differences in net farm income, then no farms would average above 2.623 or below 8.372. The farms would all average 5.5. The opposite situation is when management is the only factor affecting net farm income and farms consistently divide into the same ranking groups each year. In this case, we would expect 26.23 percent of the farms to be above average and 26.23 percent to be below average. With 626 farms in the initial analysis, this would result in 164 farms above average. By calculating the ratio of actual farms with a rating above 2.623 to the theoretical possible farms above average, we estimated a measure of management efficiency.

In addition to examining the entire state of Kansas and all farm types at once, various subsets of the data were also examined. The first subdivision was to divide farms into either crop only farms and farms that included livestock. This division resulted in 342 crop only farms and 67 livestock and crop farms. These two subgroups total less than 626 farms because some farms switch farm type over the period and were thus excluded in this particular subdivision analysis. Also, all farm types were subdivided into regional analysis.

3. Results

Figure 1 shows the distribution of average farm rankings over 15 years from using all 626 farms in the analysis. This distribution is shown with the solid colored bar graph. The gray crosshatched bar graph is the theoretical distribution of farm rankings if management was the only factor affecting net farm income (i.e., farm rankings would stay the same every year). By contrast, if net farm income was only a function of luck or weather then all farms would have an average rating of 5.5 and there would be no variation.

As this figure illustrates, there appears to be a cross between luck or weather and some management skill affecting the farm rankings. About 2 percent of the farms had an average rating of one. If management were the only factor, we would expect 10 percent of the farms to have an average rating of 1. Also, keep in mind that this first figure is based on Kansas farms with no allowance for farm size or farm type. These two factors would have some influence on net farm income as well.

Figure 2 shows the average net farm income by a particular decile for each year. Since the yearly numbers are recalculated each year and are independent of each other, there very are likely different farms in each decile each year. There are several observations worth noting from this figure. First the bottom 10 percent of farms each year lost money. Second, the next most profitable group (the group in the ninth decile) basically earned zero net farm income each year. All the other groups within a year usually earned some net farm income. In particular, the top 10 percent of farmers in a given year earned much more than the other groups.

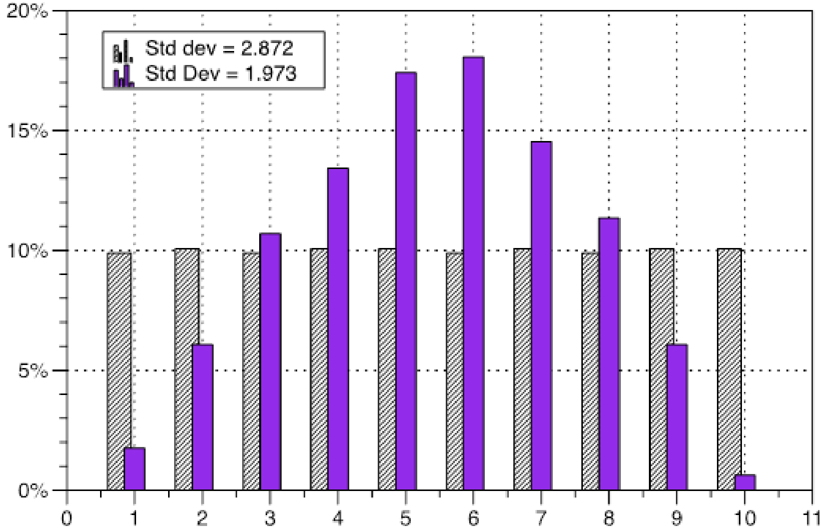

Figure 1. Distribution of average farm rankings – all farms

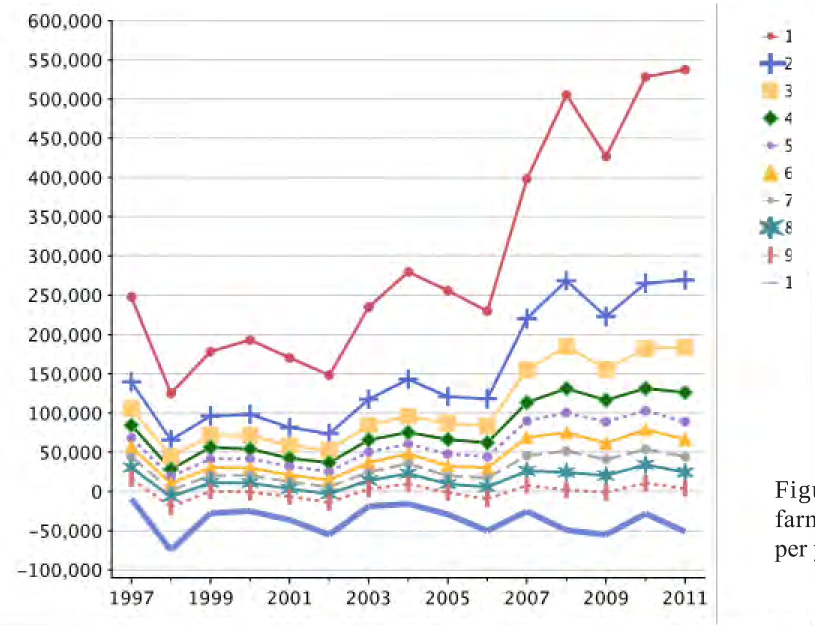

Figure 2. Average net farm income by decile per year – all farms

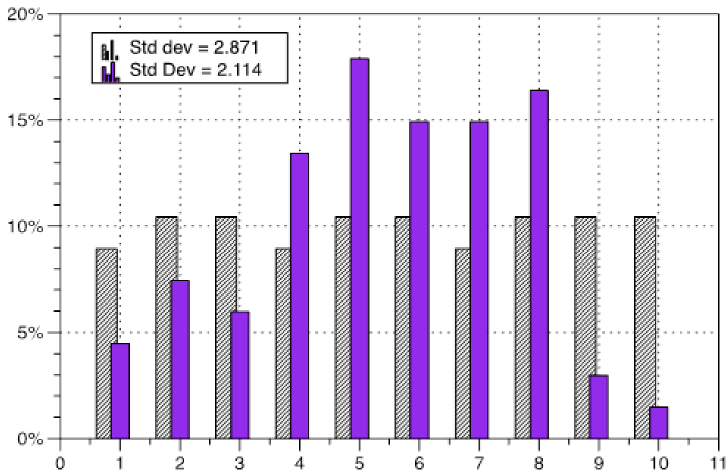

Figure 3. Distribution of average farm rankings – combination farms

Figures 3 and 4 and Figures 5 and 6 show the distribution of average farm rankings when the Kansas farms are divided into two subgroups. Figures 3 and 4 are from the 67 farms that raised livestock or a combination of livestock and crops. Figures 5 and 6 are from the 342 farms that raised crops only. Since these subdivisions take away one of the factors that might make a farm consistently more profitable each year (i.e., farm type) we might expect there to be a more vertical distribution (i.e., fewer farmers in the tails of the distribution) of farm rankings. However, this is not the case as combination farms have a greater percentage of farms ranked one and two than does all Kansas farms. The crop farms visually looks very similar to the overall Kansas farms.

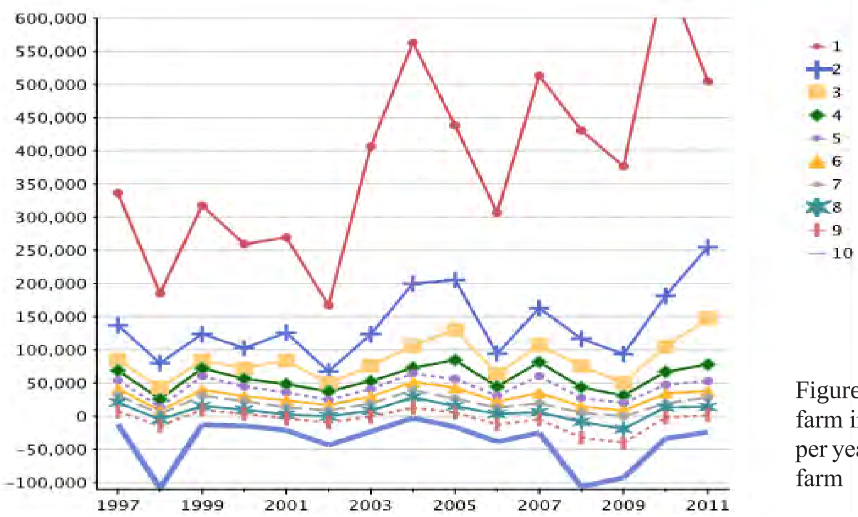

Figure 4. Average net farm income by decile per year – combination farm

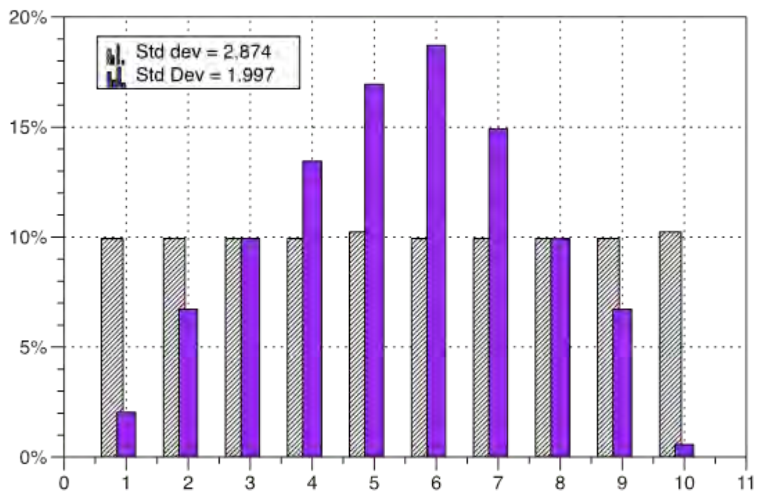

Figure 5. Distribution of average farm rankings – crop farms

The yearly distribution of average net farm income for each decile shown in Figures 4 and 6 look very similar to the overall Kansas graph from Figure 2. The only obvious point is that the top decile and the bottom decile for the livestock combination farms (Figure 4) appear to vary more from the median deciles than does either the crop farms or the overall Kansas farms (Figures 2 and 6).

Figure 7 is a comparison of the distributions of farm income rankings when the farms are divided into regions. Again, we might expect these regional distributions to be more vertical as the regional differences might be one reason that a farm is consistently more profitable than another. As this figure indicates, there are no obvious regional differences when comparing to the overall Kansas numbers.

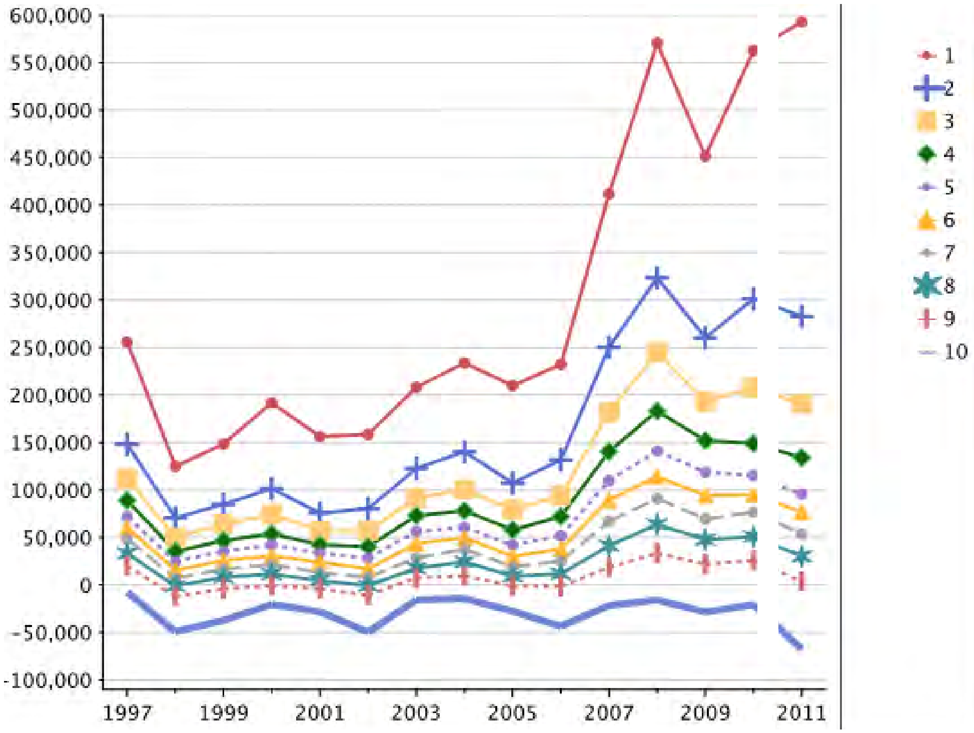

Figure 6. Average net farm income by decile per year – crop farms

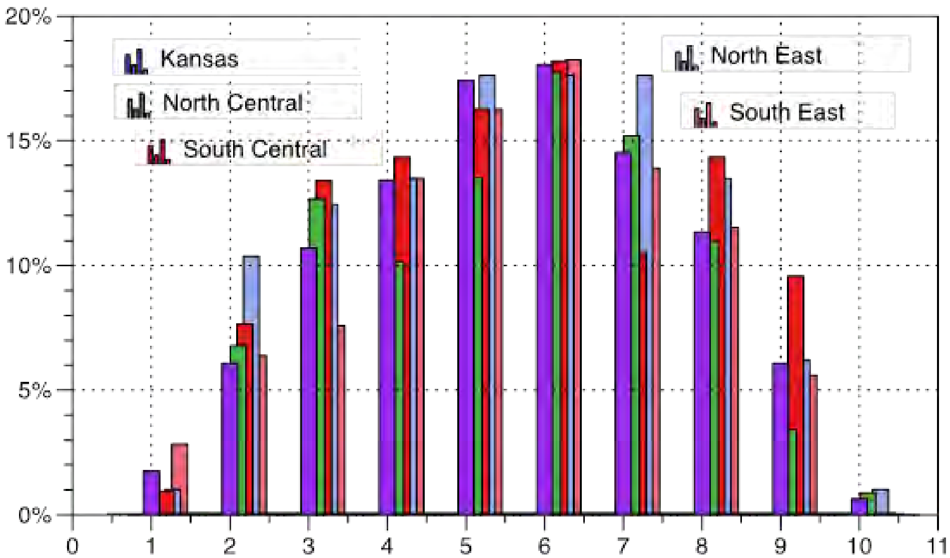

Figure 7. Distribution of average farm rankings – regional differences

Table 1. Number of farms above or below a one standard deviation range

All farms	Actual count	Theoretical maximum	% mgmt responsibility
Above average	54	164	33%
Below average	52	164	32%
Non-crop			
Above average	8	18	45%
Below average	4	18	23%
Crop			
Above average	31	90	34%
Below average	30	90	33%
North Central			
Above average	9	28	32%
Below average	9	28	32%
South Central			
Above average	11	29	38%
Below average	12	29	42%
North East			
Above average	14	28	50%
Below average	9	28	32%
South East			
Above average	25	63	39%
Below average	15	63	24%

Table 1 shows the count of farms that are either one standard deviation above the mean or one standard deviation below the mean. The theoretical maximum is when a farm ranks the same every year. This number varies in the table, as the sample size is different for each subdivision. The ratio of the actual to the theoretical gives a number called percent management responsibility. The closer this number is to one, the more likely that some factor of management was responsible for the farm being consistently above or below average.

4. Conclusions

By ranking farms by decile each year and then averaging these yearly rankings, we can get some idea of whether management or luck and weather are more responsible for differences in net farm income. If luck and weather are the main drivers of differences in yearly net farm income, then over time a farm's yearly ranking would vary and the overall average ranking for that farm should approach 5.5. Conversely, if management is more of a factor determining differences in net farm income, then a farm should consistently place in the same decile ranking year in and year out. Thus the overall 15-year average rankings of farms should be very widely distributed. That is, there would be no more farms ranked at the mean (5.5) than at the extremes.

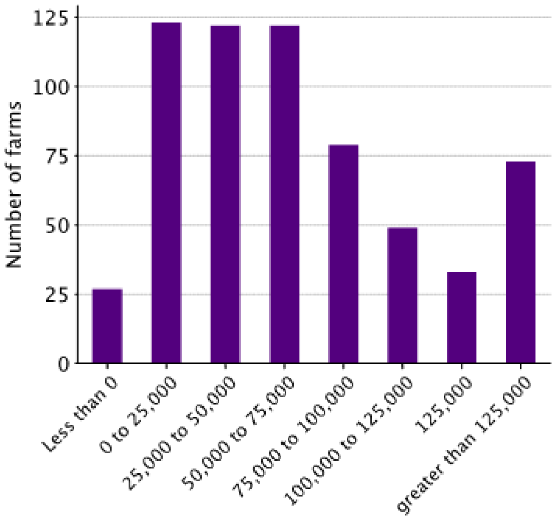

Figure 8. Number of farms with ave net farm income in these ranges

The analysis from the 15 years of Kansas data shows that it appears that weather and luck as well as management influence a farm's year-to-year net farm income. Based on the management index calculated in Table 1, management might contribute to a third of the net income variation. Included in this management ranking would be factors that weren't controlled for in the analysis (i.e., farm size, farm type, etc.). Some of the regions show more management differences than others. The North East had a management responsibility calculation of 50 percent.

Even though the yearly deciles of net farm income consistently showed the bottom 10 percent of farms losing money, these were in many cases different farms each year. As can be seen in Figure 7 only 1 percent or so of farms consistently averaged in the bottom 10 percent of yearly net farm income. The same conclusion can be drawn about the top farms as well as only 2 to 3 percent of farms consistently averaged in the very top decile. Fortunately for farm viability, this bottom decile is the smallest one. Based on the regional analysis, the two southern regions did not have a farm that averaged in the bottom 10 percent of farms.

Figure 8 shows a histogram of average net farm income over the 15-year horizon. This figure helps to confirm the conclusion that farms that do poorly one year probably don't do poorly the next year. 26 farms here had an average net farm income below zero. This amounts to 4 percent of the farms. Nearly 60 percent of the farms had an average net farm income between zero and $75,000.

TO COMMERCIALIZE OR NOT TO COMMERCIALIZE GENETICALLY MODIFIED CROPS IN THE EU ENVIRONMENT

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Abstract

Purpose The paper analyzes the decision-making process on whether or not to commercialize genetically modified (GM) crops in the current EU environment, for several agriculture industry sectors. This cross-industry analysis provides us insights in the (future) market dynamics of GM crop (applications) in the EU environment.

Methods Agribusiness stakeholders of six agricultural industry sectors were interviewed on their GM policy, using a semi-structured interview guide. This data were analyzed by content analysis.

Principal results The cross-industry analysis on GM policies between companies belonging to the same and to different agriculture industry sectors, unveils several alignments of common central arguments in their decision-making processes that precede this actual GM business policy. Accordingly, three strong hypothetical policy congruities were identified, between (1) the agricultural biotechnology and compound feed industry, who's policies are motivated by their conviction that GM imports are a by-default reality in the EU, (2) between NGO's and the organic industry, who's policy is driven by their pursued agricultural ideals (that oppose both to the current (globalizing) agricultural system and to GM crops as they reinforce this system), and (3) between all the food actors, who's GM business policy is primarily motivated from a (black-or-white) marketing consideration. Finally, our insights (1) highlight the "talking at cross-purposes" in the GM debate between different agriculture industry sectors, and (2) unveil several underlying reasons for the locked-in situation with GM crops in the current EU environment.

Keywords: business perspectives, agribusiness, genetically modified crop, EU environment

1. Introduction

Discussions about agricultural innovations increasingly polarized over the last 50 years, which is indeed the case for the discussion about genetically modified (GM) crops in the EU environment. In the GM discussion, this polarization is (partially) explained by actors' different views on 'naturalness' and 'the portrayal of nature' as these moral concepts influence the moral acceptance or rejection of the agricultural innovation (Van Haperen et al, 2012).

Besides the moral discussion about GM crops, agricultural biotechnology enters into multiple other discussions. Ranging from discussions about world trade, patenting of life forms, the role of science in society, to the future of the common agricultural policy, the vertical integration in the food chain, and beyond (Gaskell, Bauer 2001). Accordingly, agricultural biotechnology can be considered as a high impact innovation. These are innovations "that set the whole system of society in movement. They influence economy, threaten values, and mandate to recalibrate and sometimes reformulate goals" COGEM (2004).

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However, in our current 21st century society, it is not obliged that agricultural innovations become successfully implemented. Especially, because the foundations of the system and the society itself are often questioned, such as: do we pursue or oppose to a globalizing agriculture?; do we accept a vertical power distribution in our food supply chains (is this really what we mean by freedom of choice)?; do we accept public-private partnerships in fundamental research-funding?; etc. These ethical concerns are not directly (nor solely) related to GM crop (applications) *as such*, but need a socially accepted and clear answer before we can move forward with the GM debate in the EU. As there is not a socially and political accepted univocal answer to these questions, there is a strong need to study this innovation throughout the value chain. Moreover, innovation has to occur at all points along the value chain before the innovation becomes effectively implemented (Vanclay *et al,* 2013). In this regard, Wield *et al* (2013) argue that the emergence and constraint of innovation in bio-economy (which includes agricultural biotechnology) mainly depends on the interactions between three main sets of actors, being (1) innovators (scientist, technologists, industry), (2) policy-makers and regulation (including government and the emerging new institutions of governance) and (3) the public and stakeholder groups (such as advocacy organizations). However, only little research is done to obtain an in-depth understanding of the incentives that are driving the agribusiness decision-making processes on GM crops (although much attention is paid to the lessons learned from the social issues of agricultural biotechnology, as to inhibit repetition of these “mistakes” to closely-related innovation such as nanotechnology).

In particular, this study focusses on the decision-making processes of the agribusiness stakeholders to commercialize (or not) GM crops in the EU environment. Firstly, this paper questions if, and to what extent, we can identify common central arguments in the decision-making processes of companies that belong to the same agriculture industry sector. Secondly, we compare the decision-makings on GM crops between different agribusiness industries and look into what is needed to affect their decision-making process. These renewing insights can learn us more about the current stalemate in the debate on GM crop (applications) in the EU and provide some insights in the (future) market dynamics of GM crops in the EU environment.

2. Methodology

2.1. Stakeholder sampling

Forty semi-structured interviews were performed with agribusiness stakeholders of different agriculture industry sectors, interviewing both individual companies and the national plus European federations of the sectors. The following sectors were selected: (1) the agricultural biotechnology industry, (2) compound feed industry, (3) potato industry (both the fresh market and industrial processing industries (chips and fries)), (4) food processing and food marketing industries, and (5) finally the organic industry. Although we acknowledge that NGO’s have no direct commercial interest in GM crop (applications), these stakeholders were also included in the sample because many companies addressed them as being essential stakeholders for their GM business decision. Sampling occurred in Flanders (Belgium), but the companies’ scope were either national, European or worldwide.

2.2. Data-analysis

The data were analyzed by content analysis (Stemler, 2001). Our analysis focused on the common central aspects in the decision-making processes of companies that belong to the same industry, even though here were also some intrasectoral argument differences. The analysis relied on the analytical framework presented by Inghelbrecht *et al* (Submitted), which unveils the main important aspects in companies' decision-making processes on whether or not to commercialize GM crops in the EU environment. In the next step of the analysis, we have compared the central aspects in the decision-making processes of different agribusiness industries. This cross-industry analysis revealed three strong hypothetical alignments in the decision-makings of our different industry sectors: between (1) the agricultural biotechnology and compound feed industry, (2) NGO's and the organic industry, and (3) between the food manufacturing processors, retailers and companies in the potato industry ("food actors").

3. Results

The cross-industry analysis unveils strong hypothetical (read not institutionalized) alignments in the decision-making processes of (1) the agricultural biotechnology industry and the compound feed industry, (2) between NGO's and the organic industry, and (3) amongst the food actors. Each hypothetical alignment is very briefly discussed in the three following subparagraphs.

3.1. First hypothetical alignment

The decision-making process of the agricultural biotechnology industry to apply for GM crop authorizations for imports in food and feed in the EU, and the decision-making process of the compound feed industry to process GM crops in their feed as part of "Certified Responsible Animal Feed" (BEMEFA, 2011a; BEMEFA, 2011b), are similar in the way that both assess agriculture as being inherently globalizing. This agricultural perspective holds a free world-wide flux of raw materials and considers imports simply as an economic reality. GM imports are therefore seen as a by-default reality in the EU. Furthermore, both industries also doubt about the future ability of the EU to maintain its non-GM raw material demand, because the EU is attributed only a declined power in a global GM crop trading world. Moreover, both industries' decision-making process is strongly affected by their perception on the EU GM crop regulation and the experienced restrictions it imposes. These industries do, however, differ in their value judgment of GM crop (applications): the compound feed industry processes GM crops on a 'by-default' but not on a 'by-interest' basis, contrary to the agricultural biotechnology industry.

3.2. Second hypothetical alignment

The decision-making processes of NGO's and the organic industry cohere in their perception on agriculture *as such*, because both pursue agro-ecological agricultural ideals (depicted as opposed to GM crops). Both consider the EU to be perfectly feasible to maintain a systematic non-GM raw material demand (taking into account some adaptation, such as a decreased meat consumption). Contrary to NGO's - which do not have any direct product relationship with GM crops - the organic industry has a strong commercial fear on the development of organic agriculture if GM crops come into practice more extensively in the EU (in essence being an economic incentive).

3.3. Third hypothetical alignment

The decision-making processes of food actors on whether or not to commercialize GM crops is characterized by a high degree of direct commercial fear on GM crop processing and/or commercialization. They approach GM crops primarily as a marketing issue. Several food actors also had a risk-perception on GM crops from an agricultural perspective and few were skeptical on whether the EU can maintain its non-GM raw material demand in the future. Nevertheless, these risk-perceptions were subordinated to their risk-perception on (indirect) GM marketing, because of expected negative consumer and/or NGO (read societal) responses.

4. Discussion

A cross-industry analysis of different agribusiness industries' decision-making process on (not) commercializing GM crops in the current EU environment, unveils various congruities of common central arguments which motivate their eventual GM business policy.

The agricultural biotechnology industry and the compound feed industry (first hypothetical alignment) assess GM crops from a globalizing agricultural perspective and consider GM imports simply needed in EU agriculture. However, the agricultural biotechnology industry assigns a strong marketing potential to GM crops in the EU, but their perceived political structural barriers discontinue further investments in GM trait and/or crop R&D for particular cultivation in the EU. Their dissenting marketing orientation on markets outside the EU (with some spillover effect to the EU the highest), is a consequence of the high level of uncertainty on obtaining return of investments guarantees and is a consequence of the highly unpredictable regulatory GM crop environment in the EU (Nadolnyak, 2007).

NGO's and the organic industry (second hypothetical alignment, yet in the GM debate merely intertwined) oppose to GM crop (applications) from an agricultural point of view. This view is endorsed by their perception that the EU is powerful enough to control its non-GM raw material demand. The latter somehow contradicts with the forecasted difficulties to maintain a (future) non-GM raw material demand in the EU, due to (1) the import-dependency of the EU on several raw-materials (such as soy); (2) the slow GM crop authorization procedure in the EU, which disturbs the free flux of raw materials worldwide, and due to (3) the enhanced risks on sourcing non-GM raw materials in the EU that are contaminated with not (yet) EU authorized GM crop traces (Stein, Rodriguez Cerezo, 2010a; Stein, Rodriguez Cerezo, 2010b; von Witzke, Noleppa, 2010). Moreover, the organic industry also has a strong marketing incentive to oppose to GM crop (applications), as also Apel (2010) explains by concluding that the organic industry has the largest economic incentive to restrict all GM crop applications from the market.

In essence, stakeholders of the first and second hypothetical alignment judge GM crops primarily from an agricultural (ideal) point of view, yet from completely opposing perceptions. They reform the discussion about GM crop (applications) to a discussion about agricultural ideals *as such*.

Controversially, food manufacturing processors, retailers and stakeholders in the potato industry (third hypothetical alignment) primarily approach GM crops from a black-or-white choice marketing point of view (which is also applicable to the organic industry), adding additional complexity to the different values that ground the ongoing discussion about GM crop (applications) in the EU.

These insights enables us to understand why different (agribusiness) stakeholders in the GM debate talk at cross-purposes, as their decision-making process is essentially driven from different perceptions and lines of thoughts, and is driven from different sets of basic and pursued values.

5. Conclusions

In this cross-industry analysis, three strong hypothetical GM policy congruities were identified between different agricultural industry sectors. These different points of view reduce the discussion about GM crops to merely a discussion about agricultural ideals *as such* or to a simple marketing theme. Apparently, GM policy alignments between agribusiness industries form more easily when both assess GM crops as a raw material (in the case of the agricultural biotechnology and compound feed industries) or if they assess GM crops simply as being a part of an end product (in the case of the food actors). These insights offer understanding of why different agribusiness stakeholders in the GM debate talk at cross-purposes, as their decision-making process is driven from different perceptions and different sets of pursued values. If we talk about GM crops, what are we really talking about?

The results of this case-study analysis are mainly exploratory and descriptive in nature, making all extrapolation of the results speculative. Nonetheless, the analysis learns us more about the current stalemate in the debate on GM crop (applications) in the EU and provides some insights in the (future) market dynamics of GM crops in the EU environment (from an agribusiness point of view).

6. References

Apel A., 2010. “The costly benefits of opposing agricultural biotechnology”, *New Biotechnology,* Vol. 27, No. 5, pp. 635-640.

BEMEFA, 2011a. “The Production and Delivery of Compound feed making use of Certified Socially Responsible Soy”, available at: www.bemefa.be/Download.ashx?ID=84664 (accessed 31 March 2013).

BEMEFA, 2011b. “Responsible soy: Greenwashing or Truly Responsible?”, available at: www.bemefa.be/Download.ashx?ID=82039 (accessed 31 March 2013).

Busch L., 2007. “Performing the economy, performing science: from neoclassical to supply chain models in the agrifood sector”, *Economy and Society*, Vol. 36 No. 3, pp. 437-466.

Busch L., 2011. “The private governance of food: equitable exchange or bizarre bazaar?”, *Agriculture and Human Values*, Vol. 28 No. 3, pp. 345-352.

COGEM, 2004. “De Farm Scale Evaluations geëvalueerd”, The Hague, The Netherlands.

Gaskell G., Bauer M.W., 2001. “Biotechnology 1996-1999 : the years of controversy”, *Science Museum Press*, London, UK.

Inghelbrecht L., Dessein J., Van Huylenbroeck G., (Submitted), “Agribusiness perspectives on commercializing GM crops and ingredients”, Contact: Linde.Inghelbrecht@Ugent.be

Nadolnyak D., Miranda M.J., Sheldon I., 2011. “Genetically modified crops as real options: Identifying regional and country-specific differences”, *International Journal of Industrial Organization,* Vol. 29 No. 4, pp. 455-463.

Stemler S., 2001. “An Overview of Content Analysis”, *Practical Assessment, Research and Evaluation,* Vol. 7 No. 17.

Stein A.J., Rodriguez Cerezo E., 2010a. “International trade and the global pipeline of new GM crops”, *Nature Biotechnology,* Vol. 28 No. 1, pp. 23-25.

Stein A.J., Rodríguez Cerezo E., 2010b. “Low-level presence of new GM crops: an issue on the rise for countries where they lack approval”, *AgBioForum*, Vol. 13 No. 2, pp. 173-182.

Vanclay F.M., Russell A.W., Kimber J., 2013. “Enhancing innovation in agriculture at the policy level: The potential contribution of Technology Assessment”, *Land Use Policy*, Vol. 31, pp. 406-411.

Van Haperen P.F., Gremmen B., Jacobs J., 2012. “Reconstruction of the Ethical Debate on Naturalness in Discussions About Plant-Biotechnology”, *Journal of Agricultural & Environmental Ethics,* Vol. 25 No. 6, pp. 797-812.

von Witzke H., Noleppa S., 2010. “EU agricultural production and trade: Can more efficiency prevent increasing ‘land-grabbing’ outside of Europe?”, Humboldt Uversity Berlin and Agripol, 36 pp., available at: http://www.appg-agscience.org.uk/linkedfiles/Final_Report_Opera.pdf (accessed 31 March 2013).

Wield D., Hanlin R., Mittra J., Smith J., 2013. “Twenty-first century bioeconomy: Global challenges of biological knowledge for health and agriculture”, *Science and Public Policy*, Vol. 40 No. 1, pp. 17-24.

AGRICULTURAL AND RURAL INCOME TAX EDUCATION OVER THE YEARS: AN EXTENSION PROGRAM OF LAND GRANT UNIVERSITIES

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Abstract

Income tax regulations in the United States are complex, voluminous, and ever changing. Continuing education for professional tax preparers is necessary and is required for most categories of tax professionals. For decades the cooperative extension services of the Land Grant Universities have offered tax education for their constituents. This has developed into a collaborative effort led by the Land Grant University Tax Education Foundation (LGUTEF). The twenty-six member institutions of LGUTEF offered materials and training for approximately 30,000 tax professionals in 32 states 2012. North Carolina State University and the University of Kentucky are two states that offer a range of seminars to tax professionals in their respective states. This paper discusses the historical development of tax education, the logistics of its delivery, and the challenges of the future.

Keywords: taxation, education, LGUTEF, U.S.

1. Historic overview

Taxes and tax collectors are as old as the Bible, if not older. Ancient civilizations ruled by kings required “tribute” from the conquered. These tribute payments were a form of tax. Governments need revenues to provide various services and programs to the citizens of the land. Citizens, though required to pay taxes, desire to minimize that burden, especially in regards to the tax based on income.

In the United States, the earliest record of a federal income tax was legislation signed by President Abraham Lincoln, in 1862, to provide funding to pay the expenses of the American Civil War. The tax was levied on income in two brackets: a three percent tax on incomes between $600 and $10,000; and a second bracket imposed a five percent tax on all incomes above $10,000. This tax was repealed in 1872 (A Brief History of Taxes, 2013).

In 1913 the States ratified the 16th Amendment to the United States Constitution establishing income taxation as a major source of federal revenue. Since this legislation became the law of the land, the modern tax code has grown to be a complicated set of rules to be followed by individuals and businesses alike. Estimates of the size of the Internal Revenue Code (IRC) range from 34,000 to 1,000,000 pages. The latter attributed to President George W. Bush. Further, the IRC does not include other regulations and court case rulings that add to the volume of materials taxpayers must contend with annually. The last major attempt by the United States Congress to “overhaul” the Internal Revenue Code occurred during the Reagan administration with the passage of the Tax Reform Act of 1986. With the most recent tax legislation, the American Taxpayer Relief Act of 2012 passed on January 2, 2013, the highest marginal income tax rate became 39.6%, down from 50% in the early 1980s, a 70% top rate during the 1970s and an extremely top rate of 91% as recently as 1963 (A Brief History of Taxes, 2013).

To further complicate tax matters, the safety net of Social Security was created as part of President Roosevelt's New Deal in the 1930s. Social Security payments were to be paid by those working today for those who have retired. Original legislation for social security did not include farmers. However, farmers came under the obligation to pay self-employment (Social Security) taxes in 1955 (Carmen, 1997). Since the 1950s when the maximum social security tax paid was $126 (3% of a maximum of $4,200 of self-employed earnings), the rate and the upper limit of earnings have increased to 15.3% and $113,700 (Effects of Federal Tax Policy on Agriculture). The social security tax, not accounting for the unlimited 2.9% Medicare tax above the upper limit, is $17,396 for 2013. There is no upper limit on self-employed income for Medicare (www.ssa.gov). For farmers, as self-employed individuals, social security is a significant tax which needs to be managed in conjunction with income taxes.

2. Educational programming

As tax obligations grew in quantity and complexity, educational efforts were needed to help rural and urban citizens alike understand the complicated IRC and their obligations to file income tax returns. Land grant universities with cooperative extension services were in a unique position to provide this education.

An Extension effort of the North Central Farm Management Extension Committee (NCFMEC) led to the development of *"Income Tax for Farmers"* a publication published by the Committee from 1948 through 1954. In 1955 the Internal Revenue Service (IRS) took over the publication and it was re-titled *"The Farmer's Tax Guide."* Since 1955, the National Farm Income Tax Extension Committee has collaborated with IRS to publish the guide annually (Edwards, 2013).

Land Grant universities in the United States, through their respective cooperative extension services, developed and conducted educational programs for rural citizens focused on preparing and filing federal income tax returns beginning in the 1940s. These educational programs, initially delivered at the county level grew into state-wide educational programs for the emerging income tax preparation industry. In North Carolina, the first extension tax school in 1949, was known as the "Farm Tax School" and used the NCFMEC publication as the text. North Carolina State University conducted its sixty-third two-day Income Tax School for tax practitioners in November and December of 2012 through the Office of Professional Development (OPD) an office in the Division of Continuing Education. Kentucky's tax education programming began in 1963 also as a "Farm Tax School" and evolved into "Income Tax Seminars" for a wide range of tax professionals.

3. Resources

Development of high quality teaching material for a reasonable cost is always a challenge. Public universities are no exception to this challenge; however, these institutions can draw on faculty for expertise. The NCFMEC created a useful document in 1948 for teaching farmers about income tax obligations, and the advent of self-employment tax on net farm income increased the demand for teaching materials. Following the NCFMEC model, university faculty began to collaborate to develop texts for income tax education purposes. The University of Illinois at Champaign-Urbana was an institution with a history of farm tax schools. C. Allen Bock, a faculty member in the Department Agricultural Economics and an attorney, became the "editor-in-chief" of a roughly 700 page text used by many land grant university tax school programs. Bock's vision was to develop a cadre of authors and contributors from these sister land grant institutions. Such a collaborative effort was created and grew during the 1980s and 1990s. Following Bock's untimely death in 1999 changes in the editorial leadership were necessary. After an interim period, collaborating universities undertook a review of the process by which the book was created. At the conclusion of the review a decision was made to create an affiliated organization separate from any one university, but responsive to member universities to continue to develop and publish a national tax education workbook. In spite of its length and complexity, the uniformity of the tax code permits a single national publication to be applicable across all fifty states.

In 2001 the Land Grant University Tax Education Foundation, Inc. (LGUTEF) was created to continue the legacy of cooperation and the publication of a national tax book that C. Allen Bock husbanded during his tenure at the University of Illinois. In 2012 LGUTEF published 30,000 copies of the *National Income Tax Workbook* which was used by 26 members. These 26 members include 23 land grant Universities and 3 private companies which serve states where the land grant university does not have a tax education program (Land Grant University Tax Education Foundation). These programs offer income tax education in 32 states to tax preparers holding various credentials to meet mandatory continuing education requirements. Shaded states in Figure 1 offer LGUTEF based tax education seminars.

Interestingly, the University of Illinois elected not to join LGUTEF. The University of Illinois has continued to produce a text for use in tax schools, predominately in the state of Illinois. It is reported that they produce approximately 10,000 copies of their text annually.

Continuing education for income tax practitioners is delivered by range of providers: academic institutions both public and private, private enterprises that specialize in professional education, and industry organizations both at the state and national levels. The University of Kentucky and North Carolina State University are both land grant universities which are members of LGUTEF and provide continuing education to tax preparers. Indiana University and the University of Louisville in Kentucky are examples of public universities that offer continuing education as an

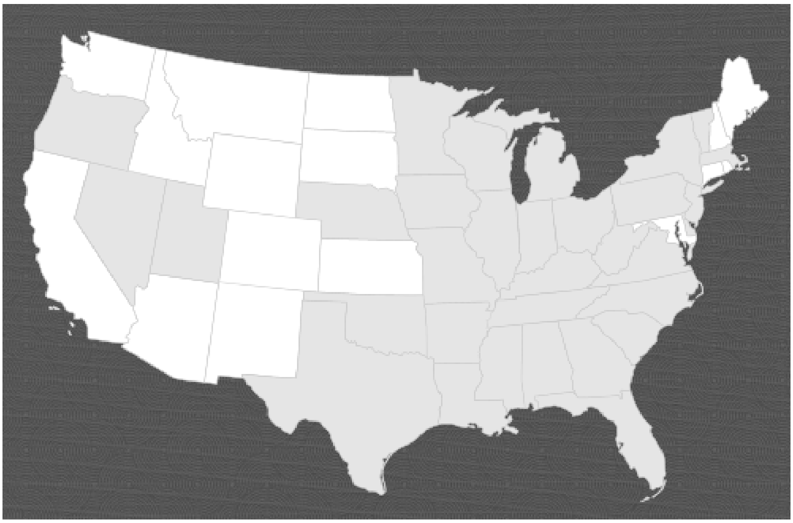

Figure 1. Land Grant University Tax Education Foundation affiliated states

outreach program of their business schools. Professional Tax Institutes, Inc. is an example of a private firm which conducts tax education across the United States for tax preparers. The North Carolina Association of Certified Public Accountants (ncaCPA) is an example of a state level professional organization that provides continuing education on tax issues as part of its mission. Finally, the American Institute of Certified Public Accountants (AICPA) is an example of a national trade organization which provides continuing education. These entities may offer publications for purchase to use for instructional purposes as well as delivery of in-house continuing education. Another continuing education book for teaching tax issues is the University of Denver's text which they use in their Accountant's Tax Education program and offer it for sale to other providers (www.aes.du.edu).

Cooperation among extension professionals is a mainstay in delivery of nationally focused programs which affect all citizens regardless of their home state. Due to decreasing resources coming from state and federal funding, individual land grant universities may not replace retiring tax knowledgeable extension faculty with persons that have equivalent training and interests as the retiree. In an effort to meet growing demand for peer-reviewed practical tax information and to fill gaps in institutional knowledge, extension specialists at 15 land grant universities collaborated to create Rural Tax Education (RTE). This collaboration led to the development of the website www.ruraltax.org for the electronic delivery of tax education material to rural business owners and extension educators. This website has over 45 fact sheets which discuss in detail tax topics which may affect farmers and rural business owners. The fact sheets are written in non-technical language so that farm and rural business owners can understand them and see how to report taxable transactions through examples. The website also has example tax returns and a 130 page e-book titled *Tax Guide for Operators of Small to Medium Sized Farms*. This text is intended to be a companion document to IRS Publication 225, *The Farmer's Tax Guide.* Increased internet access in rural areas has made this an efficient and timely tool for delivering timely tax information. For example, following a late 2012 USDA legal settlement known as the "Keepseagle Settlement", a fact sheet for the property reporting of settlement payments was posted in January of 2013. This enables recipients of this settlement to know how they must report this income on their 2012 federal income tax returns (Rural Tax Education's).

4. Logistics of delivering tax education

Among the LGUTEF states there is both consistency and diversity of delivery of tax education. Most states offer two-day workshops that will meet a range of continuing education certification requirements for federal tax, federal tax updates, and ethics. Additionally, many states will offer one-day seminars on specific topics such as partnerships, corporations, agricultural and timber tax issues, or for specific audiences such as the Registered Tax Return Preparers.

North Carolina and Kentucky are two LGUTEF member states that provide relatively standard tax education programming. In 2012, Kentucky offered seventeen two-day intermediate level seminars and eight one-day seminars to 2,085 participants. North Carolina offered training to 1,476 attendees at 12 two-day schools. The seminars are distributed geographically across the states and are held in a variety of facilities ranging from Extension offices to hotel conference centers. Audience size ranges from about 30 to over 200. Instruction is delivered by Extension educators or other tax professionals that may include Certified Public Accountants, retired federal or state revenue agents, and other tax professionals. Participants receive a copy of the aforementioned

National Income Tax Workbook and instructors use accompanying PowerPoint presentations in a lecture format to deliver 50-minute blocks (to qualify for one hour of continuing education credit) of topical information.

Unlike many Extension education programs, tax education is offered on a cost recovery basis. Attendees pay fees ranging from $150 to $350 per participant. In addition to the *National Income Tax Workbook* and its companion searchable CD text, participants receive a 1000-page Master tax guide, a 200-page state tax update, the 90-page Farmers Tax Guide and other assorted print materials. Refreshment breaks (and lunch in some states) are also provided.

A variety of professionals engaged in tax counseling and/or tax preparation attend the workshops. These include accountants, bookkeepers, Enrolled Agents, attorneys, financial planners, and Registered Tax Return Preparers. Other participants include state and local tax agency personnel, bankers, and interested individuals who prepare their own taxes (although that last category is small and diminishing). Figure 2 is an illustration of the vocational distribution of the participants in Kentucky in 2012.

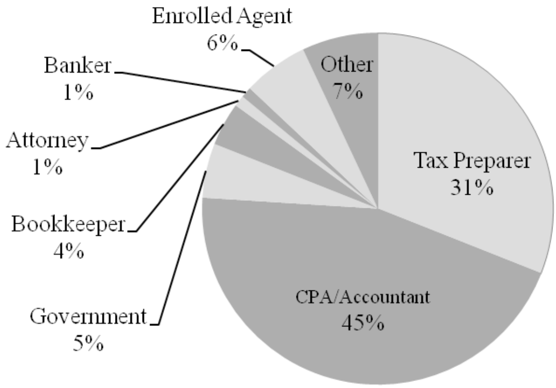

Figure 2. Income TaxSeminar Participation by Profession, Kentucky, 2012

While the direct recipients of Extension tax education are the professional tax preparers and other institutional employees, the farm community remains a major beneficiary of these programming efforts. Kentucky's 1,726 seminar participants reported filing an average of 33.4 Federal farm returns each in 2011 for the 2010 tax year. This represents 69.8% of the 82,700 farm returns reported by the IRS. North Carolina's seminar participants reported filing 12,320 farm returns, or 25.8% of the total farm returns filed in 2011. This suggests that while few farmers attend the tax seminars, many farmers benefit from the increased knowledge gained by attending Extension tax education workshops (Internal Revenue Service).

5. Future

Extension face-to-face meetings have been a traditional time honored method of knowledge and technology transfer from land grant universities to the citizens of the university's respective states. Income tax education is no exception. LGUTEF states deliver in-person training to approximately 30,000 tax professionals each year. Evidence suggests that many of them are seasoned professionals. In Kentucky the average number of years of tax preparation experience reported by participants was 21.7 in 2012. Further many are repeat customers. Kentucky's participants reported an average of 10.0 years of attending the UK Income Tax Seminars. While recent budget reductions have limited these type of delivery opportunities, the returning customers report that they appreciate the "on the spot' consultation from an expert and often respond negatively to video or distance-delivered programming.

As technologies, budgets, and demographics change, universities and extension services are constantly challenged to provide access to up-to-date information to clientele, both students and adult learners in the field. Rural Tax Education, discussed above, is but one example of the use of the internet to publish and provide access to peer-reviewed timely information that improves the lives of the rural citizenry of the United States. Obviously, through the internet, the potential audience and consumer of such published information are worldwide. Publishing tax information, for example, helps develop a knowledge level for not only individuals subject to the tax laws of the United States, but also, in a small way, helps to educate those individuals with desire to come to the United States.

Continuing education requirements as part of a credentialing process change as technology advances. Certainly, on-line education through webinars and self-study courses are in the forefront of modern delivery. However, providers need to remain responsive to different demographics of learners. These may be the "old school" wanting a face-to-face, person-in-the-chair environment or the recent graduate well versed in on-line, cloud-based delivery systems that are accessible every hour of the day from anywhere in the world. Maintaining quality of delivery, rigor of curricula, and compliance with the "proof of attendance" are all necessary to ensure the integrity of the provider, the student, and the credentialing agency. This is a challenge to be met and overcome.

6. References

A Brief History of Taxes, found at http://turbotax.intuit.com/tax-tools/tax-tips/General-Tax-Tips/A-Brief-History-of-Income-Taxes/INF18754.html, seven pages, accessed January 31, 2013.

Carmen, Hoy F., 1997. U.S Agricultural Response to Income Taxation, Iowa State University Press, 1997, pg. 123.

Edwards, William E., 2013. personal communication regarding history of the North Central Farm Management Extension Committee, January 7, 2013.

Effects of Federal Tax Policy on Agriculture / AER-800, Economic Research Service/USDA, page 29

Internal Revenue Service, Summary of Income Tax Stats- Historic Table No 2. Individual Income and Tax Data, by State and Size of Adjusted Gross Income, Tax Year 2011, http://www.irs.gov/uac/SOI-Tax-Stats---Historic-Table-2, accessed April 24, 2013.

Land Grant University Tax Education Foundation members, http://taxworkbook.com/workshop-locations/, accessed January 31, 2013.

Rural Tax Education's website, http://ruraltax.org, accessed January 31, 2013.

http://www.aes.du.edu/infos.php, University of Denver's Accountant Education Series, accessed January 31, 2013.

http://www.ssa.gov/policy/docs/quickfacts/prog_highlights/index.html accessed January 31, 2013.

THE ECONOMICS OF BIOGAS IN DENMARK – A FARM AND SOCITAL ECONOMIC PERSPECTIVE

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Abstract

Denmark has been one of the leading European Countries in using Biogas for Combined Heat and Power (CHP), since the 1980'ties. However, in the last two decades, the increase has been limited. A new energy policy aimed at increasing the profitability of Biogas was introduced in the spring of 2012. The analysis here shows that the new agreement will improve the profitability of biogas plants and increase the biogas production although the political ambition of an increase from 4 PJ to 14 PJ by 2020 seems unlikely. The analysis shows that biogas plants can be profitable even if the input is a mix of manure and solid fractions/farm yard manure given the present level of support. The analyses show that although maize increases the gas output somewhat, it increases the profit only slightly as the costs of the input is high (41€ per tonne). The overall production costs are around 0.53 € per m3 methane. Even without an investment subsidy of 30%, the case 2012, is profitable. Financing the biogas plants is a challenge. The interest used of 4.25% requires bank guaranties which in practice can be hard to get. Using a more likely interest of 7-8% reduces the yearly profit to 400.000 €. The socioeconomic analyses show that the costs of biogas as a measure to reduce CO2 emissions, are around 135 € per tonne CO2 and using maize is an expensive way to reduce emissions of CO_2 as the CO2 reducing effect is limited. The new Danish energy agreement gives subsidies to biogas used in the natural gas grid. The upgrading, including pressure adjustment, is 0.16 € per m3 methane. The analysis shows that the profit from upgrading biogas is only to be preferred if the sales prices of heat are very low. The socioeconomic cost of upgrading is, in most cases, not better than CPH. In order to reduce the cost of reducing CO2 emissions, the input to the biogas plant has to be based on farm yard manure and deep bedding as well as slurry.

Keywords: biogas, economics, upgrading biogas, cost of CO_2 reduction, environment

1. Introduction

The EU targets on renewable energy, which biogas production contributes to realize, are established to reduce EU's dependence on fossil fuels and to mitigate the climate changes. Denmark is obligated, by 2020, to decrease its total GHG emissions by 20% in the non-ETS quota sectors (housing, transport and agriculture), compared to 2005 emission levels, and to increase its share of renewable energy in the Danish energy supply system to 30% (Council Directive 2009/28/EC), (Council Decision No 406/2009/EC). Along with several initiatives, the Danish politicians made a "Green Growth" agreement in 2009, stating that up to 50% of all Danish manure should be utilized in a biogas plant by the year 2020.

Currently (2012) only 8% of the manure produced in Denmark is used for energy purposes, which puts the need for expansion of the Danish biogas production in perspective (Olesen et al., 2012). The majority of the Danish centralized biogas plants were built in the period 1987-1996, and approximately 20 of these plants are still operative today. Alongside this development, around 60 smaller farm scale biogas plants were established, who are responsible of the small but constant increase in Danish biogas production from the mid 90'ties until now. The energy from manure-based biogas production has doubled from 1.5 PJ/year in the year 2000 to 3.0 PJ/year in 2010, which is most of the total Danish biogas production of 4.2 PJ per year (Energistyrelsen, 2010).

The new Danish energy agreement was implemented in the spring, 2012. To promote the utilization of Danish manure to energy purposes, the governmental support for biogas-based energy was increased from 0.380 €/Nm^3 methane to 0.497 €/Nm^3 methane, under the condition that the biomass input consists of at least 75% manure. Furthermore, it became possible to get a subsidy for injection of biogas into the natural gas grid. Finally, to kick-start the production, an investment subsidy of 30% was given to a number of biogas plant projects in 2012. The higher governmental support, the high investment subsidy, and increased production and sales opportunities have together improved the regulatory framework and the potential income in the Danish biogas sector.

The purpose of the paper is to analyse whether the new energy deal makes Danish biogas profitable from a company perspective. What are the conditions for profitability in terms of input, price, subsidy and use of maize and etc. Will the price conditions in the new energy agreement be enough to boost biogas production in Denmark to fulfill the political ambitions? Is the new option to sell biogas to be upgraded as a profitable option? Looking at the socioeconomic perspective, is biogas a cost effective option is that also the case when it is based on maize or when only part of the heat is used? Compared to Germany the Danish biogas subsidy been too low or is it the German subsidy level which is too high?

The paper discusses the different methods used to achieve high degrees of biogas and green energy, but also the need to include both company and socio economic analyses in the assessment.

2. Danish biogas

The new Danish energy agreement has increased the value of biogas. As table 1 illustrates, the governmental support for Danish biogas has increased by approximately 30% compared to the old energy agreement. The table, furthermore, illustrates the natural gas price, the extra costs related to upgrading the biogas to natural gas quality, the values of unused quotas, and a possible green value of biogas.

Table 1. Energy price (old and new agreement)

Item	Old energy agreement, CHP (€/Nm^3 methane)	New energy agreement CHP (€/Nm^3 methane)	New energy agreement, natural gas grid (€/Nm^3 methane)
Governmental subsidy	0.380	0.497	0.497
Natural gas price	0.312	0.312	0.312
- Upgrading costs	0	0	0.168
(Quota value)	0	0	(0.048)
(Green value)	0	0	(?)
Total	0.692	0.810	0.642

Source: Tafdrup, 2012; KEMIN, 2012

As mentioned, table 1 also illustrates a quota value in relation to biogas on the natural gas grid. This value is not a reality yet, but a certificate system has been implemented in the Danish natural gas grid, so consumers are able to buy the CO_2-neutral biogas instead of the standard natural gas. If the price becomes equivalent to the CO_2 quota price (20€ / tonne), it would be equivalent to a price of 0.048 €/Nm3 methane. The table finally contains a green value, which is the value companies / consumers are willing to pay for the CO_2-neutral energy in order to improve the companies green image.

The change in the regulatory framework, providing the possibilities for upgrading biogas to natural gas quality and injecting it into the natural gas grid, has a huge effect on the sales possibilities of biogas. Earlier, the biogas producers were forced to sell their biogas to the local CHP plant, and with no alternative buyer, a relative low price on biogas was standard. With the new energy agreement, the biogas producers have an alternative buyer, which improves their situation when negotiating energy prices. The change, furthermore, enables a production of biogas in remote areas far from any CHP plants, which is necessary, if the target of degassing 50% of the Danish manure production is to be realized. In Germany the subsidy related to upgraded biogas is only given if the upgraded biogas used for local CHP production which does limit the use.

With the new energy agreement, an investment subsidy of 30% is available for a biogas plant project, if their application was approved by the end of 2012 and with the building starting in 2013. This has resulted in 42 applications and the approval of support for 19 new biogas projects in Denmark. The plant size ranges between a reactor capacity of 50,000 tons per year for farm scale biogas plants, to larger centralized biogas plants with the capacity to process almost 500,000 tons of biomass per year.

Finally, the ability to boost the biogas production with energy crops, and still be eligible for the governmental support, has also improved the conditions for the biogas producers. After the approving of the new energy agreement, a debate was initiated concerning whether it was wise to subsidize biogas based on energy crops. The concern was that biogas, based on energy crops, does not reduce GHG emissions as efficiently as manure, and that it would not contribute to the realization of the target of degassing 50% of the Danish manure production by 2020. On that foundation, it was agreed to reduce the eligible share of energy crops in the biogas input mix, from 25% in 2012 to 10% towards 2020, and maybe even to 0% in the following years.

3. Analytical framework

The potential for a sustainable biogas production in Denmark does not only depend upon the legislative framework, but there are several other factors also inflict on the economic sustainability of the production. The dry matter content in the Danish manure is one of the most uncertain parameters when estimating the biogas potential for a given biogas plant. This uncertainty exists because the dry matter content varies drastically with the type of manure. The dry matter content in cattle manure is generally the highest, whereas the manure from pigs, especially sow slurry is lower. The standard Danish values for the dry matter content for 2012 are 4.5% for sow slurry, 6.1-6.6% for slaughter pig manure, and 9.3% for cattle (Århus Universitet, 2012). But other estimates show much lower values. The most up-to-date values on the dry matter content in the Danish manure are a bit lower than the standard values. Birkmose et al. (2012) estimate the dry matter content in manure from slaughter pigs to be 5.5 and 4.0% for sow slurry. The dry matter content in cattle slurry is estimated to be 7.5%. It is assumed that it respectively takes 11.5 tons of cattle manure, or 10.8 tons of pig manure to produce 1 ton fiber fraction with a dry matter content of 33%. These are the dry matter contents used in the following estimations. Maize does increase gas production, but payment of 41 € per ton has to be made to the farmers. Increasing crop prices (e.g. wheat) will also increase the maize price which has to be paid (Jacobsen et al., 2013).

Instead of boosting the biogas production with energy crops, the biogas producer could use separated manure to increase the dry matter content in the reactor. The gas potential in separated manure is not as high in relation to its price, compared to that of maize silage. The lower gas potential results in a lower business economic surplus compared to a production where maize silage is applied. But from a welfare economic point of view, the use of separated manure is the best biomass to use, as it also reduces GHG emission, and thereby provide a very low marginal abatement costs (MAC), whereas the MAC from a maize silage-based biogas production has a MAC more than twice as high.

4. Case analysis

The following section describes the 2012 case biogas plant, regarding the plant size, the biomass input mix, the biogas production, and the energy output. It is estimated that a new centralized biogas plant in Denmark, on average, will have a capacity to degas approximately 700 ton biomass per day, which amounts to almost 260,000 ton biomass per year. The biomass input mix is based statements from new and planned Danish biogas plants. The input mix does not provide the highest possible profit for the biogas producer, but it is the most likely combination as the allowed share of maize-silage will be reduced to 10% over the coming years. Furthermore 12% of fiber fraction was added to boost gas production. It is assumed that organic industrial waste is no longer is available for the biogas producers, as it already is fully utilized by the current Danish biogas production. The table below illustrates the capacity of the biogas plant, the shares of different biomasses in the input mix and their dry matter content, along with the total biogas and methane production.

Table 2. Biomass input and production – 2012 case biogas plant

Biomass type	Input amounts	Dry matter content	Methane	Biogas	Methane	Biogas
	(ton/year)	(%)	(1000 Nm3/year)		(Nm3/ton input)	
Cattle manure	86,553	7.5	1,039	1,598	12.0	18.5
Pig manure	112,737	4.9	1,237	1,904	11.0	16.9
Seperated pig manure	17,344	30.0	1,082	1,665	62.4	96.0
Seperated cattle manure	13,316	30.0	831	1,278	62.4	96.0
Maize silage	25,550	33.0	3,182	4,895	124.5	191.6
Extra (serie-operation)	-	-	737	1,134	-	-
Total	255,500	11.5	8,108	12,474	31.7	48.8

Note: The methane yield from maize can sometimes be lower than estimated here
Source: own calculations

A part of the produced biogas is utilized in the engine in the biogas plant as process energy, which receives a governmental subsidy of 10 €/GJ. It is estimated that the process energy is equivalent to approximately 2 m^3 methane per ton biomass input. Furthermore 1% of the biogas is lost through flaring, and 10% of the biogas is lost through lack of demand for biogas-based heat in the summer period. The final amount of biogas available for sale is 6.7 million Nm^3 methane per year. The production in the first year is reduced by 25% as the system is not performing at maximum capacity right from the start.

5. Company results

The standard centralized biogas plant of 250,000 tonnes per day is estimated to have a plant-investment cost of 10.7 million €, followed by additional investment costs in e.g. trucks, land, and pipeline, which bring the total initial investment costs up to 13.2 mill. €. This initial investment cost is then eligible for the governmental support of 30%, which, in this case, is equivalent to almost 4 mill. € in 2012. Besides the initial investments, there will, after 10 years, be a need for reinvestments of approximately 2 million €. The annual maintenance costs are 0.2 million €. A total of three people will be employed with a salary of 0.2 mill € per year.

Finally, there are the transport costs. It is estimated that the new centralized biogas plant will have an average distance to its manure suppliers of 14 km. Few plants have invested in manure pipelines to transport the manure and so the main part of the manure is transported by truck. This is one of the most costly parts of biogas production, especially because the manure mainly consists of water. The annual cost of transporting 200,000 tonne of manure amounts to approximately 0.5 million €.

The interest used is 4,25%, but in many cases, this requires that the farmers can used their farm as collateral for the investment. This can, together with funding from the special credit cooperation (Kommunekredit), give a low interest. In the case that the farmers have low equity and more external capital is needed, it is likely that the average interest would be around 7-8%.

Table 3 presents the costs related to a standard centralized biogas plant with the capacity of 700 ton biomass per day. The biomass, in this example, consists of 78% untreated manure, 12% separated manure, and 10% maize silage. The annual costs over the 20 year plant lifetime, are in this case estimated to be more than 2.8 mill. €. The costs per m3 input and produced gas (not sold) gas production is also shown.

Table 3. Total annual costs for a biogas production

Annual costs	€ pr. year	€ pr. tons input	€ pr. m^3 biogas	€ pr. m^3 methane
Electricity	192,842	0.75	0.02	0.02
Investments	950,099	3.72	0.08	0.12
Reinvestments (year 10)	115,162	0.45	0.01	0.01
Maintenance	217,868	0.85	0.02	0.03
Transport of manure	662,155	2.59	0.05	0.08
Transport of energy crops	318,436	1.25	0.03	0.04
Running costs	372,279	1.46	0.03	0.05
Total	2,828,843	11.07	0.23	0.35

Source: Jacobsen et al., 2013

The income from a standard centralized biogas plant depends on who the buyer is. By selling the biogas to a local CHP plant, the biogas producer will not get paid for approximately 10% of his energy production due to the low demand for heat in the summer period. On the other hand, if the biogas producer chooses to upgrade his biogas for injection into the natural gas grid, extra costs for upgrading the biogas to natural gas quality will appear. In the best case scenario, the centralized biogas plant is situated near a very large CHP plant which has the capacity to receive and sell all the biogas which is produced. If the centralized biogas plant is located far from the nearest local CHP plant instead, it might be more profitable to inject the biogas into the natural gas grid, despite the extra upgrading costs.

Table 4 illustrates the income from the sale of the methane produced at the standard centralized biogas plant. Besides the methane sale, degassing the manure increases its fertilizing value from which the biogas producer also gains an income. Finally, the biogas producer has to buy the energy crop and pay for the separation of the manure which is used to boost the energy production.

Table 4. Total income and costs

Income	€/year	€/tons input	€/m^3 biogas	€/m^3 methane
Gas sale	5,607,523	21.95	0.45	0.69
Increased fertilizer value	206,777	0.81	0.02	0.03
Purchase of biomass	-1,714,657	-6.71	-0.14	-0.21
Total costs	2,828,843	11.07	0.23	0.35
Total profit	1,270,800	4,97	0,10	0,16

Source: Jacobsen et al., (2013)

As the calculations show in table 4, a centralized biogas plant who sells the biogas to a local CHP plant will gain an annual profit equivalent to 5 € per tons biomass, or 1.3 mill. € per year. When using a higher interest of 7.5% and lower yields from maize the annual profit is 400.000 €per year.

If the centralized biogas plant were to upgrade its biogas and inject it into the natural gas grid, the calculations would be rather different. The income from gas sale would increase by 6% as all the gas is sold, but the additional costs due to the upgrading is assumed to be 0.13 €/Nm^3 methane, equivalent to 4.35 € per ton biomass. In total the profit is a little lower than for the CHP option.

There is a need for approximately 20-30 new biogas plants, besides the existing 20 in order to reach the target of 50% of all the manure produced being used in a biogas plant. This substantial increase of new biogas plants mean that they cannot all be located near a local CHP plant, as the available manure becomes increasingly scarce. Some of the new biogas plants need to be located near the more remotely located farms, where there are no local CHP plants. Therefore, upgrading to natural gas quality and injecting the biogas into the natural gas grid, becomes the only option, but again the higher the quantity, the cheaper the cost of upgrading per unit. Alternatively the biogas plants have to be placed in livestock intensity and be based on the farms not delivering manure to a biogas plant today. This calls for a high degree of participation in biogas production which can be difficult to achieve.

6. Socioeconomic results

Beside the costs and benefits included in the business economic calculations, the production of biogas also provides some environmental benefits which are not included in the business economic calculations.

One of the side effects from degassing manure is that the foul odour emission from manure is drastically reduced. Therefore, when the farmers are fertilizing the fields with the degassed manure, the inconvenience for the neighbours is reduced, which generates a positive welfare economic value. No precise estimates of the odour emission reduction value exist, but studies shows that the odour emissions are reduced by approximately 50% (Jørgensen, 2009). Furthermore, degassing manure will result in decreased ammonia emissions when distributed on the fields. The biogas plant also functions as a storage and distributer of the manure, which is a benefit for farmers with too much manure compared to their land size.

Degassing manure also has the ability to reduce nitrogen leaching to the surrounding water. The effect of reduced nitrogen leaching to the root zone is estimated to be 0.11 kg N/ton manure. Less nitrogen leakage represents a welfare economic benefit through the reduction of a negative externality. The welfare economic value of reduced nitrogen leakage to the root zone is estimated to be 4.1 € per kg N. When degassing the manure from standard sized centralized biogas plant, a welfare economic gain of 0.4 mill. € is generated from reduced nitrogen leakages.

Finally, the degassing of manure contributes to the reduction of GHG emissions in the agricultural sector. Table 5 illustrates the GHG emission reductions related to the degassing of different types of manure.

The calculations show that the total GHG reductions are 18,500 tons CO_2-eq. per year. As noted before the reduction from Maize, leaving aside the energy substitution, is limited.

Table 5. GHG emission reductions from degassing pig and cattle manure on a centralized biogas plant

GHG	Cattle manure	Pig manure	Fiber Fractions (pigs)	Maize
	(kg CO_2-eq./t)			
Natural gas substitution	19.0	18.7	171.3	184.3
Nitrious oxide	12.8	11.2	35.9	0
Methane reduction	1.9	13.2	96.7	-60.2
Carbon storage in soil	-1.4	-1.4	-12.8	0
Total effect	32.3	41.7	291.1	124

Source: Olesen et al. (2012)

Besides the above mentioned welfare economic benefits, the biogas production also increases NO_x emissions, which causes damages of 0.3 € per ton degassed biomass. The total cost of the CO_2 emissions is 141 €/tonne CO_2. This is much higher than the current CO_2 quota price of 5-10 € per ton. It is assumed that the Danish socioeconomic costs will be high as they are converted into consumer prices. It is estimated that the change in calculation methods (interest, conversion to consumer prices etc.) on its own have increased the calculated CO_2-emission price by more than 50 € per tons CO_2.

German analyses indicate a CO_2 cost of 300 – 1.100 € per ton CO_2, and this is based on the lower direct costs. The higher Germany costs are mainly due to the fact, that only part of the heat is utilized and that a substantial part (50%) of the input is maize.

Table 6. Socioeconomic results – Biogas plant – 700 ton/day

Item	€/year	€/tons input	€/m^3 biogas	€/ m^3 methane
Total costs	5,301,670	20.75	0.43	0.65
Total income	3,133,556	12.26	0.25	0.39
Total value of dead weight loss	730,373	2.86	0.06	0.09
Total value of externalities	300,884	1.18	0.02	0.04
Total deficit (NPV 20 year)	2,597,603	10.17	0.21	0.32
Total CO_2-eq reductions. (ton)	18,454	0.07	0.00	0.00
MAC (€/ton CO_2-eq.)	141			

Source: Jacobsen et al. (2013)

7. Conclusions

As a results of the new energy agreement from 2012 and a new policy objective of using 50% of livestock manure to produce biogas, Danish politicians have changed both objectives and the framework for future biogas production. Based on 18 planned facilities the average size is expected to be approx. 700-750 m^3 per day or 250,000 tons annually. The new energy agreement gives basically a direct subsidy of DKK 15.4 € per GJ. However, increases in other taxes reduce the net effect to 13.8 € per GJ. The increased grants provide a significant boost in earnings, but the selling price in real terms will decline over time as the grants are phased out over time. The calculations show that larger plants have lower costs per. m3 of methane produced. This is due to lower operating costs. The transport distance from the farms to the biogas plant is a key parameter here. The analysis shows that almost 40% of all costs related to transportation costs. The large plants can expect that transport costs per. m3 of methane produced can be increased slightly due to longer driving distances. The withdrawal of support for the construction investment of 30% cost the biogas plant 0.3 million € per year. Losing this support can complicate financing, but the biogas plant should still make a profit without the investment support. Analyses show that the cost of upgrading biogas for distribution via the natural gas grid is roughly the same for the analyzed upgrading techniques. The total cost of the upgrade is set to 0.13 per. m^3 of methane incl. pressure equalization. Profits after upgrading will be less than when selling to CHP when an acceptable price on heat is given.

It is estimated that with the new energy deal biogas production will increase in the coming years by another 20 plants taking the use of animal manure to 20-25%. However, financing and location of facilities designated as key challenges must be resolved as well. It is a problem when banks do not what to use the asset value of the biogas plant as collateral when giving loans. Farmers are then struggling to provide enough equity on their own farms to ensure the loans to the biogas plant. In other words the analysis indicate that achieving the objective of using 50% of livestock manure in biogas production will be very difficult to achieve by 2020.

The socio-economic cost, by increasing biogas production has increased with the latest energy plan and the change in calculation methods adopted. Conversely, one must expect that society will have to pay a higher price towards the goal of elimination of fossil fuels in 2050. On the other hand the EU's declining CO_2 quota price does make Green Energy like biogas relatively more expensive.

8. References

Birkmose T., Hjort-Gregersen K., Stefanek K., 2012. Biomasser til biogasanlæg i Danmark - på kort og langt sigt [Biomas for Biogas plants in Denmark in the short and the long run]. Agrotech.

BMU, 2011. Tariffs, Degression and sample calculations pursuant to the new Renewable Energy Sources Act of 4th August 2011. Germany.

Christensen J., Hjort-Gregersen K., Uellendahl H., Ahring B.K., Baggesen D.L., Stockmarr A., Møller H.B., Birkemose T., 2007. Fremtidens biogasfælleanlæg – Nye anlægskoncepter og økonomisk potentiale [Future Biogas plants]. Rapport nr. 188. Fødevareøkonomisk Institut.

Council Directive (EC) 2009/28/EC of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC.

Council Decision (EC) No 406/2009/EC of 23 April 2009 on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020.

Delzeit R., Britz W., 2012. An economic assesment of biogas production and land use under the German Renewable Energy Source Act. Paper at the EAERE conference in Prague June 2012.

Dubgaard A., Nissen C.J., Jespersen H.L., Gylling M., Jacobsen B.H., Jensen J.D., Hjort-Gregersen K., Kejser A.T., Helt-Hansen J., 2010. Økonomiske analyser for landbruget af en omkostningseffektiv klimastrategi. [Economic analyses for Agriculture of a cost-efficienct climate strategy]. Report no. 2005. Food and Ressource Economic Institute, University of Copenhagen.

Dubgaard A. et al., 2013. Økonomiske analyser for landbruget af klimavirkemidler. [Economic analyses of Agricultural measures to reduce CO2 emissions]. Report. Department of Food and Ressource Economics, University of Copenhagen. (to be published).

Energistyrelsen, 2012. Udmøntning af øget støtte til biogas. [Description of increased support for production of Biogas in Denmark]. Notat 13. marts 2012.
Jacobsen B.H., Jespersen H.M.L., Dubgaard A., 2010. Ligevægtspris for biogas under forskellige forhold og konsekvens af opgradering til naturgas. [Required price for Biogas under different conditions and in relation to the opgrading of Biogas. Memo to the Minestry of Agriculture. 11. October 2010.
Jacobsen B.H., Laguesen F.M., Dubgaard A., Bojesen M., 2013. Biogasproduktion i Danmark – Vurderinger af drifts- og samfundsøkonomi [Biogas production in Denmark – evaluation of business and social costs]. Report from Department of Food and Ressource Economics. University of Copenhagen.
KEMIN, 2012. Aftale om Energipolitik 2012-2020. [Agreement on Energy Policies 2012-2020]. Notat 22. marts 2012. Klima-, Energi- og Bygningsministeriet.
Nielsen L.H., Hjort-Gregersen K., Thygesen P., Christensen J., 2002. Samfundsøkonomiske analyser af biogasfællesanlæg. [Socioeconomic costs of Biogas Plants]. Rapport nr. 136. Fødevareøkonomisk Institut.
Olesen J.E., Jørgensen U., Hermansen J.E., Petersen S.O., Eriksen J., Søgaard K., Vinther F.P., Elsgaard L., Lund P., Nørgaard J.V., Møller H.B., 2012. Effekter af tiltag til reduktion af landbrugets udledninger af drivhusgasser [Effects of measures to reduce Green House Gas emissions from Agriculture. University of Aarhus, Denmark.
Raven, Gregersen-Hjorth K., 2007. Biogas plants in Denmark: Success and drawbacks. Journal Sustainable and Renewable Energy Reviews, Pp. 116-132.
Scholz L., Meyer-Aurich A., Kirschke D., 2011. Greenhouse Gas Mitigation Potential and Mitigation Costs of Biogas Production in Brandenburg, Germany. AgbioForum, Vol 14 (3), pp. 133-141.
Tafdrup S., 2009. Analyse af omkostninger ved biogasanlæg [Analyses of costs related to the production of biogas]. Business case. Pers. Kommunikation.
Tafdrup S., 2012. Vurdering af ny energiaftale. [Assesment of the new energy agreement]. Energistyrelsen.

SMALLHOLDER FARMERS PARTICIPATING IN COMMERCIAL AGRI-FOOD CHAINS: LEARNING FROM EKSTEENSKUIL RAISIN PRODUCERS

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Abstract

The strict rules and regulations associated with supplying agricultural products to commercial agri-food chains often contribute to the exclusion of smallholder farmers from the formal market. New Institutional Economics theory is used in this paper to investigate the way how a group of smallholder raisin producers from South Africa cope with the strict rules and regulations associated with supplying raisins to the Fairtrade market. The findings show that, instead of viewing the rules and regulations as a fatal stumbling block, the farmers from Eksteenskuil created additional rules and regulations to help them coping with the strict requirements of the Fairtrade initiative. The conclusion is that, if incentives are correctly aligned and the financial benefit for the farmers is significant, the farmers will find a way to cope with the requirements to successfully participate in the formal market.

Keywords: linking farmers to markets, New Institutional Economics, smallholder farmers

1. Introduction

The strict rules and regulations associated with supplying agricultural products to commercial agri-food chains are well documented to be a major stumbling block that excludes smallholder farmers from developing countries from participating in such food chains (Bienabe and Vermeulen, 2007; Louw *et al*., 2008; Jordaan and Grové, forthcoming). There are, however, smallholder farmers from South Africa who do overcome the stumbling blocks and who are successfully participating in highly competitive commercial agri-food chains as described by Sartorius and Kirsten (2002); Ewert *et al*. (2006); Louw *et al*. (2006); Bediako and Debrah (2007); Louw *et al*. (2008); Hendriks and Lyne (2009). While the success stories are well described, the scope of the research did not allow the authors to comprehensively describe the way through which the farmers cope with the rules and regulations to participate in commercial agri-food chains. Consequently, there is limited information available to help other smallholder farmers how to cope with the strict rules and regulations that exclude them from commercial agri-food chains.

The aim of this paper is to explore the way through which a group of smallholder raisin producers from Eksteenskuil, South Africa, cope with the strict rules and regulations to export their raisins through the Fairtrade initiative. The theory of New Institutional Economics is used as the theoretical framework to describe the way the farmers behave within the institutional environment (Williamson, 2000; Jordaan and Grové, 2013) as specified by the Fairtrade initiative. Such

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information may provide insight that can be used to help other smallholder farmers to cope with the strict rules and regulations associated with the formal market.

Information that was used for the purpose of this paper was obtained by means of personal interviews with key role players along the value chain within which the farmers participate in 2008. These role players include the board of directors of the Eksteenskuil Agricultural Cooperative (EAC) as which the farmers have organized themselves, representatives from raisin processing companies who buy the raisins from the farmers, input suppliers, a previous governmental extension officer that was heavily involved with the farmers from Eksteenskuil, and some of the farmers from Eksteenskuil and other commercial raisin producers in the region.

2. Background to the case of Eksteenskuil raisin producers

Eksteenskuil is a rural Colored settlement situated in the Lower Orange River Valley in the Keimoes area in the Northern Cape Province of South Africa (Figure 1). Eksteenskuil consists of about 600 hectares of irrigable land. Currently, there are 76 households who farm on an average of 3.8 hectares of farmland. The main crop that is currently produced at Eksteenskuil is vines for raisins (Kok, 2008).

Despite Eksteenskuil farmers being organised as the EAC, members of EAC do not produce nor market collectively. Farmers produce individually and each farmer is responsible for selling his own produce and delivering it to the depot of South African Dried Fruit (SAD) in Keimoes.

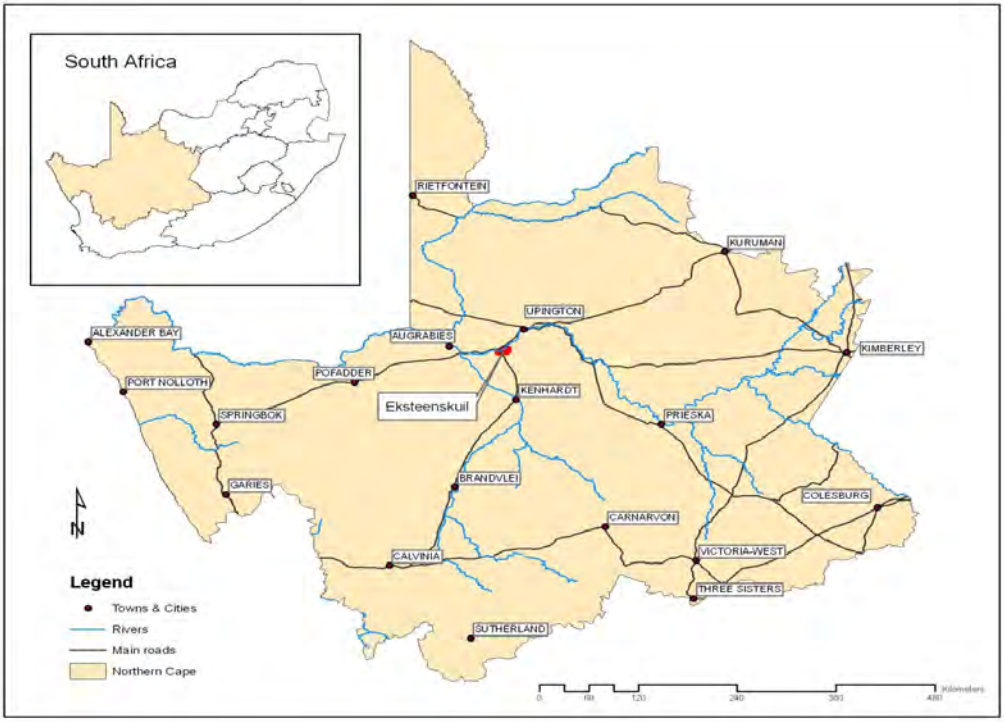

Figure 1. Map of the Northern Cape Province of South Africa to show the proximity of Eksteenskuil in South Africa

At the processor, SAD grades the raisins based on quality into choice grade, standard grade and industrial grade. Only choice grade raisins are exported via the fair-trade initiative. Eksteenskuil farmers who sell their choice grade raisins through the fair-trade initiative do receive an additional payment from the fair-trade buyer once the raisins have been exported. The additional payment is made possible through the fair price which the fair-trade buyer is willing to pay to previously marginalised producers.

SAD is the only fair-trade accredited processor in the area. Farmers thus have no choice other than to sell their raisins to SAD if they want to participate in the fair-trade value chain. Important to note, however, is that farmers do have a choice of within which marketing channel they want to participate. The additional amount paid by fair-trade, however, seems to be enough incentive for them to choose the chain via fair-trade.

3. Institutional analysis of raisin production and marketing at Eksteenskuil

Based on the theory of New Institutional Economics one would expect that changes in the institutional environment would affect the way economic agents behave (Williamson, 2000; Jordaan and Grové, 2013). Since the focus of this paper is the institutions that are specifically applicable to the case of Eksteenskuil, only the rules and regulations that are specific to the case of Eksteenskuil will be discussed. These rules and regulations include regulations that relate to Eksteenskuil raisin producers' functioning as an agricultural cooperative, Eksteenskuil raisin producers' partnership with Fairtrade, and their relationship with SAD.

3.1. Formal rules related to the Eksteenskuil Agricultural Cooperative (EAC)

Since 1994 the farmers from Eksteenskuil were organized as the Eksteenskuil Farmers' Association (EFA). As EFA the farmers started exporting their raisins through the Fairtrade initiative in 1995. In 2006, the EAC was registered and farmers are exporting their choice grade raisins via the Fairtrade initiative as EAC. Farmers who sell their choice grade raisins through the Fairtrade initiative receive an additional payment from the Fairtrade buyer (Traidcraft) once the raisins have been exported. The additional payment is made possible through the fair price that the Fairtrade buyer is willing to pay previously marginalized producers.

The conversion of EFA to EAC is a direct result of exporting raisins under Fairtrade. Members of EFA recognized that their legal status as an association was a hindrance to their functioning in the value chain. EAC consequently was registered in 2006 (Kok, 2008). The constitution of EAC provides specific requirements that have to be met by members. In addition to the constitution, EAC also has a list of guidelines that specify the conduct related to renting and using implements under its control. Most of the farmers at Eksteenskuil do not own machinery and hence they use equipment from EAC. These guidelines aim to ensure that everyone has equitable access to the equipment and that the equipment is maintained in a good, working condition.

3.2. Fairtrade Labeling Organization (FLO) standards and requirements

An individual farmer cannot become a Fairtrade producer himself. Individual farmers have to form an organization that is able to contribute to the social and economic development of their members and their communities. The requirement to form an organization resulted in the establishment of EFA in 1994. The mere formation of an organization, however, is not sufficient. Such organizations can be certified by FLO only if they comply with the requirements of the Generic Fairtrade Standards for Small Farmers' Organizations (FLO, 2005). The organization is expected to assess the environmental impact of its operations, develop plans that are designed to decrease those impacts, and monitor the implementation of those plans. Fairtrade producers are expected to continually reduce the volumes and types of agrochemicals that are used in production processes. FLO publishes a list of chemicals that may not be used at all. Producers are expected to reduce, reuse, recycle and compost waste in a manner that is suitable to the materials in question. A plan should be established for the disposal of all hazardous waste materials and also for the sustainable use of organic waste. Producers are expected to maintain and enhance the fertility and structure of soil, as well as manage water resources with the aim to conserve and not to contaminate. Fire should not be used in a manner that will be detrimental to the natural system. Finally, producers are required to ensure that no Genetically Modified Organisms (GMOs) are used either in the production or processing of the product (FLO, 2005).

In order to comply with the requirement of assessing the environmental impact, EAC contracted the services of the Environmental Monitoring Group (EMG) from Cape Town, to assist them with the interpretation of FLO specifications and with the required environmental impact assessment. With regard to reducing the amount of agrochemicals used in raisin production, EAC began to purchase chemicals in large volumes and distribute these to farmers in smaller volumes. This enabled EAC to provide only the required amount of chemicals at a lower price to individual farmers, and helped to monitor the amount of chemicals being used. Chemicals are kept at a central location and farmers have to complete and sign a form when they obtain these. A structure was erected for the disposal of empty chemical containers and other hazardous waste.

In addition to all the generic rules that have to be complied with, there are also some standards that are specific to dried fruit that need to be met. These standards can be placed on three legs: social development, economic development and environmental development (FLO, 2006). The social development leg strives for at least 80% of the delivered fruit to be supplied by members of the organization. Suitable measures must also be taken to increase the percentage of registered women growers and to promote their active role with regard to decision-making within the organization. The organization must develop a plan to ensure that all suppliers benefit from the premium until 80% of the fruit is supplied by members. The producer organization must show efforts to promote the marketing of other crops, in order to decrease the economic dependency on one single crop, and to provide producers with additional sources of income. The organization must also have the necessary infrastructure and capacity to communicate with, sell to, and deliver to overseas markets. Finally, the environmental development leg requires that all dried fruits sold with the Fairtrade label are produced by organizations that are FLO-certified.

Although the regulations specify that a small proportion of non-members may deliver under the name of the accredited organization, EAC decided that only members would be allowed to do so. Instead of allowing other farmers to deliver under its name, EAC invited other previously marginalized farmers within the region to become members. Women producers also have a major role to play at Eksteenskuil. Two of the five directors of EAC are females. EAC has also contracted Vinpro to conduct a feasibility study for wine production at Eksteenskuil. EAC aims to obtain FLO accreditation for exporting wine in order to reduce their dependence on raisins as their sole source of income.

With regard to the Fairtrade Premium, there are also some strict specifications that have to be met when spending the premium. The premium is paid only once the organization has sold their produce and submitted a report to FLO which contains the volume sold, the price received, and also the premium that was earned (Dillenseger, 2005). The premium has to be spent on activities that improve the lives of the small farmers, farm workers, and the community. More specifically, FLO stipulates five criteria that have to be met when using the Fairtrade Premium, namely, the benefit must be to the whole community rather than only to individuals; the benefit should last at least five years; the project needs to respond to the most urgent and basic needs of the workers; the benefit should also reach the families of the workers; and finally, the project also needs to bring an additional benefit to the community (Dillenseger, 2005). These specifications thus ensure that producers invest in their farms and communities.

In the case of Eksteenskuil, EAC also serves as the Premium Committee. The projects where money from the premium has been utilized include equipping and maintaining of EAC's office; buying and maintenance of farming equipment; coordination and dissemination of agro-chemicals to individual farmers; organizing farmers' days (twice-yearly) and information sessions; funding of educational equipment for primary schools; funding of women's projects; organizing and facilitating training of a group of women in tourism; workshops on basic business management (for farmers and non-farmers); and hydroponic training for a group of youths from the community. These projects meet the requirements specified by FLO.

It is clear that there are a number of strict regulations that need to be met by Eksteenskuil raisin producers in order for them to continue benefiting from Fairtrade. Should farmers fail to meet the specified requirements, the accreditation of the whole organization is suspended until the organization can prove that the necessary corrections have been made.

3.3. Relationship with SAD

Upon the request from Traidcraft, a formal contract had to be drawn up between EAC and SAD (Koch, 2009). The contract has to specify a list of farmers allowed to deliver under the name of EAC for the purpose of selling raisins through Fairtrade. The aim of the contract is to protect the Eksteenskuil farmers who are regularly audited through compliance with strict rules and regulations, and to protect the integrity of the Fairtrade initiative by ensuring that produce comes from previously marginalized producers. SAD also require from all farmers from whom they procure raisins to complete and submit a list that state all chemicals that has been used during the production season on the grape vines. In order for farmers to sell their raisins to SAD, they have to comply with the above specifications.

4. Discussion and conclusions

The analysis of the institutional environment within which Eksteenskuil raisin producers operate indicated that the farmers from Eksteenskuil face a number of strict rules and regulations that have to be met to supply raisins to the Fairtrade market. Eksteenskuil farmers collectively export their raisins via the Fairtrade initiative which earns them prices that is higher than market prices, and a Fairtrade Premium. EAC plays a major role in helping the farmers to cope with the strict rules and regulations associated with the Fairtrade initiative.

Although Eksteenskuil farmers initially exported raisins as EFA, EAC was established as a legal entity to allow the farmers to export their raisins themselves to increase their share in the final price. Currently, the South African Government has an incentive scheme whereby groups of previously marginalized farmers who organize themselves as smallholder farmers' cooperatives get access to government grants. The aim is to incentivize smallholder farmers to form cooperatives since it is believed that collective action will enable them to supply enough produce of an acceptable quality to enable them to enter commercial agricultural value chains. Stimulating collective action is in line with developments in other developing countries (Chibanda, *et al.*, 2009). Kaganzi, et al. (2009), however, conclude that collective action as such is not the only answer to enhance performance and increase profits of individual farmers. They argue for the need to evaluate when to use collective action, since it will only be effective if gains from working together sufficiently compensate additional costs. Strong leadership within the group and ensuring the transfer of skills to individual farmers are required to ensure effective collective action (Kaganzi, et al. 2009). The EAC management board exhibits strong leadership which is evident from their endeavors to maintain FLO accreditation, capacitate farmers to improve their farming practices and enhance their share in the final price for the past seven years. It is important to note that the farmers have taken full ownership of EAC without any government involvement. In fact, government has played no role in the development of the value chain within which the Eksteenskuil producers participate, nor have the farmers accessed any government grants through their collective action. The sole reason for Eksteenskuil farmers becoming part of the Fairtrade value chain is because the benefits of participating in the value chain outweigh the costs of participating in the value chain. The conclusion is that correctly aligned incentives may get farmers to organize themselves into an appropriate collective entity (not necessarily a cooperative) to help them to cope with the strictly enforced institutions of commercial agri-food chains.

The case of Eksteenskuil confirms that smallholder farmers can benefit from integration in high value niche markets (Hendriks & Lyne, 2009; Raynolds, 2009) and global value chains (Dollar & Kraay, 2004; Roy & Thorat, 2008; Minten, et al. 2009; Béné, et al. 2010). Eksteenskuil raisin producers also prove that emerging farmers can upgrade their traditional value chain to a higher value option. The South African Government should reconsider its current policy where access to government grants serves as an incentive for emerging farmers to form cooperatives. Instead of incentivizing collective action, government should rather incentivize business development. Collective action will then be used as the vehicle to develop the business, and not only to gain access to grants. The role of government should be to provide an enabling environment for these businesses to develop through the establishment of secure property rights, institutions, policies, and service delivery.

5. References

Bediako J.A., Debrah K., 2007. Finding a sustainable linkage between the emerging farmer and formal markets: The case of Pick ‘n Pay and the Zanyokwe farmers in the Eastern Cape of South Africa. Paper presented at the 2007 AAAE Conference, 26-28 Sepetember 2007, Johannesburg, South Africa.

Béné C., Lawton. R., Allison E.H., 2010. "Trade matters in the fight against poverty": Narratives, perceptions, and (lack of) evidence in the case of fish trade in Africa. World Development. Submitted for publication.

Bienabe E., Vermeulen H., 2007. New trends in supermarkets procurement systems in South Africa: The case of local procurement schemes from small-farmers by rural-based retail chain stores. Paper presented at the Mediterranean Conference of Agro-Food Social Scientists. 103rd EAAE Seminar, Barcelona, Spain, April 23-25 2007.

Chibanda M., Ortmann G.F., Lyne M.C., 2009. Institutional and governance factors influencing the performance of selected smallholder agricultural cooperatives in KwaZulu-Natal. Agrekon, 48(3):293-306.

Dillenseger V., 2005. A practical guide for fair trade premium projects for small farmers and joint bodies. http://www.emg.org.za/documents/Guide_to_Fair_trade_Premium.pdf Accessed 19 January 2009.

Dollar D., Kraay A., 2004. Trade, growth and poverty. The Economic Journal, 114:22-49.

Ewert J., Eva G., Hamman J., 2006. The inclusion and empowerment of farm workers through partnerships: The case of "Thandi" Fruit and Wine. Report for the Regoverning Markets Programme.

FLO (Fairtrade Labeling Organization), 2005. Generic fairtrade standards for small farmers' organizations. http://fairtrade.net/pdf/sp/english/Generic %20Fairtrade %20Standard %20SF %20Dec %20 2005 %20EN.pdf Accessed 19 January 2009.

Hendriks S.L., Lyne M.C. (eds)., 2009. *Does food security improve when smallholders access a niche market?* Scottsville: The African Centre for Food Security, University of KwaZulu-Natal.

Jordaan H., Grové B., 2013. Conceptual framework for value chain analysis for poverty alleviation among smallholder farmers. *Agrekon* Forthcoming.

Kaganzi E., Ferris S., Barham J., Abenakyo A., Sanginga P., Njuki J., 2009. Sustaining linkages to high value markets through collective action in Uganda. Food Policy, 34:23-30.

Koch N., 2009. Personal communication, Marketing manager, South African Dried Fruits. Cape Town, South Africa.

Kok N.C., 2008. Personal communication, Chairman, Eksteenskuil Agricultural Cooperative, Keimoes, South Africa.

Louw A., Jordaan D., Ndanga L., Kirsten J.F., 2008. Alternaitve marketing options for small-scale farmers in the wake of changing agri-food supply chains in South Africa. *Agrekon*, 47(3):287-308.

Louw A., Vermeulen H., Madevu H., 2006. *Integrating small-scale fresh produce producers in to mainstream agri-food systems in South Africa: The case of a retailer in Venda and local farmers*. Paper presented at the 7th International Conference on Management in AgriFood Chains and Networks, 31 May – 2 June 2006, Ede, the Netherlands.

Minten B., Randrianarison L., Swinnen J.F.M., 2009. Global retail chains and poor farmers: Evidence from Madagascar. World Development, 37(11):1728-1741.

Raynolds L.T., 2009. Mainstreaming Fair Trade coffee: from partnership to traceability. World Development, 37(6):1083-1093.

Roy D., Thorat A., 2008. Success in high value horticultural export markets for small farmers: the case for Mahagrapes in India. World Development, 36(10):1874-1890.

Sartorius K., Kirsten J., 2002. Can small-scale farmers be linked to agribusiness? The timber experience. *Agrekon,* 41(4):295-325.

Williamson O.E., 2000. The new institutional economics: taking stock, looking ahead. Economic Literature, 38(595-693).

VOCATIONAL REORIENTATION OF FARMERS AND MEMBERS OF THEIR FAMILIES – A NEW CHALLENGE FOR RURAL POLAND

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Abstract

In view of inability of most of the farms in Poland to develop, there arises a big social problem connected with the necessity to hunt for additional main sources of incomes outside farming. This problem was the subject matter of the studies conducted in the Mogilno poviat, which belongs to typical agrarian poviats. These studies aimed at recognizing farmers' and household members' readiness by vocational reorientation. It results from the conducted studies, that 66% of respondents' answers are rather no and decisively no. The fact that on farms up to 5 ha as many as 61% respondents do not want to take up reorientation is particularly alarming. Analyzing main problems why farmers do not want to reskill to another profession , those pooled mention the lack of time connected with excess of work on a farm. Lack of financial means is an important argument, as well as a big distance from educational centres. On the other hand women stress the necessity of care over children and elder persons. However, special attention should be paid to the lack of belief among these polled ones, that they would get a job – it is the opinion of 1/3 of respondents. The results of the poll studies were a kind of inspiration to commence started from 2009, the realization of the regional programme of vocational reorientation in Kujawsko-Pomeranian Province, the effects of which have also been presented in this article.

Keywords: differentiation of farms' situation, vocational reorientation of farmers and members of their families, awareness and motivation of taking up a job, readiness to hunt for a job, problems while trying to get a job

1. Changes in agriculture as a reason of vocational reorientation

The relationship between the nature of work and the mode of life of its inhabitants, as well as their mutual relations was the most important indicator of the economic country's system in a traditional agrarian society. Country's local systems were based on a closely fixed hierarchy, where both the skills and technique were subordinate to. Self-sufficiency was an important feature of such local-country systems. As there reminds Wilkin [1999], a traditional country had its character described today as a multi-functional one, as farmers apart from production of crops also produced means for production, tools, machines, pastures, construction materials. The remaining country's inhabitants somehow supplemented that multi-functional system with supplies of other products necessary for country's inhabitants and their families living. After 1989 there occurred many important changes in the Polish agriculture, which decisively speeded up following Poland's integration with the European Union. Work on own farm stopped being the sufficient source of income for most of farmers and members of their families. As it results from the data quoted in the Strategy of Development of Rural Areas[1] the agrarian activity is the main source of living only for about 27% of households with a user of a farm. In the second half of the 90's, there occurred studies talking on a huge scale of unemployment in a village, where there were references to the so-called hidden unemployment,

[1] Directions of Development of Rural Areas assumptions to the „Strategy of Development of Rural Areas" (Warszawa 2010) p. 79.

that is surpluses of unexploited labour force occurring most often on small farms [Frenkel: 1997, 65-68; Frenkel: 2001, 98-153]. On the basis of the data of the Agrarian Census from 1996, in households with a user of an individual farm and an agrarian plot together with the so called „expendable population" amounted to 917 thousand people [Frenkel: 2003, 138]. What's interesting, the data from the Agrarian Census from 2010, that is the measurement after 14 years, show the increase of persons expendable on farms amounting even to a million [Frenkel: 2012, 61-91][2].

The forecasted in the Strategy of the Rural Development by 2015, decreased employment in the I sector of economy[3] from 17,4% in 2005 to 11,0% in 2015 results from the increase of productivity of agriculture, but it also means the necessity of creation of real perspectives of employment outside agriculture for hundreds of thousand of villages' inhabitants in the scale of the country. As it results from the data of the Agrarian Census 2010 [PSR 2010], per 1 563 thousand of farms of the area above one hectare, as any as 92,3% have the area not exceeding 20 ha. Considering the current developmental tendencies it may be assumed, that in practice on each farm at least one person should try to find for himself an additional source of income. For sure such a process has already taken place in the group of the smallest farms. The process of vocational reorientation considerably differs from other methods of education of adults (for ex. of unemployed persons). There is a proposal to create a new opportunity for farmers and household members based on the skills and abilities gained by them within the frames of work on a farm. The ability to operate different machines field works, works in a garden, preparation of traditional dishes, care over children and elder persons, these are the skills very often encountered in a village, which in order to constitute an opportunity on a labour market, require their formal confirmation, certification, supplementation, acceptance, etc. The process of reorientation means mainly individual consultancy for a farmer, and sometimes for the whole family, within the frames of which there sometimes follow a new glimpse on own professional position and an attempt to find a positive solution.

Started from the beginning of the 90's of the last century in Poland farmers have been taking up adaptation caused by restoration of the market economy and the European integration [Mańko et al.: 2005, 326-336]. More and more distinctly there has been distinguished a group of commercial farms [Karwat-Woźniak: 2005, 13-16]. Farmers from these farms, making use of the EU support programmes and investment credits with surcharges to interest, have been trying to invest, increase the area, modernize technologies and increase the scale of production in order to increase the quality and competitiveness of production conducted with respect for environment. Specialization of production has also been taking place. This group of farmers, through the adaptation activities, aims at reaching a durable improvement of economic situation and maintaining the ability for development and is expecting, that a farm shall be the main source of a family's income [Józwiak: 2007, 10-23].

A farm stops being a place of existence of an agrarian family, and is becoming an economic undertaking, which is to ensure appropriate incomes [Mańko et al.: 2007, 169-176]. However, is it clearly visible, that a group of developmental farms is in minority, that is about 8-10% of the total farms in Poland. On the other hand, the second group of farms are the non-developmental farms – social ones, which are in decisive majority. From the studies conducted by the Institute of Agricultural and Food Economis it results, that only farms of economic area 16 ESU were singled out by over parity of own work's fee and broadened reproduction of fixed assets. However, farms of the size of 8-16 ESU are characterized by a simple reproduction of fixed assets [Józwiak: 2008, 5-7].

[2] PSR 2010 was conducted with the application of a New methodology of measurement of the so-called annual labor units (RJP) constituting the equivalent of the labour time of a fully employed person (here there are assumed 2120 labour works per year that is 265 laour days 8 hours a day).

[3] covering: agriculture, forestry, hunting, fishery

The purpose of his article was to become familiar with the opinions of farmers and members of their families concerning their readiness for vocational reorientation and factors influencing this process both positively and negatively.

2. Readiness of farmers and household members to hunt for a job outside a farm

The topic of vocational reorientation was the subject matter of studies conducted in Mogilno poviat in the Kujawsko-Pomeranian province, which belongs to typical agrarian areas with farms of a small area (only 20% has the area above 15 ha.). The studies aimed at identification of the problem of readiness of farmers and household members of the Mogilno poviat for vocational reorientation towards the increasing necessity to hunt for additional or main sources of incomes outside agriculture caused mainly by worsening of the income standing of most of the farms.

These studies were of a diagnostic survey character, and a questionnaire form was the basic survey tool [Gruszczyński: 2002, 25-36; 2003, 47-56]. The selection of a testing sample was of a random character. In total 312 persons, 223 farmers and 89 household members aged 18-55 were covered by the survey, older persons were not covered as potentially completely not interested in vocational reorientation. Interviews with drawn farmers were conducted with consultants from the Agricultural Advisory Centre in Minikowo, already trained by the employees of the Institute of Sociology of Nicolaus Copernicus University in Toruń. Having conducted the basic survey, a checking survey at 16 respondents (5%) was conducted . The checking survey confirmed the correctness of conducting of the basic survey.

2.1. A farm's vision and readiness to take up reorientation

On the first stage of the studies, possible aspirations of respondents both to hunt for a job outside a farm as well as in looking for a chance to change profession, were subject to analysis. We were interested in the vision of a farm in the opinion of respondents, as well as allowing by them for the possibilities of complete giving up of agrarian production in case of its non-profitability. While asked about the future of their farm in two years' time, the respondents presented a high level of optimism. As many as 32% of them considered, that their farm shall develop, while the next group 44% considers, that the situation will not get worse and that the status quo shall be maintained. De facto, the second group also show a positive approach. Only 11% of farmers and members of their family covered by the study, provide for worsening of the situation on one's own farm. In division into farmers and household members, a slightly higher level of pessimism among household members, from which about 14% think, that the situation on a farm they live, shall deteriorate, on the other hand among the farmers such an idea is expressed by only 10% of respondents. However, this difference is too small to determine on existence of decisively different opinions concerning the vision of development of own farm (tab. 1).

Table 1. Future of a farm in two year's time (in %)

Respondents' opinions	Household members	Farmers	Average
Shall develop	35,29	30,51	32,11
The situation shall not change	39,50	45,34	43,38
The situation shall deteriorate	14,29	9,75	11,27
Don't know	10,92	14,41	13,24

Source: own study

However there exists a clear relationship between the area of a farm and the optimism concerning its future. The bigger is a farm, the lower is the level of pessimism amongst its owners and household members (tab. 2).

Table 2. Future of a farm depending on a farm's size (in %)

Respondents' opinions	Size of a farm in ha				
	Up to 5	5-15	15-30	30-50	Above. 50
Shall develop	5,68	19,71	42,31	49,89	76,19
The situation shall not change	61,96	50,36	36,92	38,50	14,29
The situation shall deteriorate	14,71	14,23	9,23	3,92	4,76
Don't know	17,65	15,71	11,54	7,69	4,76

Source: as in tab. 1

From the conducted studies it results, that there occurs a strong relationship between the presented optimism as compared to the future of own farm and the willingness of vocational reorientation. As many as 22% of respondents seriously thinking of abandoning to conduct agrarian production are the persons who can perceive the future of their farm quite well (tab. 3). Generally, there does not however exist any strong enough dependency between the willingness to abandon production on a farm and pessimism as to its future.

Table 3. Abandonment of agrarian production depending on a farm's vision (in %)

Future of a farm within two year's time	Do You consider abandonment of agrarian production?			
	Decisively yes	Consider	Do not consider	Does not know
Shall develop	11,00	10,50	39,40	12,82
Situation shall not change	4,50	44,50	45,45	35,90
Situation shall get worse	72,00	40,00	4,90	25,64
Do not know	12,50	5,00	10,25	25,64

Source: as in tab. 1

Appearing of the idea to abandon in the future to conduct agrarian production is out of the question in case of owners of farms of the area of 15-30 ha and 30-50 ha. On these farms the level of optimism is the highest one. In the bracket above 50 ha there are more doubts. Maybe among these farmers the decision on resignation from farming and dealing with other business would be easier – maybe emotional ties with a farm are weaker there (tab. 4).

Table 4. Resignation from farm production depending on the size of a farm (in %)

Do You consider resigning from farm production	Size of a farm in ha				
	Up to 5	5-15	15-30	30-50	above 50
Decisively yes	7,41	3,40	0,77	0,00	0,00
Sometimes consider	12,12	8,16	3,08	0,00	23,81
Do not consider	56,23	76,87	86,15	96,15	76,19
Does not know	24,24	11,56	10,00	3,85	0,00

Source: as in tab. 1

2.2. Awareness and motivation to take up employment

An important part of the studies was to determine the level of perceptible needs connected with the necessity or willingness to take up a job outside a farm by a farmer himself or members of his family. The issues of motivation which hypothetically accompanies or shall accompany to get a job was also submitted to analysis. We were interested in to what extent these efforts shall be the effect of willingness of respondents („want to get a job"), and to what extent they shall be the result of an internal duress („I *have* to find a job ") and an external duress („they want me to *find* a job ").

Data confrontation concerning the necessity to hunt for a job outside forming by persons from families of respondents concerning the visions of the future of a farm looks very interesting. So it was found, that work shall be hunted for in families where the future of a farm shall be perceived in black colours, but such a dependency should be regarded as an obvious one. However – what's most interesting – also high is the proportion of persons (29%), who say, that the future of a farm shall be clear, but maybe because, that someone from the family shall have to look for a job outside a farm. Interesting is also the fact, that as many as 63% from those who think that in the future the situation of their farm will not change, see no need to look for a job (tab. 5).

Table 5. Necessity to look for a job outside a farm depending on the farm's vision (in %)

Future in two years' time	Shall someone from the family have to look for a job outside a farm?		
	shall have to find a job outside a farm	there shall be no such need	do not know
Shall develop	29,21	38,25	32,54
Situation shall not change	16,43	63,23	20,34
Situation shall deteriorate	30,39	15,37	54,24
Do not know	40,47	31,42	28,11

Source: as in tab. 1

In the division among different groups of farm sit can be clearly noticed, that the necessity to look for a job outside a farm shall occur mainly in very small and small farms (from l to 15 ha). In farms above 15 ha this need radically decreases (tab. 6). Taking up of employment outside a farm is connected very clearly with the size of a farm. The bigger the farm is, above 15 ha, then more than 50% of respondents do not see any necessity to take up employment. In a group of farms 5-15 ha 40% think, that one or two household members shall take up employment. Attention should be paid to the fact, that 32% respondents from farms up to 5 ha do not see such a necessity, on the other hand 16% of respondents in the group of farms above 50 ha think, that one person shall take up employment (tab. 6). It is important, as in the group of developmental farms (above 30 ha) there is a considerable percentage of persons noticing the necessity to look for an additional employment, and on the other hand in the group of non-developmental farms (up 5 ha) such a big is the share of respondents not perceiving any necessity to look for an additional employment.

Table 6. Necessity to take up employment outside a farm depending on the size of a farm (in %)

Shall anybody from the family take up employment	Size of a farm in ha				
	Up to 5	5-15	15-30	30-50	above. 50
Yes, at least one person or more	15,79	20,95	4,69	0,00	0,00
Yes, it will be one person	21,05	19,05	9,38	16,00	16,67
No, there wil be no such Reed	31,58	33,33	53,13	56,00	66,67
Hard t say, I do not know	31,58	26,67	32,81	28,00	16,67

Source: as in tab. 1.

In the conducted studies, motivations that may accompany respondents in their attempts to find a job outside a farm were taken into account. They depend on the size of a farm and in the smallest farms the willingness to take up employment is expressed only less than 8% of respondents, on the ther hand in the iggest farm sit amounts to more than 25%. The respondents coming from small farms as a motive of taking up employment say, tat they have to (tab. 7). On the other hand in the biggest farms (above. 50 ha) 25% of respondents want to take up employment, but in his group of farms also 25% of respondents think, that they have to take up employment, what strongly puzzling taking into account big scale of production as for Polish conditions.

Table 7. Motive of taking up employment depending on the size of a farm (in %)

Motives of taking up employment	Size of a farm in ha				
	up to 5 ha	5-15	15-30	30-50	above. 50
I want	7,69	26,56	23,33	38,46	25,05
Somebody from my family wants me to	46,15	10,94	20,00	15,38	50,10
I have to	46,15	62,50	56,67	46,15	25,23

Soure: as in tab. 1

The respondents, as the main reasons for looping for employment mention (respondents could give three reasons):

- unprofitability of agrarian production – 79%,
- lack of perspectives in agriculture – 33%,
- better earnings outside agriculture – 24%,
- lighter work, less absorbing from to – 9%.

Worth stressing is the fact, that none of the respondents can see problem in looking for a job outside agriculture, a desire of social advance and making dreams come true. On the other hand, the main problems a farmer of a member of a farmer's family trying to train may encounter, the following ones have been pointed out (respondents could point out all the possible problems):

- lack of time connected with excess of work on a farm – 44%,
- lack of financial means – 26%,
- too big distance from educational centres/ bad communications – 22%,
- bad state of health – 21%,
- care over small children or elder persons, ill persons from family – 21%,

As the main reasons why the farmers do not want to reskill from a farmer's profession into another profession, there were mentioned (respondents could give all the possible problems):

- as they will not get a job anyway – 34%,
- they do not have time for it – 31%,
- the farm is the most important for them – 28%,
- they do not have money for education – 28%,

Analysisng the main problems a farmer or a household member may encounter as well as the reasons why farmers do not want to reskill to another profession, there occur a big unanimity of respondents' opinions as far as expression of the problems is concerned. As the main problem/ reason they mention the lack of time connected with the excess of work on a farm. It is a quite big surprise, as the respondents come from middle size farms (10-20 ha), and there are two, three adults in a family. The lack of financial means (26-28%) as well as a big distance from educational centres is also an important argument in the opinion of respondents. Women on the other hand stress the necessity to care over children and older persons. However, special attention should be paid to the lack of faith among the respondents, that they shall reskill and get a job, this is the opinion of 1/3 of respondents.

2.3. Readiness to take up vocational reorientation and hunt for employment

Finding the readiness of the respondents to take up vocational reorientation and to hunt for employment was placed as the main problem. However, earlier their views concerning the best form of employment were examined (permanent job, irregular job or in own company). As far as the preferred forms of employment are concerned, the respondents surprised with a high level of readiness to establish on companies. As many as 38% think, that if they would have to look for other incomes for own family urgently – they would have decided to establish own company. A slightly smaller group would prefer employment permanently – 34%.

Table 8. Willingness to take up reorientation depending on the size of a farm (in %)

Would You take up reorientation	Size of a farm in ha				
	Up to 5	5-15	15-30	30-50	above. 50
Decisively yes	27,78	23,36	7,81	8,07	9,09
Rather yes	11,11	18,69	32,81	20,20	9,09
Rather no	55,56	34,58	46,88	48,00	27,27
Decisively no	5,56	23,36	12,50	24,34	54,55

Source: as in tab. 1

As far as the readiness to take up vocational reorientation is concerned, to the question: would You take up reorientation, as many as 66% answer rather no and decisively no. Such a big percentage of persons not interested in reorientation is astonishing. The fact that in very small and small farms there are more negative than positive answers, should be particularly worrying. As an example, in a group of farms up to 5 ha 61% respondents do not want to take up reorientation, and there is almost 39% (tab. 8) of those decided ones. Puzzling is such a big share of respondents from a group of farms up to 5 ha of arable lands, which has no motivation to hunt for employment outside a farm, there is about 52% of respondents. In this group of farms only 21% is positively predisposed as far as hunting for a job is concerned (tab. 9). Motivation in looking for a job is closely connected with the experience on the labor market. Persons who work, are positively predisposed to hunt for a job (46,5%). On the other hand, the second group is composed of persons who have never worked and as many as 70% of them do not see any need to look for a job, and 14,2 answer do not know (tab. 10).

Table 9. Motivation in hunting for a job depending on the size of a farm (in %)

Will You look for a job	Size of a farm in ha				
	Up to 5	5-15	15-30	30-50	above. 50
Decisively yes	5,26	13,08	6,25	3,85	0,00
Rather yes	15,79	13,08	7,81	11,54	0,00
Rather no	36,84	32,71	35,94	34,62	33,33
Decisively no	15,79	20,56	35,94	38,46	66,67
Do not know	26,32	20,56	14,06	11,54	0,00

Soure: as in tab. 1.

Table 10. Motivation in hunting for a job and experience on a labour market (in %)

Will You look for a job	Experience on a labour market		
	Yes and still work	Yes but do not work	Has neper worked
Decisively yes	27,91	8,24	7,08
Rather yes	18,60	12,94	8,85
Rather no	30,23	37,65	30,09
Decisively no	11,63	18,82	39,82
Do not know	11,63	22,35	14,16

Soure: as in tab. 1

3. Activities for vocational reorientationof farmers and villagers taken up by the Kujawsko-Pomeranian Agricultural Advisory Centre in Minikowo (KPODR)

In 2008 KPODR started up a new type of activities within the frames of the so-called vocational reorientation of farmers and villagers. In the Mogilno, Toruń and Aleksandrowo's poviats, there were realised pilot projects from within that scope and a concept of broadening activity in the next years was drawn up. The studies of the representative group of farmers conducted by the scientists from the Institute of Sociology of the Nicolaus Copernicus University in Toruń showed big demand for activities in the field of reorientation. On the basis of the studies there was conducted a series of meetings with the leaders of agrarian organizations, commune and poviat self-governments, and job centres' institutions. As a resut of the discussion, there was formed a methodology of activities for reorientation, then included in the implementation project, which was granted the KPODR Minikowo to be implemented started the beginning of 2010 (subactivities 8.1.2. of the Operating Programe Human Resources). Thanks to a special engagement of local partners, in the Mogilno powiat there was signed the „Agrement for vocational reorientation of the inhabitants of the Mogilno Poviat" within the frames of which there was established the Vocational Reorientation Bureau of Farmers.

The specialist courses cover on average 90 theory and practice ours classes and end with an obligatory exam and issuance of a certificate confirming participation and gaining of the basic knowledge and skills necessary for taking up employment or self-employment in a specific profession. The outfarming activity proved to be rather high (27%) (Tab. 11), however the most desired result there would be formal taking up of activity and „getting out of KRUS system", which so far has occurred rather seldom (5,2%). Farmers and members of their families decisively prefer staying „under the shelter" of KRUS declaring at least taking up an occasional employment.

Among the key problems concerning activities for reorientation, there should also be pointed out the lack of a detailed diagnosis of „non-developmental" farms and members of family of these farmers. The statistics of KRUS, GUS, data bases of agricultural consultancy centres, poviat job centres and other institutions do not give explicit information how many farmers in fact and their household members do need vocational reorientation. Here there are needed detailed studies which shall show the real scale of the problem. The so-far support in the field of vocational reorientation realized within the scale of the whole country among the others within the frames of the Integrated Operating Programme of Regional Development for the years 2004-2006 and other ones financed from the European Social Fund, was of incidental and short-lasting nature (without taking hold in local environment). So there are needed long-term consultancy activities,

Table 11. Activites and results of reorientation in the Kujawsko-Pomeranian province

Activities taken up for reorientation in the Kujawsko-Pomeranian province	Obtained results
2010 project „Time for changes – vocational rerientation of farmers”	• Analysis of situation of 480 farms • 360 persons completed specialist vocational courses
2010 - 2013 project „NEW PROFESSION – NEW CHANCE for farmers and villagers of Kujawy and Pomerania” • Training of 38 reorientation consultants • Creation of 19 poviat vocational reorientation centres • Recruitment and promotion activities in the regional and local press, radio, television, among borough leaders, in job centers, communes, parishes and schools	• 4000 Individual Plans of Vocational Reorientation (by the end of 2013) • Number of persons who completed vocational courses by the end of 2012: – 408 persons the course for excavating-digging machine operator, – 340 persons the course of small and medium enterprises accountancy, – 260 persons a driver’s course category C and C+E, – 38 persons a course for organizers of occasional parties, – 197 persons the florists course with the elements of interior decorations, – 124 persons completed the course of daily care, – 61 persons the welder’s course, – 61 persons the cook course, – 51 persons the hairdressing course, – 527 persons motivation courses and entrepreneurship trainings,
• Monitoring of beneficiaries’ activity following completion of courses. • **By mid of 2012** - 937 out of all the persons covered by reorientation (for whom individual plans were earlier drawn up and they were referred to specialist trainings) were covered by monitoring.	• 44 persons got employment, • 33 persons took up economic activity, • 176 persons took up casual or seasonal work in a new profession. • In total 253 persons (27%) took up non-agrarian activity. • 49 (5,2%) persons renounced insurance in KRUS and changed for ZUS.

Source: reports of KPODR Minikowo

establishment of reorientation offices, appointment of local coalitions for reorientation of such institutions as: agricultural consultancy centres, forming organisations, job centres, local self-governments, local activity groups, other non-governmental organisations and other ones. Also the lack of appropriate preparation of agrarian consultants but also other institutions (job centres, social assistance centres, etc) taking up with farmers and members of their families within the scope of reskilling is also an undoubted limitation. So, training of personnel in the direction of vocational reorientation is needed.

4. Summary

Following integration with the European Union, the process of diversification of farms' income situation speeded up. Data from the Agrarian Census 2010 as well as forecasts up to 2020 point out at several hundred thousand of persons employed at present on farms, who shall be forced to hunt for an alternative of additional source of income for themselves.

In case of farmers and members of their families, there should be made a distinction between vocational reorientation and other forms of lifelong learning. Most of all, persons so far working on a farm have skills and abilities constituting a base for performance of many different activities and works in other professions, however very seldom they may turn out to be formal skills. The process of reorientation means most of all individual consultancy for a farmer, and sometimes for his whole family, within the frames of which there occurs a quite new look at own vocational situation and an attempt to find a positive solution.

In the farmers and members of their families' researches concerning the future of farms and the change of a profession, there occurs a big level of optimism towards the future of a farm and an accompanying it the lack of willingness concerning taking up of activities both in aid of hunting for employment as well as the change of profession (most of a the population of optimists is composed of persons with agrarian education). Optimism as to the future of a farm results in the lack of activity concerning the willingness to reorientate. It mainly concerns persons from big farms and persons who have never had any contact with the labour market. Small area middle-aged and young ones farmers (not household members) who have to take up employment and their vocational preparation is not adequate for the market needs and vocational ambitions are on a real level, is the most promising group for the needs f reorientation. Optimism of respondents towards the future of own farms does not correspondent with pessimistic vision of respondents as to the quality of life on a Polish farm. They can see, that life in a village is much harder, the number of small farms decreases, but they do not see such negative changes at themselves (or do not want to see).

Reorientation should cover educational and informative activities forming among the farmers the ability to assess the consequences of structural transformations in agriculture and also growing requirements of the labor market resulting from the development of market economy. Hard issues connected with a decision on abandonment the profitable insurance in KRUS for permanent employment and converting to ZUS, for sure are a big challenge for resigning from agriculture and looking for systemic solutions on an all-Poland scale.

Experiences of the Kujawsko-Pomeranian Agrarian Consultancy Centre show a real scale of demand for a support in vocational reorientation of farmers and members of their families. The specific approach to consultancy-reorientation covering usually whole agrarian families is worth stressing. If in the Kujawsko-Pomeranian province, where farming is counted among the best one is Poland, the problem of the income situation of farms has risen at present to such dimensions that decisive steps have to be taken up to offer a real alternative for many farmers and members of their families, then in the regions of less intensive and efficient farming these issues require much bigger interest. From that perspective, the experiences of the regional programme realized by KPODR Minikowo may become a specific testing ground for implementation of this part of assumptions of the „Strategy of Rural Areas Development" on the territory of the whole country.

5. References

Frenkel I., 1997. Ludność, zatrudnienie i bezrobocie na wsi w latach 1988-1995, Instytut Rozwoju Wsi i Rolnictwa, Polska Akademia Nauk, Warszawa, s 65-86.

Frenkel I., 2001. Rynki wiejskie: Ziemia, Kapitał, Praca, Instytut Rozwoju Wsi i Rolnictwa, Polska Akademia Nauk, Warszawa, s.98-153.

Frenkel I., 2003. Ludność, zatrudnienie i bezrobocie na wsi, Instytut Rozwoju Wsi i Rolnictwa PAN Warszawa.

Frenkel I., 2012. Pracujący w gospodarstwach rolnych. Tendencje zmian w latach 2005- 2010. [w:] Rozwój wsi i rolnictwa w Polsce. Andrzej Rosner (red.) Instytut Rozwoju wsi i Rolnictwa PAN Warszawa. s. 61-91.

Gruszczyński L.A., 2002. Elementy metod i technik badań socjologicznych, Śląskie Wyd. Naukowe, Tychy, s. 25-36;

Gruszczyński L.A., 2003. Kwestionariusze w socjologii, Wydawnictwo Uniwersytet Śląski, Katowice, s. 47-56

Józwiak W., 2008. Konkurencyjność polskich gospodarstw, „Nowe Życie Gospodarcze”, 23-24, s. 5-7.

Józwiak W., 2007. Dochody różnych grup polskich gospodarstw na tle dochodów gospodarstw “starej” Unii, [w:] Sytuacja ekonomiczna i aktywność gospodarstw różnych grup polskich gospodarstw rodzinnych, Wstępne wyniki badań, IHRiGŻ-IB, Warszawa, s. 10-23.

Karwat-Woźniak B., 2005. Możliwości rozwojowe chłopskiego rolnictwa na przykładzie gospodarstw wysokotowarowych., [w:] A. Sikorska (red.), Ekonomiczne i społeczne uwarunkowania rozwoju polskiej gospodarki żywnościowej po wstąpieniu do Unii Europejskiej, lERiGŻ PIB, Warszawa, s. 13-16.

Kierunki Rozwoju Obszarów Wiejskich założenia do „Strategii Rozwoju Obszarów Wiejskich”, 2010. Ministerstwo Rolnictwa i Rozwoju Wsi. Warszawa.

Mańko S., Sass R., Sobczyński T., 2005. Dochody z tytułu zarządzania i ryzyka wybranych typów rolniczych gospodarstw w zależności od skali produkcji, „Zeszyty Naukowe BTN”, Prace Komisji Nauk Rolniczych i Biologicznych. XLIV, Seria B Nr 58, s. 326-336.

Mańko S., Sass R., Sobczyński T., 2007. Dochody z zarządzania i ryzyka w zależności od wielkości ekonomicznej gospodarstw i kierunku produkcji, „Folia Universitatis Agriculturae Steti- nensis, Oeconomica”, 254 (47), s. 169-176.

Pierwszy krok do reorientacji zawodowej rolników powiatu mogileńskiego, 2009. Materiały konferencyjne, Kujawsko-Pomorski Ośrodek Doradztwa Rolniczego w Minikowie, s. 20-21.

Polska Wieś 2000, 2001. Raport o stanie wsi, Fundacja na Rzecz Rozwoju Polskiego Rolnictwa, Warszawa.

Powszechny Spis Rolny 2010. Raport z wyników. Główny Urząd Statystyczny.

DEVELOPMENT OF PRODUCTIVITY OF DAIRY AND PIG FARMS IN GERMANY

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Abstract

The development and change of productivity, as well as of its influencing factors, is of interest in economic research. In this paper we analyse the development of productivity in dairy and pig farms in Germany. Balanced farm panels are selected from the German national FADN. As productivity measure we use the Färe-Primont Index proposed by O'Donnell. Results shows an increase of Total Factor Productivity (TFP) of 1% p.y. of dairy farms, a rather constant TFP level of pig fattening farms and decreasing TFP of farms specialized in piglet production. Due to cyclical pig prices the variation of TFP is rather high in pig farms. Significant scale effects are identified with highest TFP levels of large sized farms. The variation of income in time is much more pronounced than of TFP, which might partially be determined by the rather high aggregation of output and input variables used for FP calculations.

Keywords: Total Factor Productivity, dairy and pig farms, Farm Accountancy Data Network

1. Introduction

The development and change of productivity, as well as its influencing factors, is of interest in economic research. Analysis can be undertaken at the global, sector or micro level. An assessment of productivity changes at the micro level is one of the activities of the OECD 'Network on Farm Level Analyses'. To get own experiences in this area, we used a free software package of CEPA[1] which allows the calculation of Total Factor Productivity (TFP) indexes, i.e., Laspeyres, Paasche, Fischer, Lowe, Malmquist, Hicks-Moorsteen, and the Färe-Primont Index. However, the free-of charge version is limited to the calculation of the last mentioned tree indexes.

In this study we use this programme for productivity analysis for balanced samples of

- dairy farms in the north of Germany (Kleinhanss, 2012a) ,
- farms specialized in pig fattening or piglet production in Germany (Kleinhanss, 2012b).

In addition to global productivity development, the question is how productivity is influenced by the huge variation of output and input prices. A further question is whether or not productivity estimates are similar with, e.g., income indicators. Method and data is briefly described in the following. In a further step results of productivity estimates are discussed and finally compared with income indicators.

2. Methods and data

The estimation methods for productive indexes can be categorized into parametric and non-parametric methods (Grilliches, 1996). 'The former involves econometric modelling of a production function and often uses regression techniques to estimate the relationships between total outputs and major types of inputs, … The residual of these regressions can be used as a measure

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[1] Centre of Efficiency and Productivity Analysis, School of Economics, University of Queensland (AU).

of total factor productivity' (Zhao et al., 2012). An example is the analysis of TFP between organic and conventional farms in Germany based on Stochastic Frontier Analysis (Tiedemann and Latacz-Lohmann, 2011). The so-called index methods – Laspeyres, Paasche, Fischer, Tornqvist – as well as Data Envelopment-based Malmquist, Lowe, Hicks-Moorsteen, Färe-Primont – are non-parametric methods.

The Fischer Index is recommended by Zhao et al (2012). It is a combination of the square root of the product of the Laspeyres and Paasche Index. Diewert (1992) shows that the 'Fischer Index is exact for a quadratic cost function'… 'while the 'Tornqvist index is exact for a Translog cost function'. With regard to data requirements, a further advantage is that the Fischer index can work with missing or negative values and is therefore more appropriate for individual farm data. Analyses for US Agriculture based on the Fischer index were realised by Ball et al. (2010).

Referring to the Lowe and Färe-Primont indexes, O'Donnell (2012a) argues that they 'are economically-ideal in the sense that they satisfy all economically-relevant axioms and tests from index number theory, including an identity axiom and a transitivity test. This means they can be used to make reliable multi-temporal (i.e., many period) and/or multi-lateral (i.e., many firm) comparisons of TFP and efficiency'. A further advantage of the Lowe and Färe-Primont Index is that prices for input and output are not required, and shadow prices derived from the Linear Programming solution are used instead. Especially input prices are often lacking at the farm level. An application of the Lowe index for US agriculture at State level was realised by O'Donnell (2012b).

As the Lowe index can only be calculated with the professional version, we focus on the Färe-Primont index, which can be calculated with the free-of charge version of DPIN (O'Donnell 2011). Although shadow prices cannot be listed by the free-of-charge version, they are internally calculated.

The Färe-Primont index proposed by O'Donnell (2012a) is composed of two indexes developed by Färe and Primont (1995):

$$TFP_{hs,it} = \frac{D_O(x_0, q_{it}, t_0)\, D_I(x_{hs}, q_0, t_0)}{D_O(x_0, q_{hs}, t_0)\, D_I(x_{it}, q_0, t_0)}$$

The Färe-Primont index is calculated referring to a reference farm (to be determined) in the 1st period. To identify a reference farm we use the following procedure. In a 1st run we calculate TFP for all farms referring to Farm i. Then we calculate the mean TFP of the 1st period over all farms. Next we select a new reference (Ref) farm with a TFP closest to mean TFP in period 1. In the 2nd run we use farm (Ref) as reference farm; therefore TFP's of all other farms and periods are referring to Ref.

Farm data are taken from the German national FADN (Farm Accountancy Network).[2] Balanced samples of farms were selected with no-missing data of each input and output used. The sample of **dairy farms** includes 170 dairy farms for 15 periods (1996/97 – 2010/11); farms are located in the north of Germany (Lower Saxony and Schleswig Holstein). Only farms with more than 30 dairy cows in 2009/10 and with milk production in each period are included. For the model we used a rather aggregated set of variables;

- 3 outputs: milk (€), other returns (€), subsidies (€)
- 5 inputs: variable input of crop production (€), livestock (€), other costs (€, excl. land rentals and hired labour costs); UAA (ha), AWU

2 BMELV-Testbetriebe.

For further differentiation of results we use three size classes (dairy cows): 1: 30-60; 2: 60-100; 3: > 100.

For pig production we distinguished between farms specialised in **fattening** or **piglet production**, covering the period 2000/1 to 2010/11. The balanced panel of fattening farms includes 364 farms, those with piglets 195 farms. Results were stratified wrt average pig livestock units (LU) over the whole period: < 50; 50-100; 100-150 and > 150. For the model we use an aggregated set of variables;

- 2 outputs: Pigs (€), other returns including subsidies (€)
- 5 inputs: variable costs livestock production (€); variable costs crops (€); other variable costs (€, excl. land rentals and hired labour costs); land (UAA ha); labour (AWU)

3. Results

In this chapter we show first results for one farm taken as example. Then we describe changes of productivity for groups of individual farms as well as the variation by farm size. Lastly, we compare these results with the development of income usually taken as main indicator for economic performance.

3.1. Development of productivity of dairy farms

Figure 1 shows the development (change) of productivity (dTFP) over the 15 year period, taking 1996/97 as reference. TFP is rather constant in the first three years, then moves down to 0.89 in 2000/01, which might be an effect of the BSE crisis. It moved up to around 1.17 in 2001/02 and 2004/5 to 2007/8. Periods with negative productivity change (< 1) were in 2002/3 and the following year, as well in 2008/9. The highest level was reached in 2010/11. Therefore productivity increased by 0.37 during this 15-year period. Change of this index is the result of change of aggregated output referring to aggregated input. Under condition of existing milk quota system a high level of aggregated output is a sign for rather high milk prices.

Beside TFP, the model also calculates other indicators, of which only changes in technical efficiency (dTech), changes in output-oriented technical efficiency (dOTE) and changes in output-oriented scale mix efficiency (dOSME) are shown. dOTE is less than 1 in the first periods indicating a low output-oriented efficiency change. Development of dOTE and dOSME is close to dTFP, but with time lags and reaching lower levels in 2010/11.

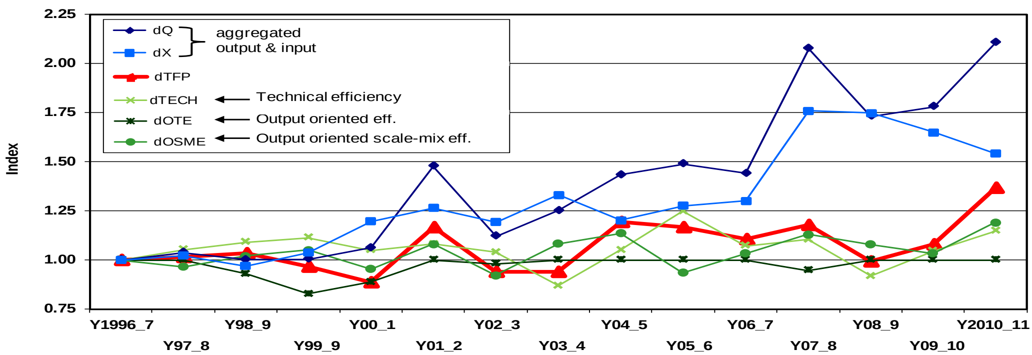

Figure 1. Level and decomposition of productivity of one dairy farm
Source: own calculations based on BMELV-Testbetriebe

Development and variation of TFP over the whole period is shown in Figure 2. The box plot shows the Median and variation (50% of farms between 1st and 3rd Quantile, as well as minimum and maximum TFP's.[3] TFP successively increased until 2000/01, followed by a period of lower productivity until 2006/07. Highest TFP was reached in 2007/8 due to favourable price levels especially for milk. In 2008/09 – due to lower milk prices – TFP was even lower than in the first period. TFP moved up in 2010/11 to almost the same level as in 2007/8. There is a high variation of TFP ranging from 0.65 to 1.3/1.6. Farm ID's indicates that some farms, such as ID = 151 and ID = 166, stay at a high performance level for several years.

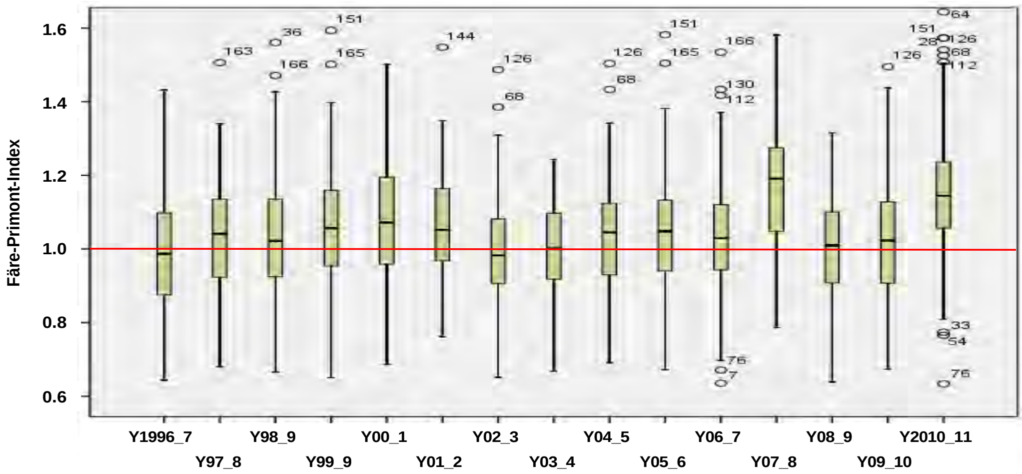

Figure 2. Development and variation of Färe-Primont index of dairy farms
Source: own calculations based on BMELV-Testbetriebe

Figure 3 shows the development of TFP for all dairy farms in the sample and by size classes. Average TFP increased from 1 to 1.08 in 2000/1 and went down to 0.98 in the following 2 years. It stayed at a level of 1.04 until 2007/8, the period when the milk market reform, resulting in lower milk prices, was implemented. TFP significantly increased in 2007/8 by one third to 1.18 thanks to rising milk prices. In the following year TFP decreased to 1 due to the milk price crisis with the lowest milk prices since the existence of the Common Market of the EU. In the last year of the underlying period, TFP increased again to 1.15, which is almost the same level as 3 years before.

Although the smallest farms are not included in the sample, significant differences of TFP exist between farm sizes. Farms with 30-60 dairy cows show TFP of about 0.05 less than average. TFP of size class 50-100 is about 0.02 higher than the average. The largest farms (> 100 dairy cows) show 0.05 to 0.08 higher TFP than the average. They reach the highest TFP of 1.25 in 2007/8. It's interesting to see that TFP in the year of milk price crisis was almost 1 for all size classes, whilst under favourable economic conditions the spread is about 0.1 in favour of large farms. Relative changes of TFP from 1996/7 to 2010/11 are almost the same for all size classes.

[3] Minimum and maximum values are defined by 1.5 times of the distance of the box (representing 50% of observations. Outliers are defined by the distance between 1.5 to 3 times of the distance of the box; greater than 3 times of the distance of the box are defined as extreme values.

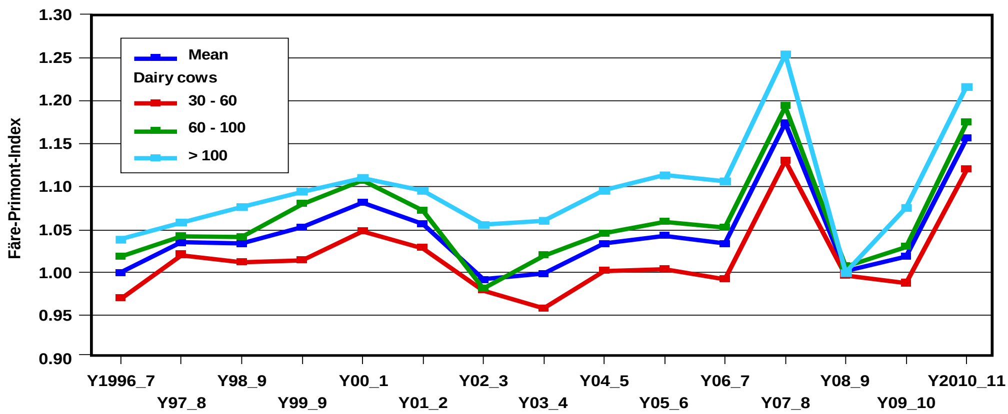

Figure 3. Development of TFP by size of dairy farms
Source: own calculations based on BMELV-Testbetriebe

3.2. Productivity change in specialized pig farms

As will be shown later, the income development of pig farms is largely influenced by pig price cycles. In the last few years it has been further influenced by rising feed costs inducing price pressure especially for piglets. While income development was similar in pig fattening and piglet production until 2006/7, it became rather unfavourable in piglet production. In the following, TFP results are differentiated between farms specialized in pig fattening or piglet production.

Figure 4 shows the development and variation of TFP in farms specialised in **pig fattening**. In the first year, 50% of farms reach TFP levels between 0.94 and 1.07. TFP levels decreased in the following three years and then increased to almost 1.0 on average in 2004/5, 2007/8 and 2010/11. In the interim years, TFP was around 0.95. Referring to the beginning and ending year, there is almost no increase of TFP. The spread of TFP for 50% of farms (box) is almost the same over the years. However there is a large variation from about 0.75 to 1.3 indicated by the vertical bars. Also, many individual coef-

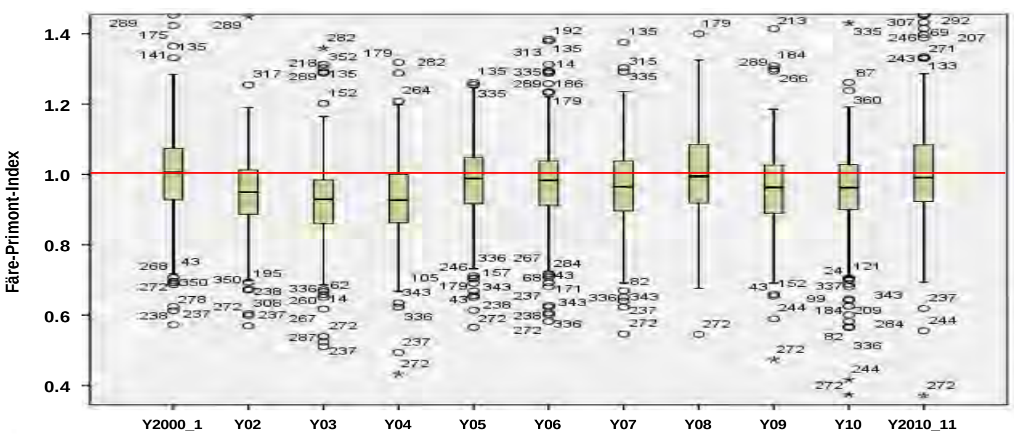

Figure 4. Development and variation of TFP of farms with pig fattening
Source: own calculations based on BMELV-Testbetriebe

ficients are shown, indicating high TFP's in the upper part and low TFPs in the lower part of the figure. Some farms stay in the same category, i.e., ID = 272 with very low TFP and ID = 292 with a high TFP.

TFP of farms specialised in **piglet production** is shown in Figure 5. The figure shows a cyclic development of TFP of about 3 to 4 years. It reached its highest level in 2000/1, and then decreased to 0.83 in 2002/3 to 2003/4. It increased again in 0.95 in 2004/5, went down until 2006/7 and fell to the lowest level in 2007/8. On top of the pig price cycle, high price of feed induced this low level of TFP. In 2008/9 TFP raised again to 0.95 and dropped to 0.9 until 2010/11. Therefore TFP decreased by 1% p.a. Variation of TFP is about 0.2 for 50% of farms; it is rather stable in time. The variation between min and max TFP values is rather high and shows a cyclical development, as well.

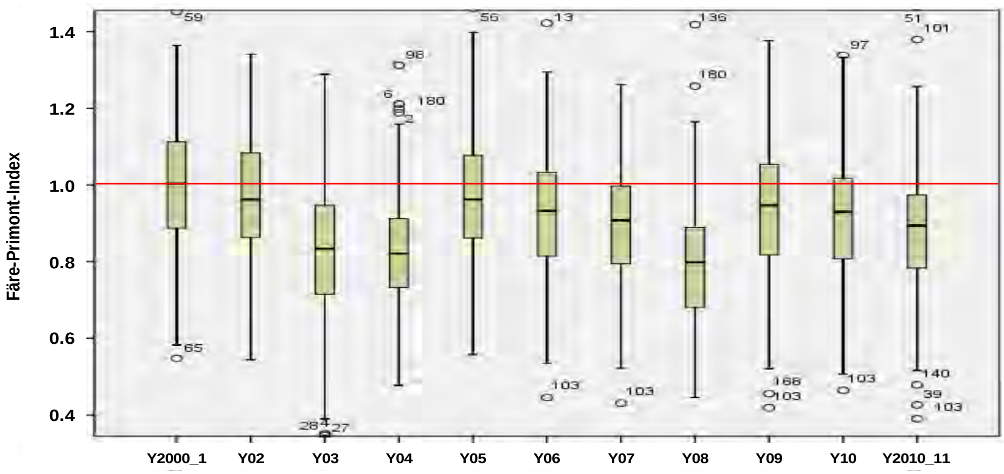

Figure 5. Development and variation of TFP of farms with piglet production
Source: Own calculations based on BMELV-Testbetriebe

Figure 6 shows average TFP for both samples as well as by size classes, expressed in pig livestock units (LU). Average TFP of **fattening** farms is rather constant; it is close to 1 in the beginning, middle and end of the underlying period. It decreased to 0.92 in 2002/3 and the succeeding year and to 0.95 in 2008/9 and 2009/10. Small farms show TFP levels between 0.8 and 0.9. Farms with 50 to 100 LU show TFP levels of about 0.05 less than average. TFP for farms with 100 to 150 LU is close to average, while those of the largest farms is about 0.03 higher.

Development of TFP in **piglet production** is more cyclic than in pig fattening with levels of only 0.8 in 2002/3 and 2007/8. Even at the end of the period, TFP is only 0.9, indicating a decrease of TFP. Small farms show low TFP levels of about 0.85 at the beginning, 0.75 in 2002/3 and 2007/8 and of around 0.8 in the remaining years. TFP of size class 50-100 LU is slightly below average and those of size class 100-150 LU 0.05 above average. The group of largest farms show TFP of 1.12 at the beginning and of about 1.05 in 4 other years. It dropped to about 0.85 in 2002/3 and 2007/8. It is worth mentioning that the spread of TFP between large and small farms became rather small in the bottom of a cycle while it exceeds up to 0.3 under favourable economic conditions.

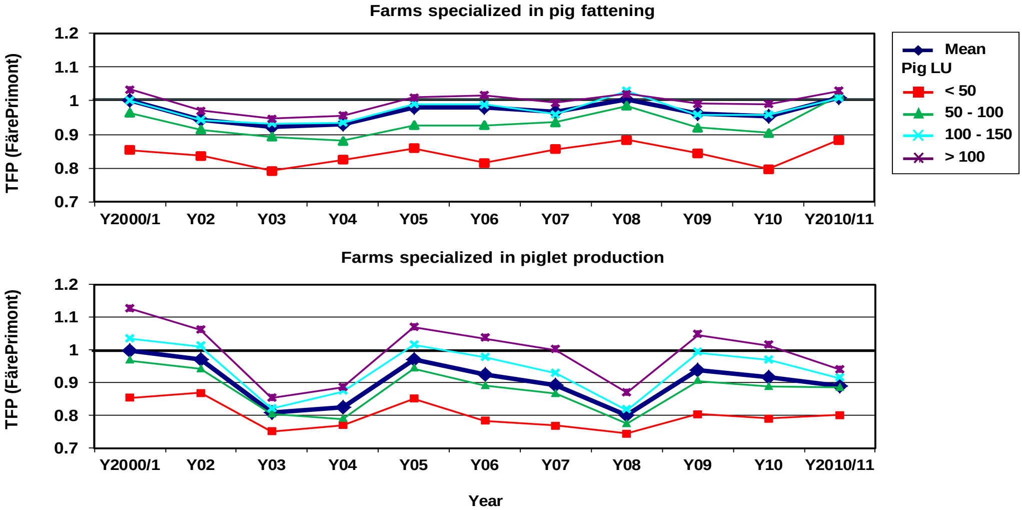

Figure 6. TFP of farms specialized in fattening/piglet production by farm size (LU-pigs)
Source: Own calculations based on BMELV-Testbetriebe

3.3. Comparison of TFP and income

In the following we compare development of TFP with income. Family Farm Income (FFI) expressed in € per farm is used as income indicator.

The development of average TFP and FFI for **dairy farms** relative to the base year (= 100) is shown in Figure 7. As already mentioned, changes of TFP are rather low; in most of the years it is close to 1 and only in 2007/8 and 2010/11 does it move up to around 120. The development of FFI is more significant; it increases to 150 in 2000/1, and then goes down to near 100 in 2003/4 and the succeeding year. In 2007/8 it switches to its highest level of 270. In the year of crisis (2008/9) it fell again close to 100. It recovers to 230 in 2010/11.

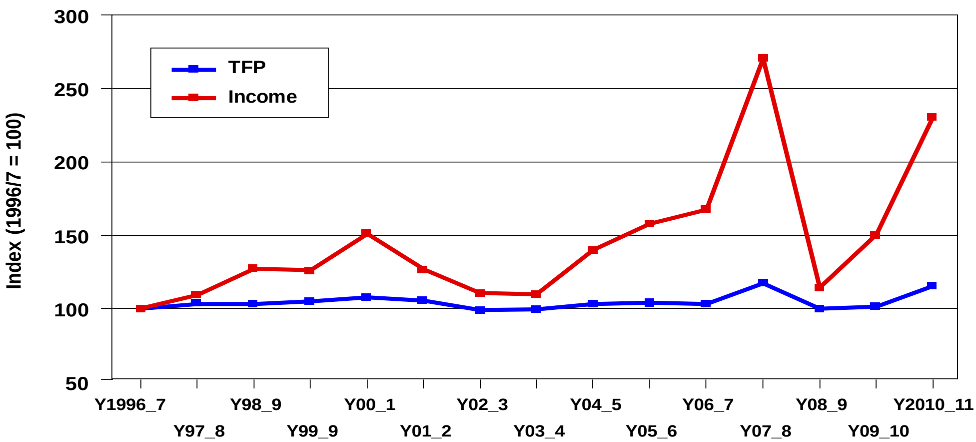

Figure 7. Comparing the development of TFP and income (FFI) dairy farms
Source: Own calculations based on BMELV-Testbetriebe

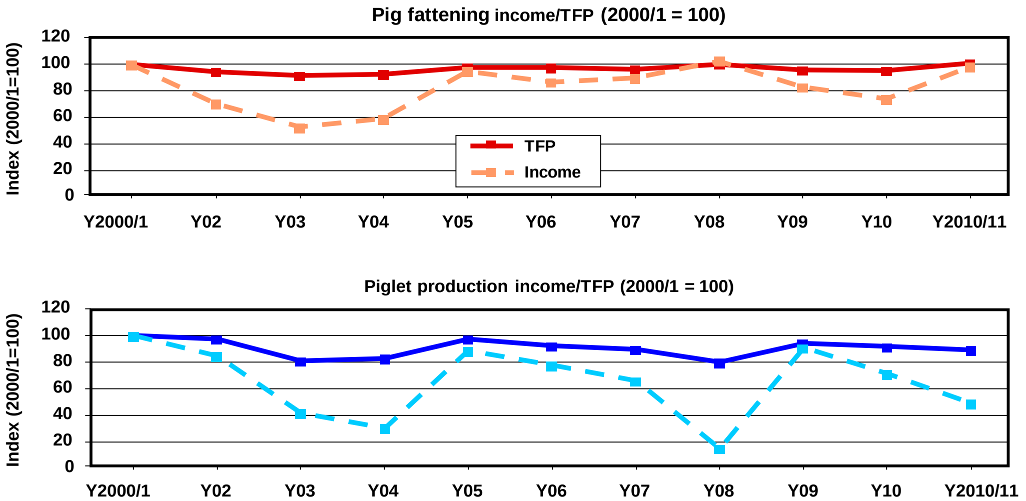

Figure 8. Comparing the development of TFP and income (FFI) of pig farms
Source: Own calculations based on BMELV-Testbetriebe

The development of average TFP for pig fattening farms (Figure 8) is rather continuous, even under worse economic conditions TFP index is only 5% lower. Variation of income is more pronounced; it was 40% less in 2002/3 and 25% less in 2009/10. TFP of specialized piglet farms show higher periodic variation and a decreasing trend of TFP. Income variation is extremely high; it reached only 35% of first period in 2003/4 and less than 20% in 2007/8. After recovering in 2008/9 it halved again in 2010/11.

Based on these results it can be concluded that TFP estimates show much lower variation than the development of income. One reason is that TFP estimates are based on a rather aggregated set of output and input variables; not all variables influencing income are included.

4. Conclusions

This paper is a first step in analysing the development of TFP at the micro level. It is based on balanced samples of dairy and pig farms in Germany. Both sectors are of interest due the high variation of prices and other determinants of income. For the TFP calculations we used a free of charge program. It has the advantage that prices of physical factors are internally derived from shadow prices of the Linear Programming model.

The calculation shows a rather low increase if TFP of dairy farms of about 1% p.a. It is largely determined by milk price development. TFP in small farms is significantly lower than in large farms. The variation of income is much more pronounced between size classes in years of high milk prices.

TFP is rather stable for farms specialized in pig fattening; it shows a higher variation and decrease of 1% p.a. in piglet production. Variation of income is much higher in pig fattening (40% less than average in the years 2002/3); it is extremely high in piglet production with around 80% lower incomes in two periods. In the year 2007/8 incomes fell by 80% while in pig fattening incomes increased slightly to a long term trend. This situation is influenced by changes in the market power of fattening farms against piglet producer: rising feed costs were entirely compensated by lower piglet prices, but also due to competition with piglet imports from Denmark and The Netherlands which considerably increased at the same time.

5. References

Ball V., Batault J., San Juan C., Mora R., 2010. Productivity and international competitiveness of European Union and United States agriculture, Agricultural Economics, vol. 41 pp. 611-27.

Diewert E., 1992. Fischer ideal output, input, and productivity indices revisited, Journal of Productivity Analysis, vol. 3, pp. 211-48.

Fare R., Primont D., 1995. Multi-output production and duality: theory and applications. Kluwer, Boston

Griliches Z., 1996. The discovery of the residual: A historical note. Journal of Economic Literature 24, 1324-1330.

Kleinhanss W., 2012a. Change of Productivity in German Dairy Farms. 20th Pacioli Workshop, Rome, 1-3 October 2012.

Kleinhanss W., 2012b. Development of Performance and Productivity in German Pig Farms. OECD Joint Seminar APM and Network for Farm-Level-Analysis, Paris, 15 November 2012.

O'Donnell C., 2011. DPIN 3.0 A program for decomposing productivity index numbers. The University of Queensland, Centre for Efficiency and Productivity Analysis, Brisbane (AU).

O'Donnell C., 2012a. An aggregate quantity framework for measuring and decomposing productivity change. J Prod Anal. (doi:10.1007/s11123-012-0275-1).

O'Donnell C., 2012b. Nonparametric estimates of the components of productivity and profitability change in U.S. agriculture. Am J Agric Econ 94:873-890.

Tiedemann T., Latacz-Lohmann U., 2011. Development of Productivity in Organic and Conventional Agriculture: An Empirical Analysis. GJAE Volume 60 (2011), Number 2: 101-118.

Zhao S., Sheng Y., Gray E.M., 2011. Measuring productivity of the Australian broadacre and dairy industries: concepts, methodology and data. http://www.cabi.org/cabdirect/FullTextPDF/2012/20123305095.pdf

ANALYSIS OF THE BAMBARA GROUNDNUT VALUE CHAIN IN WESTERN KENYA

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Abstract

Bambara Groundnut (Vigna subterranean (L) Verd) is a palatable indigenous crop that is rich in nutrients, and therefore has immense potential as a food security crop. Despite this potential, and just as for many other indigenous crops, little research on the crop has been done. Although the crop has been neglected in Kenya, it is cultivated in a few districts of Western Province. The objective of the research was to carry out a value chain analysis of the Bambara groundnut in Western Kenya. A census approach was used to sample 59 farmers, 33 retailers and 4 Bambara wholesalers from Butere, Mumias and Busia districts. Data analysis involved the generation of descriptive statistics and the seller concentration ratios. Results show that farm level productivity is extremely low at an average of 63.4 kg/ha compared with other regions that attain between 300-800 kg/ha under traditional farming systems. Further, planting fertilizer is sparingly used at the rate of 49.3 kg/ha and no pesticides are used. Despite the low output, farmers consider Bambara groundnut as a commercial crop with 68.2% of the yield being sold. At the market end, results of the 4 and 8 concentration ratios show that the market structure is moderately concentrated with competitive fringe. The research concludes that Bambara groundnut production is at subsistence level and recommends agronomic research by Regional Research Institutions to enable the development of the indigenous crop.

Keywords: Bambara groundnut, indigenous crop, production, consumption, marketing

1. Introduction

1.1. Background to the study

Although food production outpaces population growth in most regions, the demand for food is mounting and many of the world's people are going hungry (World Bank, 2004). In the first two decades after independence, Kenya's agricultural sector grew at an average of 6% per annum. This growth recorded an annual average of 3.5% between 1980 and 1990; 1.3% between 1990 and 2000, and 0.7% in 2002. The declining agricultural productivity was identified as a major cause of food shortages, unemployment, low incomes and poor nutritional status (Kenya, 2001). Although a steady growth to about 6% was observed between 2003 and 2007, other emerging challenges as high costs of production due to fertilizer, fuel and machinery costs have emerged.

Since these challenges continue to threaten Kenya's food security, stakeholders in the food production industry need concerted efforts to provide adequate food for Kenya's nationals. One of the options to counter food insecurity is to refocus farmers' attention to the production of the Neglected and Underutilized crop Species (NUS), also referred to as "orphaned" and sometimes broadly termed "indigenous crops". One such crops is the Bambara groundnut whose description is given below.

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1.2. Description of Bambara groundnut

Bambara groundnut originated in the dry savannas in the north of Nigeria and in Cameroon. It has been widely cultivated in tropical regions since the 17^{th} century. In addition to Sub-Saharan Africa, it is now found in many parts of South America, Asia and Oceania. It is an annual herbaceous plant whose germination is hypogeal (the cotyledons remain underground) and fruiting as with groundnut (*Arachis hypogea*), is subterranean. However, the subterranean fruiting mechanism is different for in Bambara groundnut, the peduncle of the raceme elongates, and by positive geotropism, forces the tip of the inflorescence under the soil. In groundnuts, underground fruitification is brought about by elongation of the ovary base, with formation of a peg.

About 40 days elapse between fruit-setting and pod ripening. The seeds contain 6.5% oil and 18% protein, values less than those observed in groundnut seeds, which have a minimum content of 34% oil and 22% protein. However, they are rich in carbohydrate (60%), with the protein having a high lysine content, which is a limiting amino acid in cereals (Baudoin and Mergeai, 2001). Table 1 shows that the nutritional composition of Bambara groundnuts is superior to those of the main staples, maize, rice and wheat. Although the Bambara groundnut's nutrient composition is comparable with that of maize in many nutrients (carbohydrate, oil and fibre), it is superior in the protein composition.

Further, the Bambara groundnut is quite different from the groundnut (*arachis hypogea*) in the carbohydrate and oil composition, indicating the potential value of Bambara groundnut as a balanced staple food crop.

Table 1. Nutrient Composition of Bambara Groundnuts and Other Staples

Nutrient	Bambara Groundnut	Groundnut	Maize	Rice	Wheat
Carbohydrate	60	11.4	62	79	50
Protein	18	26	8	7	20
Oil	6.5	47.5	7	1	8
Fibre	5	1.9	8	1	11
Water	10	13.2	13	12	11
Total	99.5	100	98	100	100

Source: Schroeder, 1997; Baudoin and Mergeai, 2001

1.3. The study area

The research was carried out in Butere, Mumias and Busia districts of the Western Province, Kenya. These districts were chosen because they are the major producers of Bambara groundnuts in the Province. These districts are bordered by Uganda to the west (of Busia), Teso district to the north, Kakamega district to the east, Vihiga district to the south and Siaya district to the south west.

The annual average rainfall ranges between 900 and 2,200 mm. The region receives convectional rainfall of the first rainy season (March - May), so that the long dry season (June-October) receives heavy rains too with a peak in August-September. The annual average temperature is between 21.0°C and 22.7°C. Humidity of the air is relatively high due to proximity to Lake Victoria and the potential precipitation is between 1,800- 2,030 mm per year.

The main economic activity in the Province is farming; Bungoma district being the leading sugarcane producer with Kenya's largest sugar factories, as well as numerous small-holder sugar mills. Maize is grown for subsistence, alongside pearl millet and sorghum. Dairy farming and poultry production are widely practiced. Busia district experiences perennial floods from the Nzoia River, and the dominant economic activity is fishing on Lake Victoria. Limited commercial farming is also practiced, mainly of sugar cane. Subsistence farming of cassava is widely practiced.

Poor soils often underlain by hard-pans are a major problem in the Province. Cassava, which is common, should not be the only answer to the poor soil conditions. More legumes, for instance Bambara groundnuts which grow on very poor soils and accumulate nitrogen should be promoted (Jaetzold *et al*, 2005).

1.4. The study's objective and hypothesis

The broad objective of this research was to perform an economic analysis of Bambara groundnut production in Western Kenya with the specific objective of determining the market structure of Bambara groundnuts in the study area. In line with this objective, this study hypothesized that the market structure of Bambara groundnuts in the study area was not competitive.

Justification for the Study

Kenya's staple food crop is maize. It is widely believed that food security implies sufficiency in the maize stock supplies. Since the advent of the colonial government, indigenous crops have largely been neglected at the expense of cash and plantation crops. Despite the neglect, Bambara groundnuts are known to be highly nutritious. The production of the major food staples has over the years declined or stagnated. For the country to meet its food consumption requirements, there is need for a diversified food crop production. Furthermore, indigenous crops use little or no farm inputs (such as pesticides and fertilizers), making them potential candidates for mitigating food insecurity problems. This calls for research in hitherto forgotten indigenous crops such as Bambara groundnuts.

In 2008/09 Kenya faced unprecedented drought throughout the country, even in its traditional grain baskets, which have had a relatively stable rainfall pattern and reliable food production. This saw a sharp increase in the price of maize occasioned by shortage of the staple food. The Ministry of Agriculture noted that the country needed more maize than it produced and identified some of the "orphaned" crops and targeted them for promotion as complements to the traditional food staples. These included the traditional food crops cassava, arrowroots, green grams and sweet potatoes (Muriungi, 2008). Traditional food crops are well adapted to local growth conditions, are often drought resistant and have low farm input requirements. The diversification of production and research in the traditional food crops is therefore justified.

2. Research methodology

2.1. The sample frame, sampling procedures and sample sizes

For the producers, the sample frame consisted of the set of Bambara groundnut farmers in the three districts of Butere, Mumias and Busia in Western Kenya. The sample frame for the traders was all the sellers of Bambara groundnut in the leading market centres of the three districts.

It emerged that Bambara groundnut production was grown by very few farmers concentrated in certain locations within the administrative divisions of respective districts. These producers were so few that a census approach was used to select all Bambara groundnut producers in the three districts. The census approach was similarly used to select traders from market centres in the districts. This sampling yielded a total of 59 farmers, 33 retailers and 4 wholesalers.

2.2. Data collection and analysis

Although both primary and secondary data were required, primary data was more crucial, and therefore formed the major data type for this study. Primary data were obtained from the producers and marketers of bambara groundnut by use of structured questionnaires and focused group discussions.

Some of the data obtained included the input and output variables in Bambara groundnut production; the land area allocated to Bambara, quantities of labour, planting fertilizer, and quantity of seed planted, among others. The socioeconomic variables included farmers' age, the level of formal education, experience in production, number of field days attended in the past year, and the quantity sold to the market, among others.

Descriptive statistics on the distribution of respondents by District, gender, age, land tenure system, and seller concentration ratios were the main data analyses performed. The seller concentration ratio is an index that measured the market structure. The seller concentration ratio for the largest m traders (CR_m) was given by the expression:

$$CR_m = \sum_{i=1}^{m} P_i \Big/ \sum_{i=1}^{n} P_i \qquad (1)$$

Where n is the total number of traders and Pi is the share of the volume traded.

3. Results and discussions

3.1. Respondents' discrete socioeconomic characteristics

The census of Bambara groundnut producers resulted in 26 female and 33 male farmers comprising 44.06 and 55.93% of the respondents respectively. Most of the respondents (45.8%) were from Busia, closely followed by those from Mumias (39%). The rest 15.3% were from Butere.

These results revealed that there were more Bambara groundnut producers in Busia (composed 39.4%) than there were in Butere (18.2%) and Mumias districts (42.4%). This was attributed to the agroecological suitability of Busia (Lower Midland Zone 4- LM_4), with a 66% rainfall reliability of between 400-900 mm pa in the first rainy season. This area is more suited than the wetter Lower Midland Zone 1 (LM_1) in Butere and Mumias districts. Although the statistics show that both male and female genders were well represented at the farm level, the majority of the traders who sold Bambara groundnuts were women. For instance, there was no male retailer who sold the crop in Butere market.

The analysis of the respondents' level of formal education revealed that the majority of the producers (42.4%) had attained the primary level, closely followed by those who had attained secondary level of formal education (39%). In both Butere and Busia, the majority of the producers had attained primary level of education (44.4 and 48.1% respectively), while the majority of farmers in Mumias had attained secondary level (56.5%). On the whole, the proportion of the respondents who had attained a certain level of education decreased from primary to secondary and to tertiary levels of education (42.4, 39 and 18.6% respectively).

3.2. Farmer and retailer continuous variables

The results of the farmer continuous variables (Table 2) show that farmers have a mean age of 48. This indicates that the farmers are generally energetic and should be able to produce agricultural products with ease. Given that the mean experience in production is 7.29 years, this crop is not new to them. Despite the positive indications, the hectarage still remained very low at a mean of 0.21 ha with a mean yield of 63.42 kg/ha. Yields between 300 and 800 kg/ha have been registered in traditional farming systems in other countries. Bambara groundnut trials for off-season production in Zimbabwe yielded 1.9 tons/ha and 2.3 tons/ha for landraces and improved varieties respectively (Makanda *et al*, 2008). However, yields of up to 3,000 kg/ha have been recorded under commercial production (Baudoin and Mergeai, 2001).

Most of the respondents did not apply planting fertilizer. Those who did applied very small quantities averaging 49.3 kg/ha. Given that soils in the region have been depleted due to continuous cropping, not much yield was achieved. The farmers' experience was gauged by the number of years they have been engaged in Bambara groundnuts production.

Table 2. Summary Statistics for Farmers' Continuous Variables

Variable	Min.	Max.	Mean	S.D.
Age of the respondent (years)	15.00	71.00	47.98	12.48
Respondent's years in Bambara production	1.00	32.00	7.29	7.49
Hectares under Bambara production in 2008	0.08	0.81	0.21	0.14
Bambara yield (kg/ha)	1.01	362.90	63.42	69.55
Number of extension visits received per month	0.00	15.00	1.94	3.24
Number of field days attended in the last 2 years	0.00	40.00	4.38	5.72
Fertilizer application rate (kg/ha)	0.00	250.00	49.33	78.39
Proportion of Bambara yield sold (%)	0.00	100.00	68.25	26.79

Source: Computation from Survey Data, 2009

Their experience ranged between one and 32 years with an average of 7 years, indicating that the crop was familiar to the farmers. A similar scenario was observed with the experience the retailers had in selling Bambara groundnuts, which ranged between one year and 44 years, with a mean experience of 10.9 years. However, just as the yield statistics, the stock levels among the retailers were low, at a mean of 74.69 kgs/ retailer (Table 3).

Table 3. Summary Statistics for Retailers' Continuous Variables

Variable	Min.	Max.	Mean	S.D.
Period in Bambara marketing (yrs)	1	44	10.96	10.98
Bambara stock level (kg)	4	400	74.69	81.82
Bambara buying price (KShs/2 kg tin)	150	400	230.90	60.17

Source: Computation from Survey Data, 2009

The gross margin analysis of Bambara groundnuts per kilogram showed that with a buying price of KShs. 115.45, the retailer paid for transport, market *cess* (levy) and meal costs that added up to KShs. 3.60 /kg of product. The low costs were due to the many products that were sold by the individual retailers which included beans, simsim, groundnuts, tobacco, maize and a myriad of other cereals in small quantities. This calculation (Table 4) showed that retailing in Bambara groundnuts was profitable with a margin of KShs. 44.30 (about US$ 0.6). The unit of measure was the *gorogoro*, a measure approximated to be 2 kg.

Table 4. Bambara Groundnut Retailer Marketing Margin per Kilogram

No.	Item	Price/ Cost (Ksh) per kg
1	Bambara buying price/kg*	115.45
2	Transport costs to the market	1.45
3	Market *cess* (levy)	0.76
4	Meals	1.50
5	Total costs	119.16
6	Selling price**	163.48
7	Retailers net margin	44.32

* This is the price retailers paid the farmers for the produce
** This is the retail price that the consumers paid retailers for the produce

Source: Computation from Survey Data, 2009

3.3. Bambara production, consumption and marketing

On average, the farmers' practice is to plant about 17.96 kg seed/acre (44.02 kg/ha). No or little fertilizer is added but weeding is done twice. When the yields are good, the conversion rate of the seed to output is estimated at 1:4 with the crop taking an average of 3.5 to 4 months to maturity.

The gross margin analysis at farm level shows that farmers incur total variable costs of up to KShs. 21,419/ha (about US$ 285) (Table 5). The major costs include land preparation labour (ploughing, harrowing and removal of couch grass), seed materials and the weeding operation. Although no pesticides are used, the level of production is so low that the enterprise is unprofitable, with a gross margin of KShs. – 14,098/ha.

Table 5. Gross Margin/Ha of Bambara Production in the Study Area

No	Item	Quantity	Price/Unit (KShs.)	Total Output/ Cost (KShs.)
1	Bambara groundnut output	63.42	115.45	7,321.84
2	• Variable costs:			
	• Land preparation labour	1	6,270.86	6,270.86
	• Seed materials	50.38	163.48	8,236.12
	• Fertilizer	49.33	50.00	2,466.50
	• Manure	458.33	0.17	76.39
	• Weeding and ridging			4,370.11
	• Total variable costs			21,419.98
3	Gross Margin/Ha			(14,098.14)

Source: Computation from Survey Data, 2009

The consumers of Bambara groundnut confirm that this food crop is extremely palatable. It can be boiled in shells and eaten, boiled when shelled and eaten, or boiled in a mixture of maize and beans. There were no stocks in all the rural markets visited during the reconnaissance survey (Butere and Sabatia, among others) in July 2008; not a single trader had any stocks of Bambara groundnuts. However, traders quoted prices of between KShs. 250 (at farm level) to KShs. 400/2kg tin; between US $ 1.66 to 2.66/kg.

In the determination of the market structure for Bambara groundnut, the seller concentration ratios for the largest four and eight traders were calculated. The seller concentration ratios for the largest 4 and 8 retailers were 41.78 and 56.80 indicating that the Bambara retail marketing system was moderately concentrated with competitive fringe (Table 6). This revealed that the marketing system was far from being atomistic, implying that there was an insufficient number of sellers in the market to warrant a competitive market structure. The study therefore failed to reject the hypothesis that the Bambara marketing system was not competitive.

According to Korir (2005), a market structure is considered atomistic when the concentration ratios are small and number of sellers is very large, each firm contributing less than 1% of the product. However, 4 and 8-seller concentration ratios of between 35-50 and 45-75 respectively with the number of sellers being large is considered moderately concentrated with competitive fringe (Table 6).

Table 6. Seller Concentration Ratios for Bambara Groundnut Retailers

Largest i retailers	Sales share (P_i)	Sum of the largest m shares $\sum_{i=1}^{m} P_i$; i=1, …,8	Concentration ratio $\sum_{i=1}^{m} P_i \Big/ \sum_{i=1}^{n} P_i$	Market structure
1	400	400	16.23	Moderately concentrated with competitive fringe
2	270	670	27.18	
3	180	850	34.48	
4	180	1,030	41.78	
5	100	1,130	45.84	
6	90	1,220	49.49	
7	90	1,310	53.14	
8	90	1,400	56.80	

Source: Computation from Survey Data, 2009

Although the range of the proportion of the yield that was sold by the producers was between zero and 100%, the mean stood at 68.25% with a standard deviation of 26.79. This indicates that the crop is generally regarded as a cash crop. Some of the producers indicated that the crop was their ‘gold’ in that it was highly valued. The proceeds from Bambara sales were used in paying school fees and in meeting other household requirements.

4. Conclusions

Kenya government policy is yet to address the research and development of indigenous crops. The production of Bambara groundnut is at the subsistence level characterized by very low yields, high labour use and low levels of commercial input use. Further, the market structure is moderately concentrated with competitive fringe.

5. Recommendations

Regional Research Centres particularly in the humid agroecological zones should consider running agronomic researches and on-farm trials that help farmers increase production of Bambara groundnuts. Of particular importance are the appropriate input levels that can shift output from subsistence to commercial levels of production. These should include introduction of high yielding varieties and research on appropriate plant densities, seed rates, pest and disease control and fertilizer application rates.

6. References

Baudoin J.P., Mergeai G., 2001. Bambara Groundnut *Vigna subterranean (L.) verd*. *In* Raemaekers, R.H. *Crop Production in Tropical Africa*. Brussels. Directorate General for International Cooperation, Ministry of Foreign Affairs, External Trade and International Cooperation, 313-317.

Jaetzold R., Schmidt H., Hornetz B., Shisanya C., 2005. *Farm Management Handbook of Kenya, Vol. II, Part A, West Kenya, Subpart A1, Western Province*. 2nd Ed. Ministry of Agriculture, Kenya in Cooperation with the GTZ,

Kenya, 2001. *National Agricultural Extension Policy*. Nairobi: Ministry of Agriculture and Rural Development.

Korir M.K., 2005. Cross Border Bean Marketing Between the Northern Zone of Tanzania and Nairobi, Kenya. MPhil. Thesis. Moi University, Eldoret.

Makanda I. *et.al*., 2008. Evaluation of Bambara Groundnut Varieties for off-Season Production in Zimbabwe." *African Crop Science Journal* 16.3 175-183.

Muriungi P., 2008. Turn to Traditional Food to end Crisis." *The Standard Newspaper* 10th December 2008.

Pearson S., Gotsch C., Bahri S., 2003. *Applications of the policy Analysis Matrix in Indonesian Agriculture* Available http://www.stanford.edu/group/FRI/Indonesia/newregional/network.html

Perloff J.M., 2008. *Microeconomics: Theory and Applications with Calculus*. Boston: Pearson Education Inc.

Schroeder J.W., 1997. Corn Gluten Feed: Composition, Storage, Handling, Feeding and Value. North Dakota State University, AS-1127.

World Bank, 2004. International Bank for Reconstruction and Development. *World Bank Atlas.* Washington D.C. The World Bank.

ECONOMIC AND ENVIRONMENTAL ASSESSMENT OF PULSE ROTATIONS IN CANADIAN PRAIRIES

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Abstract

As consumers regard for corporate responsibility increases, governments, industries and organizations have begun to assess the sustainability of their activities. Sustainability has many criteria, and those related to environmental impacts and economic effects are of interest to policy makers. Pulse (dry peas) crop production is on the rise in Saskatchewan. Although exports of peas to other countries are important from a local development perspective, their use for local activities has some appeal. In this paper, a combined life cycle assessment (LCA) and economic impact analysis (EIA) of growing peas or lentils in a four-year rotation was undertaken and compared to a rotation without pulse crops (i.e. an oilseed-cereal rotation). Inclusion of peas in a rotation is desirable as it is known to break disease and pest cycles, as well as fix atmospheric nitrogen through symbiotic association with Rhizobia. This results in decreased requirements of fertilizer, pesticide and insecticide application. These changes resulted in major financial implications for the producers, as the economic returns increased by $131 to $158 per ha for the pulse rotation over the baseline rotation. The LCA results demonstrated lower environmental impacts in all categories with the pea or lentils rotations as compared to the oilseed-cereal rotation. The results of the study suggest that adding dry peas and /or lentils in oilseed-cereal rotations improve the sustainability of crop production systems.

Keywords: life cycle assessment, economic assessment, pulses, Canadian Prairies, rotations

1. Introduction

The Prairies play a very important role in Canadian agriculture, providing 32 million hectares of arable land and accounting for approximately 85% of farmland. Historically, cereal-fallow rotations have been the predominant cropping system in the semiarid Canadian Prairies and northern Great Plains of the USA (Spratt et al., 1975; Grant et al., 2002). With the demise of grain transportation subsidy in Canada on shipping grains to export locations, and facing cost-price squeeze, producers are seeking better avenues for diversification. Pulses offer this opportunity, particularly in production areas where other crop alternatives are limited. In addition, pulse crops are an attractive crop to include in the rotation because not only do they break disease cycles, but in a symbiotic association with bacteria (called *Rhizobium* spp.), they are capable of using nitrogen from the atmosphere in a process called fixation. Nitrogen fixation reduces the dependence on inorganic fertilizer application on the pulse crop itself and, due to residual soil nitrogen, reduces nitrogen fertilizer requirements for the following grain crop.

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2. Project objective

The major objective of this study was to assess the sustainability of the environmental effects of including pulse crops in a crop rotation and the associated economic effects.

The environmental and economic effects associated with the production of pulse crops were examined to determine the environmental effects and economic implications of including pulse grains in an oilseed-cereal rotation and various pulse grain end-uses.

3. Study methodology

Various tools are available to investigate the sustainability of a product. A popular and useful tool that measures the environmental sustainability of a product is life cycle assessment (LCA). The LCA is a cradle-to-grave approach in that it takes into consideration the major activities during the product's life span from its manufacture, distribution, use and final disposal. Recognizing the necessity for LCA analysis of pulse crops on a rotational level, Nemecek and Baumgartner (2006) modeled the environmental and economic effect of including pulse crops in cereal/oilseed-based rotations in Europe, as well as the effect of replacing the soybean meal in swine feed with pulse grains. Results of the crop rotation scenario indicated that crop rotations that included pulse grains had a lower life cycle environmental effect compared to the alternative scenarios.

Similar to environmental sustainability, multiple tools are available to assess the socio-economic sustainability of products. Typical approaches that can be used to evaluate economic desirability of a crop rotation include partial equilibrium approach, whole farm systems models and stochastic dominance models. Of these approaches, the partial equilibrium approach is the simplest and most appropriate for comparison of alternative rotation regimes. Such an approach can be used in simulation models, as suggested by Hewitt (1995). Furthermore, it also complements LCA, as it can be performed using the exact parameters used for the LCA.

The focus of this study was a comparison of the baseline rotation against the alternative rotations involving pulses. A four year rotation is commonly followed on the Canadian Prairies. These rotations were:

- baseline: canola – wheat – wheat – wheat,
- alternative rotation 1: canola – wheat – peas – wheat,
- alternative rotation 2: canola – wheat – lentils – wheat.

Although three wheat crops may not always be grown in succession in Western Canada, the selected rotation ensured that the LCA was modeled using the best available field data. To ensure that all changes in impacts between the cereal-oilseed scenario and the scenarios including pulse crops were due to the inclusion of pulse crops, the pulse crop was the only variable to change in the rotation. Each of these rotations was subjected to a combined economic analysis and life cycle assessment.

3.1. Economic Analysis

A simulation model for the three Prairie Provinces was developed for three soil zones: Brown, Dark Brown and Black soil zones. In addition, it contained three types of tillage systems, summerfallow, continuous cropping system and direct seeding. The model consists of a series of integrated worksheets linking yield and input levels for various crops in each of the three Prairie

Provinces[1] under different tillage systems. Results of relative economics of the rotation were estimated in nominal values and present values using a 5% rate of discount.

The economic analysis was based on several assumptions. The following are noteworthy:

1. Crop yield and fertilizer and pesticide application rates assumed were the same as that used in the LCA modeling.
2. All crops were grown using direct seeding technology.
3. Cost of production and, therefore, the economics of a rotation were determined by the location of the farm, where type of soil is a major factor.
4. Cost of production of various crops reflects 2010 economic and market conditions. This was the most recent data available for western Canada. These prices were obtained from Saskatchewan Ministry of Agriculture (2009a).
5. Producers were assumed to be price takers. In other words, a change in the rotation and level of production is assumed to not change the level of the price received at the farm gate.
6. In the Brown soil zone, canola is not a major crop produced. It was assumed that mustard is an equivalent crop for canola in this soil zone. Being oilseed crops, they were considered to be agronomically equivalent for this study.

The economics of a given crop rotation was an aggregation of the crops grown over four years in a given rotation. The economics were also presented in present value (PV) form by using a discount rate of 5%. This level of discount rate is commonly used, and is close to the rate of discount used for public benefit-cost analysis. The PV was calculated using the following equation:

$$PV\ Rotation = \sum (NR_i) / r^{(1+t)};\ i = 1, \ldots, 4.$$

Where:
NR – the net returns from the crop during year I,
r – rate of discount (assumed to be 5%) and
t – time counter.

Gain in the net return under the alternative rotation provided the basis for economic desirability of the said rotation.

3.2. Sensitivity analysis for economic assessment

One of the major sources of variability in economics of a rotation is the pricing of products – inputs and outputs. In this study the three rotations were simulated under varying market conditions.

Table 1. Details of simulations for sensitivity analysis of economic returns

Simulation No.	Price of cereal and oilseed	Price of pulses	Price of fertilizer
1 (HHH)	high	high	high
2 (HHL)	high	high	low
3 (HLH)	high	low	high
4 (HLL)	high	low	low
5 (LHH)	low	high	high
6 (LHL)	low	high	low
7 (LLH)	low	low	high
8 (LLL)	low	low	low

[1] Since very little area is devoted to pulse crops in the province of British Columbia, the data for three Prairie Provinces is taken as representative of Western Canada.

Different level of prices for grain, oilseed, and pulse crops were selected for various simulations by examining past ten year (1991-2010) farm level prices received. Using two standard deviations around the mean, price levels were determined. The 'high' prices were taken at two standard deviations to the right of the mean, and the 'low' prices were determined as two standard deviations away to the left of the mean. Eight such simulations were conducted, as shown in Table 1.

4. Life cycle analysis

A popular and useful tool that measures the environmental sustainability of a product is life cycle assessment (LCA). It is a cradle-to-grave approach in that it takes into consideration the major activities during the product's life span from its manufacture, distribution, use and final disposal. Furthermore, LCA is an inclusive method, which allows changes in a system to be tracked throughout the analysis and identified in the outcome.

The system boundary differentiates the system under analysis from its environment (Audsley et al., 2003). The system boundary for agriculture ideally stops when identical products pass out of the farm gate. The crop rotation analysis includes all inputs required for grain production. The analysis endpoint is the grain elevator – the point at which all grain has been cleaned, packaged and is ready for use.

In this study, LCA was conducted using SimaPro (version 7.1.8, PRé, 2008). The software includes thousands of processes and substances across several inventories, as well as methods for impact assessment. The environmental effects of completed life cycles are categorized and quantified based on the type of damage they cause. A list of these impacts included in the study is shown in Figure 1. The following is a brief description of each impact category, as well as the units used:

- *Human toxicity*: Carcinogenic and non-carcinogenic emissions from metals and inorganic

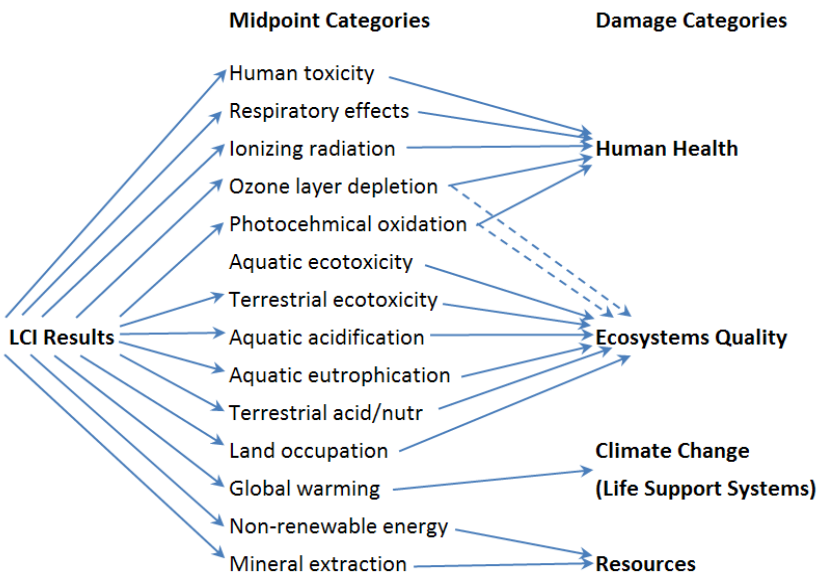

Figure 1. Midpoint and endpoint categories of life cycle impact assessment method
Source: Jolliet et al., 2003

compounds from soil, water and air (kg chloroethylene into air equivalents/kg emission);

- *Respiratory effects*: Air pollutants such as sulfur oxides and volatile organic compounds [kg particulate matter (PM) below 2.5 micron size/kg emission];
- *Ionizing radiation*: Natural and artificial radiation sources (becquerel of C-14 equivalents/kg emission);Ozone layer depletion: Several ozone depleting gases, such as chlorofluorocarbons (CFCs) and halogenated compounds (kg CFC-11 equivalents/kg emission);
- *Photochemical oxidation*: Includes smog-forming particles, such as olefins and hydrocarbons (kg ethylene into air/kg emission);
- *Aquatic ecotoxicity*: Emissions to water sources, such as surface water, lakes and rivers (kg triethylene glycol (TEG) equivalents into water/kg of emission);
- *Terrestrial ecotoxicity*: Emissions to soil, such as metals, hydrocarbons and pesticides (kg TEG equivalents into water/kg of emission);
- *Aquatic acidification*: Potential proton release of substances such as nitrogen oxides and ammonia [kg sulfur dioxide (SO2) equivalents into air/kg emission];
- *Aquatic eutrophication*: Chemical nutrient contribution to bodies of water from such sources such as nitrogen oxides and phosphates [kg phosphate (PO43-) into water/kg of emission];
- *Terrestrial acidification and nitrification*: Proton release and/or chemical nutrient release to soil (kg SO2 equivalents into air/kg emission);
- *Land occupation*: Effects of occupying and transforming land on the species-area relationship (m2 organic arable land*year equivalents);
- *Global warming*: All gases thought to contribute to global warming, such as carbon dioxide, methane and nitrous oxide [kg carbon dioxide (CO2) equivalents/kg emission]; The global warming impact category is based on the 2001 IPCC global warming potential (GWP) factors across a 500 year time horizon (IPCC, 2001).
- *Non-renewable energy*: Finite sources of energy, such as fossil fuels [mega joules (MJ) of total primary non-renewable or kg crude oil (860 kg/m3) equivalents/kg emissions]; and
- *Mineral extraction*: Based on the theory that additional energy will be required for every subsequent mineral extraction after primary extraction due to the depletion of resources and quality of the remaining minerals [MJ of additional energy or kg of iron (in ore) equivalents/kg of emission].

The functional unit is a clearly defined measure of performance which the system delivers and is the basic unit of comparability for the study (Audsley et al., 2003). To determine the functional unit, the basic function of a system must be identified, which in the case of farm level rotations is to produce grain for the purposes of human consumption. As both pulse and cereal grains are considered to be sources of protein (Whitney and Rolfes, 2005), protein was chosen as the unit of comparison in terms of nutritive value. A protein content of 14% was chosen for the crop rotation LCA as it is the average protein content in wheat when all methods of farming and crop rotations are included (Canadian Grain Commission, 2009). In summary, the functional unit selected for the crop rotation study was one tonne of fourteen percent protein-corrected grain (1 t 14% protein-corrected grain).

5. Results

Results of net returns of various crops in the three rotations were estimated using a fixed price (given as of 2010 crop year prices). For this reason, a test of robustness of the three rotations was examined further under different price and cost conditions. To undertake sensitivity of results to changing conditions, additional simulations were made. Three types of prices were subjected to

Table 2. Weighted average economics of alternative crop rotations, present value of net returns ($/ha), western Canada, 2010

Particulars	Baseline (oilseed-cereal)	Alternative rotation 1 (Dry pea)	Alternative rotation 2 (Lentil)
Weighted average for western Canada: Net returns Over variable costs ($/ha)	-$19.40	$115.97	$145.72
Weighted average for western Canada: Net returns over total costs ($/ha)	-$522.22	-$403.84	-$378.49
Difference from BAU rotation for net returns over variable costs ($/ha)	--	$137.42	$175.14
Difference from BAU rotation for returns over total costs ($/ha)	--	$130.85	$158.86

Table 3. Results* of sensitivity analysis – discounted value of rotational period net returns over variable costs (ha) under study scenarios

Study scenario**	Base rotation	Dry pea rotation	Lentil rotation
1 (H-H-H)	$1,136.86	$1,440.38	$1,289.19
2 (H-H-L)	$1,205.85	$1,501.19	$1,385.72
3 (H-L-H)	$1,068.78	$1,103.89	$939.80
4 (H-L-L)	$1,205.85	$1,211.52	$1,039.45
5 (L-H-H)	-$224.61	$270.92	$320.95
6 (L-H-L)	-$72.22	$378.55	$420.60
7 (L-L-H)	-$196.23	-$22.91	-$9.67
8 (L-L-L)	-$72.22	$96.94	$74.33

* Results are based on weights for various soil zones in western Canada using proportion of dry pea area,
** Scenario symbols are: first letter for grain prices (high or low), second symbol for pulse prices (high or low) and the third symbol is for fertilizer prices (high or low)

change: price of non-pulse crops (spring wheat, canola and mustard); price of pulses (dry pea and lentil); and price of fertilizer. In total, eight simulations were made (Table 2).

The study model was used to estimate economic desirability of the two study rotations – dry pea rotation (canola – wheat – dry pea – wheat) and lentil rotation (canola – wheat – lentil – wheat), over the Table 3 in terms of net returns over variable costs for these rotations plus the base rotation (canola – wheat – wheat – wheat). Results suggest that under high grain and oilseed prices, all rotations generate a positive return over variable costs. However, when low grain and oilseed prices are assumed, results for the base rotation (canola – wheat – wheat – wheat) show a negative return over variable costs, but this is not the case for the pulse rotations (either the dry pea or lentil rotation) except when pulse prices are low and fertilizer prices are high.

Economic desirability of pulse crop rotations (those having a dry pea or lentil) was further examined using returns over and above total cost relative to the base rotation. Results are shown in Figure 2.

When dry pea and lentil were included in an oilseed-cereal crop rotation, the environmental effects associated with the rotations were reduced in all categories (Table 4). Higher reductions (i.e. over 20% in both alternative rotations when compared to the base rotation) were noted for

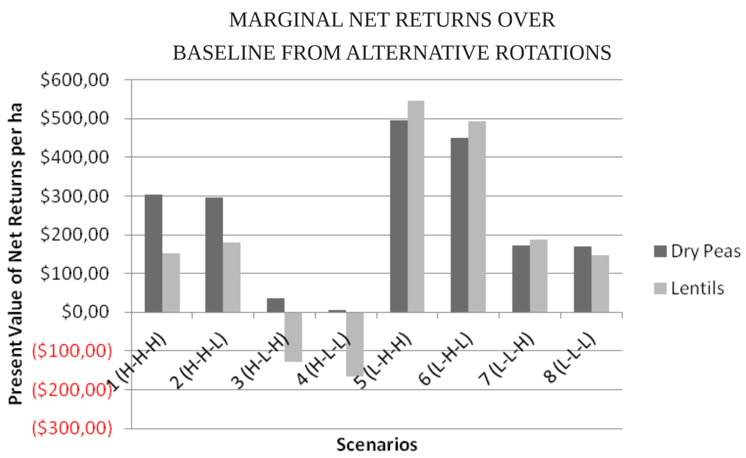

Figure 2. Results of sensitivity analysis for study rotations

Table 4. Selected results of life cycle assessment of rotations

Impact category	Percent reduction from baseline rotation	
	alternative rotation: dry peas (%)	alternative rotation: lentils (%)
Carcinogens	23	19
Non-carcinogens	15	3
Respiratory inorganics	21	13
Ionizing radiation	17	13
Ozone layer depletion	28	23
Respiratory organics	21	15
Aquatic ecotoxicity	19	11
Terrestrial ecotoxicity	15	1
Terrestrial acidification/ nutrification	24	21
Land occupation	17	1
Aquatic acidification	22	17
Aquatic eutrophication	20	8
Global warming	25	22
Non-renewable energy	21	17

Ozone layer depletion (23-28%), Terrestrial acidification/nutrification (21-24%), Global Warming (22-25%) and Non-renewable energy (21-25%). Since these rotations had greater nitrogen availability due to the inclusion of pulse crops, fertilizer application requirements were reduced (i.e. no application to the pulse crop and reduced application to the succeeding cereal crop) and the yield and grain protein content of the following wheat crop were increased.

These results suggest that dry pea and lentil rotations can generate lower environmental impacts than the oilseed-cereal crop rotation in all impact categories. Major reasons for these results could be explained as follows: the nitrogen fixation abilities of pulse crops; the reduction in nitrogen requirements of a cereal crop succeeding a pulse crop; and the increase in quantity (grain yield) and nutritive quality (protein content) of a cereal crop following a pulse crop. In Western Canada, crop nitrogen requirements are achieved via the application of synthetic nitrogen fertilizers, such as urea. By reducing the requirement for synthetic nitrogen fertilizers, pulse crops inherently reduce the emissions and energy use associated with the production, use and disposal of fertilizers. Furthermore, because pulse crops fix their own fertilizer, they do not require application of a synthetic nitrogen fertilizer to grow, except for the small amount in applied phosphorus fertilizer.

6. Study conclusions for economic analysis

This study suggests that pulse crop rotations, in general, are more sustainable than oilseed-cereal rotations. This conclusion is based on two major pillars of sustainability – economic desirability and environmental benefits. Only under lower pulse (either dry peas or lentils) prices are the alternative rotations (including pules) not more economically desirable over the baseline rotation. This conclusion is supported by the present economic analysis. Relative to the oilseed-cereal rotation (i.e. canola – wheat – wheat – wheat), pulse crop rotations (either canola – wheat – dry pea – wheat, or canola – wheat – lentil – wheat) generate higher net returns over variable as well as total (variable and fixed) costs. This conclusion remains unchanged under several assumptions of prices of grain, oilseed, and pulses, except when grain and oilseed prices are high and pulse crop prices are low.

The environmental effects of crop production are related to the amounts of material and energy required to produce a defined amount of grain. The inclusion of pulse crops into oilseed-cereal rotations is environmentally beneficial as pulses reduce the nitrogen fertilizer requirements and increase the overall grain yield and quality (i.e. protein content) of the rotation.

Higher producer profits and minimized effects on the environment can be realized with optimized crop management that can include combining dry pea and/or lentil with other high yielding crops in the rotation, as well reduced amounts of material and energy inputs.

7. References

Audsley E., Alber S., Roland C., Cowell S., Crettaz P., Gaillard G., Hausheer J., Jolliet O., Kleijn R., Mortensen B., Pearce D., Roger E., Teulon H., Weidema B., van Zeijts H., 2003. Harmonisation of Environmental Life Cycle Assessment for Agriculture. European Commission DG VI Agriculture, 119 pp.

Grant C.A., Peterson G.A., Campbell C.A., 2002. Nutrient Considerations in Diversified Cropping Systems in the Northern Great Plains. Agronomy Journal 94:186-198.

Hewitt T.I., 1995. Economic and Environmental Simulation of Alternative Cropping Sequences in Michigan. Journal of Sustainable Agriculture. 5(3): 59-86.

Jolliet O., Margni M., Charles R., Humbert S., Payet J., Rebitzer G., Rosenbaum R., 2003. IMPACT 2002+: A New Life Cycle Impact Assessment Methodology. International Journal of Life Cycle Assessment 83:24-330.

Nemecek T., Baumgartner D., 2006. Environmental Impacts of Introducing Grain Legumes into European Crop Rotations and Pig Feed Formulas. Concerted Action GL-Pro. WP4: Environmental Analysis. Final report. Deliverable 4.3.

PRé., 2009. SimaPro 7 - Product Ecology Consultants. Software Documentation. 124 pp.

Spratt E.D., Strain J.H., Gorby B.J., 1975. Summer Fallow Substitutes for Western Canada. Canadian Journal of Plant Science 55:477-484.

Whitney E., Rolfes S.R., 2005. Understanding Nutrition, Tenth edn. Wadsworth, Belmont, CA. 280 pp.

INVESTIGATION OF BOTTLENECKS AND SUCCESS FACTORS FOR NETWORKING AS A TOOL FOR INNOVATION IN THE ORNAMENTAL PLANT SECTOR

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Abstract

Networking and innovation are important sources for entrepreneurs to achieve competitive advantage. This paper aims to investigate bottlenecks and success factors for networking of ornamental plant growers. To reach this objective, following research questions are formulated: (1) What kind of innovations are applied?, (2) What kind of networks are used?, (3) What role does networking play in the contribution to the development and implementation of innovations?, (4) What are the main bottlenecks and success factors for networking as a tool for innovation?

The research data are collected by means of in-depth interviews and focus group discussions with ornamental plant growers and network coordinators. The results show that ornamental plant growers have many possibilities in the domain of product, process, market and organizational innovation at their disposal, which are often underutilized. With regard to networking, a high diversity in the intensity of network activity and in the appeal to different network types are determined. Network types include horizontal and vertical networks as well as collaboration with third parties. Actually a link between network activity and innovation is observed, under condition that networking occurs in an effective and efficient way. Important bottlenecks for networking as a tool for innovation are a lack of human and financial resources, a strong competition and conflicts of interest between the network partners, leading to individualism and distrust, a high threshold between growers and research and governmental institutes and a low perceived added value or organized network activities. Some critical success factors for networking are lowering the threshold and enhancing trust and transparency among network members. Growers should take advantage of the underutilized innovation possibilities through enhanced networking. This would increase the farmers' insights into changing markets and consumer needs and the necessary and relevant partners and information as trigger for innovation. This study delivers valuable insights and implications for growers as well as network coordinators. An important recommendation is that growers as well as network coordinators should apply strategies to connect with each other in the most effective and efficient way.

Keywords: innovation, network activity, ornamental plant production, qualitative research, Flanders

1. Introduction and objectives

For farmers, as well as entrepreneurs in general, innovation is widely recognized as an important strategic tool to increase the competitive advantage of their companies (Schumpeter 1934; Nonaka et al. 2000; Gellynck et al. 2007), resulting in a better financial as well as sustainability performance (Diederen et al. 2003; Sporleder 2003; Knudson et al. 2004; Deuninck et al. 2008;

van Galen and Verstegen 2008). Innovation can be defined as an ongoing process of learning, searching and exploring, resulting in new products, new processes, new forms of organisation and new markets (Lundvall, 1995). In this context, several authors state that it is important to specify to whom the innovation is new: the economy, the sector or the farm (Goldenberg et al. 2001; Garcia and Calantone 2002; Mann 2005). In this paper, the focus is on innovations that are new to the farm and to the sector. Furthermore, all degrees of innovation ranging from incremental to radical innovations are considered. The ornamental plant sector in Flanders (northern Belgium) is selected because of its historical geographical concentration and problems with developing and implementing innovations (Taragola et al 2002; Taragola 2003; Van Lierde et al. 2011). These problems are possibly solvable through networking (Fearne and Hughes 1999; Omta 2002; Pittaway et al. 2004; Camps 2004; Thorpe et al. 2005; Röling 2009). In this paper, networking is defined as the exchange of information or services among individuals, groups, or institutions and aims at the cultivation of productive relationships for business (Merriam-Webster 2013). In the next section the link between networks and innovation is outlined in more detail.

2. Conceptual framework

The three key elements from the previous section – farm, innovation and network- are situated within the conceptual framework below. The framework outlines the research questions.

Plenty of recent studies indicate that the locus of innovation is no longer the individual firm, but increasingly the network within which the firm is embedded (Powell et al. 1996; Omta 2002; Pittaway et al. 2004). Approaches considering agricultural innovation as the result of a process of networking and interactive learning among a heterogeneous set of actors, such as farmers, input industries, processors, traders, researchers, extensionists, government officials, and civil society organizations, are increasingly applied (e.g. Hall et al. 2003; Morris et al. 2006; Spielman et al. 2008; Klerkx et al. 2010). The network therefore plays an important role for firms in terms of developing innovation (Figure 1)(Omta 2002; Pittaway et al. 2004). The introduction of innovations through networking can be hampered or facilitated by numerous bottlenecks and success factors, which can be internal or external to the farm (Avermaete et al. 2003; Scozzi et

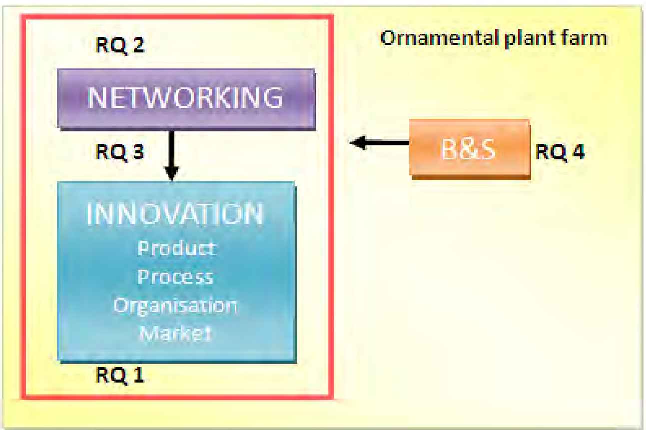

Figure 1. Conceptual framework for investigating bottlenecks and success factors (B&S) for networking as a tool for innovation (adapted from Gellynck X. et al, 2007), and research questions (RQ. 1-4)

al. 2005; Maravelakis et al. 2006; O'Regan et al. 2006). This paper focuses on the investigation of bottlenecks and success factors for networking in the ornamental plant production. The objective is to investigate the bottlenecks and success factors for networking. To reach this objective, first the following research questions are formulated: 1) What kind of innovations are applied?, (2) What kind of networks are used?, (3) What role does networking play in the contribution to the development and implementation of innovations? This leads to the final research question: (4) What are the main bottlenecks and success factors for networking as a tool for innovation?

3. Methodology

Between June 2011 and March 2013, 20 in-depth interviews and two focus group discussions with 9 growers were conducted, which are both qualitative research methods that assemble detailed attitudinal and experiential information from the respondents by using open-ended, exploratory questions in a semi-structured way (Powell and Single 1996; Malhotra 1999). Interview guides based on a comprehensive literature review were pilot-tested and adapted accordingly. Data were collected from growers and network coordinators active in the Flemish ornamental plant sector. In total, 14 ornamental plant growers were interviewed, from which 5 were also network coordinators. Furthermore, 6 interviews were conducted with exclusively network coordinators. For the focus groups, the subsector of azalea production was selected, because of its high importance in Flemish ornamental production. One group was characterized by a high network activity and another by a low network activity. All interviews and focus groups were audio-recorded and transcribed. The analysis of the data is based on the grounded theory-approach, which implies that information gathering and theoretical conceptualization of a given phenomenon evolve through a continuous interplay between analysis and data collection (Strauss and Corbin 1994). Rather than starting with a hypothesis, the first step is data collection. From the data, key points are marked with a series of codes. The responses were categorized in different analytical groups based on common similar words, concepts or themes. We ended with selective coding to refine the analytical categories. The data were sorted and coded using NVIVO.

4. Findings

4.1. What kind of innovations are applied in the ornamental plant sector?

The first question to the respondents was dealing with their perception of innovation, resulting in the reporting of mainly product and process innovations. Only some of them mentioned spontaneously market and organizational innovations as well. Afterwards, we formulated our definition of innovation: "Product, process, market and organizational innovations which are new to the farm or the sector, ranging from incremental to radical innovation", ensuring that everyone was speaking about the same. The innovations mentioned were those already implemented or likely to be implemented by the respondents. Table 1 gives an overview of the mentioned innovations by domain.

PRODUCT INNOVATION: As ornamental plant production is subject to trends, and consumers are keen on new products and product varieties, product innovation is necessary and hence an important type of innovation. However, a lot of growers are rather reluctant to introduce radical product innovation, because of the risk of investing in a product in which consumers might not be interested. Other introduced product innovations are driven by income related reasons, for example a change-over from indoor plants to outdoor plants to reduce energy costs.

Table 1. Innovation in ornamental plant production by domain

Product innovation	Process innovation	Market innovation	Organizational innovation
– New product-/ pot size – New product variety – New product – Selling flowering plants instead of the plants in bud – Switch to cultivation of less energy requiring plants	– Robotization – New cultivation method – Water recycling – Expansion – New technical solutions to improve quality – Installation of cogeneration engine, solar panels – New fertilization techniques – Applying alternatives for pesticides	– Own label – New packaging – Establishment web shop – Self-service field with cut flowers – New product combinations packed together	– Move labour intensive tasks to low wage countries – Hire East-European labour forces – Establishment of close collaboration with colleagues to assure sales – Elimination of links in the chain – Establishment of close collaboration with chain partners to fulfil market needs – Joint product development activities – Formation of a joint research network – New establishment – Introduction of a new software system

PROCESS INNOVATION: In general, process innovations are driven by high labour and energy costs, environmental regulations and the need to improve the quality of their products. Labour costs are decreased, for example by introducing robots to plant or sow products, while installing a cogeneration engine or solar panels helps to minimize energy costs. In order to meet the increasing environmental requirements, investments in environmental friendly techniques such as water and waste recycling are necessary. To improve plant quality, innovations in the production process, such as new fertilization methods and alternatives for pesticides are important.

MARKET INNOVATION: To assure and increase their sales, growers have to introduce market innovations. Examples in this domain are the development of a label or new packages. Other identified market innovations are preparing new product combinations packed together, the set-up of a self-service field with cut flowers or the establishment of a web shop.

ORGANIZATIONAL INNOVATION: This kind of innovation can be very diverse with various underlying drivers. High labour costs are an important driver for moving production branches to low wage countries or hiring East-European seasonal labour forces invoking the need for accommodation and adapted human resource management. Collaborative initiatives are set up between growers to distinguish themselves in the market, and between growers and research institutes, to develop market oriented product varieties. Furthermore, changes of relationships within the chain are observed. Several intermediary links are eliminated, which brings the grower closer to the end-consumer. In this way, the added value of the sold product can be shared among less links, and the grower is better aware of the market needs because of his closer contact with the end-consumer. Also close collaboration with the chain partners is another observed possibility to be better aware of the market needs. Other examples of organizational innovations are the introduction of a new software system and the building of a totally new establishment.

Although innovations in all domains are applied by ornamental plant growers, most of the interviewees do not acknowledge the necessity of innovating in other domains than process innovations.

4.2. What kind of networks are used in ornamental plant production?

Table 2 gives an overview of the networks used, divided in three major categories: horizontal and vertical networks as well as collaboration with third parties (based on Gellynck and Kühhe, 2008).

HORIZONTAL NETWORKS (peers): A large variety of formal collaboration possibilities with peers is identified, including organisation of transport, marketing or buying of products, developing new products, ... More informal networks are : the exchange of information with colleagues from inside as well as outside the sector, following on the activities organized by sector associations or network activities for entrepreneurs in general, contact with colleagues at fairs, conversations related to the companies' activities with family, friends and personnel.

VERTICAL NETWORKS (chain): We observed that collaboration of growers is often better with suppliers than with customers, due to the stronger bargaining power of the latter. Via suppliers, growers are informed about the novelties on the market and the possibilities for their farm. Collaboration with customers to obtain access to market needs seems to be difficult. Nevertheless, in some of the cases, examples of close collaboration are identified. Furthermore, collaboration with wholesalers is difficult since many growers do have the perception that they want to exploit them.

THIRD PARTIES: These are persons or entities which are other than peers or the chain. Noteworthy is Sietinet, which is a network established and coordinated by a research institute (ILVO) with the aim to improve the translation and transfer of research results to the sector via individual

Table 2. Networking and collaboration for innovation in ornamental plant production by type of network

Type of network	Type of partners
Horizontal (peers)	Colleagues ornamental plant growers Network established by advisor Sector association/ producer association Professional network of entrepreneurs/ business club Cooperative auction Fairs Personnel Family Friends Colleagues outside of the sector
Vertical (chain)	Suppliers of materials, infrastructure Wholesalers/traders Customers End-consumers
Third parties	Research institutions Governmental institutions Educational establishments Consultancy agencies Innovation Support Centre Financial provider Think-tank 'Ornamental Plant Strategy 2020' (growers, chain partners, producer association, government, research institutes)

advice and the organisation of workshops and courses. The coordinating research institute collaborates with eight other Flemish research institutions to support innovation in the sector. Only the members of the network can make use of the offered services. Moreover, this network brings multiple growers together, which offers numerous opportunities for horizontal networking. In addition, the role of consultancy agencies is significant. Furthermore, collaboration takes place with governmental institutions, the Innovation Support Centre, and educational establishments. Besides, financial providers are also important third parties, facilitating innovation. Also the Think-tank ‘Ornamental Plant Strategy 2020’, which has the mission to formulate strategies and actions for the future. It is established by the Flemish government, including a number of progressive growers, an export company, an advisor, practice-based and fundamental researchers and a representative of a producer organization.

4.3. What role does networking play in the contribution to the development and implementation of innovations?

Respondents were asked how important they perceive networks in the contribution to the development and implementation of innovations. They reported that the outcomes of network participation were generally advantageous to learn something, to reduce the distance between the sector and policymakers, to prevent them from insulation, to know the right people/place when information is needed and to obtain information from outside the sector. Further advantages mentioned were the possibility to exchange knowledge with colleagues and the higher awareness of things that happen and new trends. Overall, networking is perceived as an important strategic tool to come to innovation in the sector.

An observation is that the networks used partly differ dependent on the type of innovation. For product innovations, growers work frequently together with a research institute for the development of a new product, and appeal to networks with customers to gather market information. To obtain ideas for product innovation, they mainly are drawn back on colleagues and suppliers. For market innovations, some recent collaboration initiatives are set up to market products together with colleagues. With regard to organizational innovations, it is observed that networking with people from outside the sector is very important to obtain ideas. Also the Innovation Support Centre is mentioned as an important network for developing and implementing organizational innovations.

4.4. What are the main bottlenecks and success factors for networking as a tool for innovation?

BOTTLENECKS: Based on the interviews, internal as well as external bottlenecks for networking can be distinguished. A lack of human resources is an important internal bottleneck, including problems in terms of managerial competencies and the absence of a strategic vision. Also a lack of financial resources in terms of time and money are an internal bottleneck, which are often linked to the size and structure of the company. External bottlenecks relating to horizontal networks involve a strong competition between the network partners, leading to individualism and distrust, fear of losing own identity and difficulty to find connections with others. Ornamental plant growers are individualists; the smaller the market, the more competition and distrust. With respect to vertical networks within the chain problems arise when chain members do not consider each other as potential partners for collaboration, due to conflicts of interest and disbelief that collaboration efforts would deliver greater benefits for all chain members. Also the strategic vision towards innovation often differs between the members of the chain. An important bottleneck for networking with third parties such as research institutions, governmental institutions, etc. is that the threshold is often too high. Nevertheless, recent initiatives of collaboration between growers and research institutes, such as Sietinet, have proven to be successful. Another bottleneck is the low perceived added value of organised network activities. Respondents mentioned that the same topic is often covered by different organizers. Moreover, as growers' problems and hence the required information and knowledge is very company specific, they spend a lot of time listening to less relevant information. Furthermore, growers state that they are often not aware of organized activities.

SUCCESS FACTORS: Critical success factors for networking in general are lowering the threshold between the network members and enhancing trust and transparency. Trust, or the lack of trust, were much-discussed issues for horizontal and vertical networks. With respect to networking with third parties, recently initiatives are launched by research institutes to decrease the threshold with the growers, which is mentioned as a significant improvement by the sector. For example, in Sietinet, trust is enhanced via a contract, guaranteeing that research results remain confidential and property of the company who asked the question.

5. Conclusions

The answers on the first research question of this paper '*What kind of innovations are applied?'* reveal that ornamental growers have many possibilities in the domain of product, process, market and organizational innovation, which are often underutilized. In general, innovations in the ornamental plant sector are driven by high energy and labour costs, environmental regulations, product quality improvement and difficulties to market products.

The second research question is: *What kind of networks are used?* The findings indicate that a high diversity in network types is used, which can be categorized as horizontal and vertical networks and collaboration with third parties. Research question three investigates *The role of networking in the contribution to the development and implementation of innovations?* Among the respondents, networks are perceived as very important in the contribution to innovations, similarly to the finding of Omta (2004) and Pittaway et al. (2004). The fourth research question, which can only be answered on the basis of the previous findings focuses on the *Investigation of the main bottlenecks and success factors for networking as a tool for innovation.* Internal bottlenecks are the lack of human and financial resources, which are often linked to the size and structure of the company. In general, the internal bottlenecks observed are in line with previous studies in agribusiness in general (Avermaete et al. 2003; Scozzi et al. 2005; O'Regan et al. 2006; Kühne 2011) and more specifically in ornamental plant production (Taragola and Van Lierde 2010; Van Lierde et al. 2011). External bottlenecks relating to horizontal networks involve strong competition between the network partners, leading to individualism and distrust. Also previous research in the ornamental plant sector confirms this lack of trust among the growers, which can be related to the individual commercialization structure with a small number of producers per product (Taragola et al. 2002; Taragola 2003; Van Lierde et al. 2007; Van Lierde et al. 2007). External bottlenecks relating to the vertical network are induced by conflicts of interest and disbelief that collaboration efforts could deliver greater benefits for all chain members. This is also a finding of Kühne (2011), which was also confirmed by Van Lierde et al. (2011) in their research in the ornamental plant sector. With regard to networks with third parties, important bottlenecks are the high threshold between the growers and research and governmental institutes, etc. and a low perceived added value of organized network activities. However, recently some initiatives to lower this threshold are launched. The growers prefer to invest in company aligned information instead of in general information provided by governmental research institutes. Furthermore, the growers state that they are often not aware of organized activities. Critical success factors for networking in general are lowering the threshold between the network members and enhancing trust and transparency.

Hence, growers should take advantage of the underutilized innovation possibilities through enhanced networking. This would increase the farmers' insights into changing markets and consumer needs and the necessary and relevant partners and information as trigger for innovation.

This study delivers valuable insights and implications for growers as well as network coordinators. As also found in the literature on networking of small and medium sized enterprises (e.g. Birley 1985), an important recommendation is that growers as well as network coordinators should apply strategies to connect with each other in the most effective and efficient way.

6. References

Avermaete T., 2004. Dynamics of innovation in small food firms, Universiteit Gent, Faculteit Landbouwkundige en Toegepaste Biologische Wetenschappen. Thesis submitted in fulfilment of the requirements for the degree of Doctor in Applied Biological Sciences: 181.

Avermaete T., Viaene J., Morgan E.J., Crawford N., 2003. Determinants of innovation in small food firms. *European Journal of Innovation Management* 6(1): 8-17.

Birley S., 1985. The role of Networks in Entrepreneurial Process. *Journal of Business Venturing* 1(1): 107-117.

Camps T., 2004. Chains and networks: theory and practice. IN: Camps, T., P. Diederen, G. J. Hofstede and B. Vos. *The emerging world of chains and networks. Bridging theory and practice*. 's Gravenhage, Reed Business Information.

Deuninck J., Carels K., Van Gijseghem D., Piessens I., 2008. Innovatie in land- en tuinbouw in Vlaanderen: resultaten van het Landbouwmonitoringnetwerk. Brussel, Beleidsdomein Landbouw en Visserij: 47.

Diederen P., van Meijl H., Wolters A., Bijak K., 2003. Innovation Adoption in Agriculture: Innovators, Early Adopters and Laggards. *Cahier d'économie et sociologie rurales* 67.

Fearne A., Hughes D., 1999. Success Factors in the Fresh Produce Supply Chain: Insights from the UK. *Supply Chain Management* 4(3): 120-128.

Garcia R., Calantone R., 2002. A critical look at technological innovation typology and innovativeness terminology: a literature review. *The Journal of Product Innovation Management* 19: 110-132.

Gellynck X., Vermeire B., Viaene J., 2006. Innovation and Networks in the Food Sector: impact of regional factors. International European Seminar on Trust and Risk in Business Networks. Bonn, Germany.

Gellynck X., Vermeire B., Viaene J., 2007. Innovation in food firms: Contribution of regional networks within the international business context. *Entrepreneurship & Regional Development* 19(3): 209-226.

Goldenberg J., Lehmann D., Mazursky D., 2001. The idea itself and the circumstances of its emergence as predictors of new product success. *Management Science* 47: 69-84.

Hall A., Sulaiman R.V., Clark N., Yoganand B., 2003. From measuring impact to learning institutional lessons: an innovation systems perspective on improving the management of international agricultural research. *Agricultural Systems* 78: 213-241.

Klerkx L., Aerts N., Leeuwis C., 2010. Adaptive management in agricultural innovation systems: The interactions between innovation networks and their environment. *Agricultural Systems* 103: 390-400.

Knudson W., Wysocki A., Champagne J., Peterson H.C., 2004. Entrepreneurship and innovation in the agri-food system. *American Journal of Agricultural Economics* 86(5): 1330-1336.

Kühne B., 2011. Understanding innovation capacity in food chains: the European traditional food sector. Agricultural economics. Ghent, University Ghent. Doctor in Applied Biological Sciences: 184.

Mann D., 2005. On Innovation Timing. ETRIA TRIZ Future Conference. Graz, Austria.

Maravelakis E., Bilalis N., Antoniadis A., Jones K.A., Moustakis V., 2006. Measuring and benchmarking the innovativeness of SMEs: A three-dimensional fuzzy logic approach. *Production Planning and Control* 17(3): 283-292.

Merriam-Webster, 2013. Company, B.

Morris S., Massey C., Flett R., Alpass F., Sligo F., 2006. Mediating technological learning in agricultural innovation systems. *Agricultural Systems* 89: 26-46.

Nonaka I., Taoyama R., Konno N., 2000. SECI, Ba and leadership: a unified model of dynamic knowledge creation. *Long range planning* 33(1): 5-34.

O'Regan N., Ghobadian A., Sims M., 2006. Fast tracking innovation in manufacturing SMEs. *Technovation* 26: 251-261.

Omta O., 2002. Innovation in chains and networks. *Journal on Chain and Network Science* 2(2): 73-80.

Omta O., 2004. Management of Innovation in Chains and Networks. IN: Camps, T., P. Diederen, G. J. Hofstede and B. Vos. *The Emerging World of Chains and Networks. Bridging theory and practice*. 's-Gravenhage, Reed Business Information.

Pittaway L., Robertson M., Munir K., Denyer D., Neely A., 2004. Networking and innovation: a systematic review of the evidence. *International Journal of Management Reviews* 5-6(3-4): 137-168.

Powell W.W., Koput K.W., Smith-Doerr L., 1996. Interorganizational Collaboration and the Locus of Innovation: Networks of Learning in Biotechnology. *Administrative Science Quarterly* 41(1): 116-145.

Röling N., 2009. Pathways for impact: scientists' different perspectives on agricultural innovation. *International Journal of Agricultural Sustainability* 7: 83-94.

Schumpeter J.A., 1934. The Theory of Economic Development. Cambridge, Harvard Economic Studies.

Scozzi B., Garavelli C., Crowston K., 2005. Methods for modeling and supporting innovation processes in SMEs. *European Journal of Innovation Management* 8(1): 120-137.

Spielman D.J., Ekboir L., Davis K., Ochieng C.M.O., 2008. An innovation systems perspective on strengthening agricultural education and training in sub-Saharan Africa. *Agricultural Systems* 98(1-9).

Sporleder T., Peterson C., 2003. Intellectual capital, learning, and knowledge management in agrifood supply chains. *Journal on Chain and Network Science* 3: 75-80.

Strauss A., Corbin J., 1994. Grounded Theory methodology: An overview. London, Sage Publications.

Taragola N., 2003. Knelpunten en toekomstperspectieven van de Vlaamse snijbloemensector. *C.L.E.-Publication,* 1(05): 70.

Taragola N., Van Huylenbroeck G., Van Lierde D., 2002. Use of information, product innovation and financial performance on Belgian glasshouse holdings. XIIIth IFMA Congress.

Taragola N., Van Lierde D., 2010. Factors affecting the internet behaviour of horticultural growers in Flanders. *Computers and Electronics in Agriculture* 70: 369-379.

Thorpe R., Holt R., Macpherson A., Pittaway L., 2005. Using knowledge within small and medium-sized firms: a systematic review of the evidence. *International Journal of Management Reviews* 7: 257-281.

Van Galen M., Verstegen J., 2008. Innovatie in de agrarische sector: We kunnen er niet genoeg van krijgen! Den Haag, LEI Wageningen: 83.

Van Kleef E., van Trijp H.C.M., Luning P., 2005. Consumer research in the early stages of new product development: a critical review of methods and techniques. *Food Quality and Preference* 16: 181-201.

Van Lierde D., Taragola N., Saverwyns A., 2011. Back to the future - een kritische kijk op vijftig jaar sierteelt in Vlaanderen door bevoorrechte getuigen.

Van Lierde D., Taragola N., Vandenberghe A., Cools A.M., 2007. Differences in attitude of horticultural entrepreneurs towards the introduction of reduction techniques for pesticides and nutrients. XVI[th] IFMA Congress.

Van Lierde D., Taragola N., Vandenberghe A., Cools A.M., 2007. Factors influencing the introduction of reduction techniques for pesticides and nutrients by ornamental plant growers. *Acta Horticulturae* 831(83-92).

DERIVING FULL PRODUCT COSTS FROM FARM ACCOUNTANCY DATA (AN APPLICATION FOR SWISS DAIRY FARMS IN THE MOUNTAIN REGION)

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Abstract

This paper derives the full cost or full product cost for all activities or production branches of a sample of 48 Swiss dairy farms in the mountain region. For this purpose, data from the Swiss Farm Accountancy Data Network (FADN) are used, applying a non-proportional approach for joint cost allocation among production branches. This results in a median full product cost of CHF 2.12 per kilogram of milk, which is in accordance with the literature. In order to cope with potential price cuts in future, labour input per kilogram of milk, which is responsible for 60% of the full product cost, must be substantially reduced.

Key words: full product costs, production branch, dairy, Switzerland, mountain region

1. Introduction

As a non-member of the European Union, Switzerland has a different agricultural policy in place from the common agricultural policy (CAP). The production of milk, Switzerland's most important agricultural commodity, is supported by tariffs on all dairy products except cheese, as well as by subsidies for cheese production. As a result, the farm-gate milk price in Switzerland is substantially higher than in neighbouring regions such as southern Germany or Austria. In 2010, the average price for a kilogram of raw milk was CHF 0.62[1] (Federal Office for Agriculture, 2011), while prices in Bavaria and Austria were CHF 0.43 (EUR 0.31; Agrarmarkt Austria, 2011). A potential free-trade agreement for agricultural commodities between Switzerland and the European Union as currently under discussion would lead to a substantial drop in the producer milk price in Switzerland. Trade liberalisation represents a considerable challenge, especially for dairy farms in less-favoured areas such as the Swiss mountain region. Accordingly, a detailed knowledge of the present cost situation of dairy farms in the mountain region is of major interest. The full cost or full product cost of a kilogram of milk for a large group of dairy farms in the mountain region is a valuable source of information for dairy-farm managers and farm consultants, providing both the absolute size and cost structure of cost items.

Comprising several hundred dairy farms in the mountain region, the Swiss Farm Accountancy Data Network (FADN) provides direct costs for all production branches or activities. Joint-cost items such as labour, machinery or buildings are reported on a farm-wide basis. As usual, the allocation of joint costs to production branches is necessary in full product cost analysis in order to derive full product costs. Although a proportional joint cost allocation has been widely used, Lips (2012) suggested an approach allowing a non-proportional allocation, and applied this for Swiss crop farms. This paper is based on the same method, while extending it to farms with crops and animal husbandry and addressing the situation of Swiss dairy farms in the mountain region.

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1 CHF = Swiss Franc, exchange rates (Feb. 28, 2013): CHF 1 = EUR 0.82; CHF 1 = USD 1.08.

Furthermore, since milk production consists of highly diverse sub-activities such as roughage production, breeding, and of course dairy-cow husbandry, this paper calculates full product costs at the sub-activity level. Subsequently, the full product costs per kilogram of milk are derived.

2. Method

2.1. Direct costs, land costs and joint costs

There are three categories of cost items to distinguish for the analysis: direct costs, land costs and joint-costs. Direct costs such as feed concentrates or veterinary services and products are recorded at the production-branch level by the Swiss FADN, ready to use for full product cost analysis. For land, the average costs per hectare must be calculated assuming homogenous land quality among all plant-production branches except for forest. The FADN provides the total rent for leased land, while the opportunity costs of own land are derived by applying the interest rate of Swiss federal term bonds.

The third class of joint costs such as labour and machinery is available in the FADN for the whole farm. Joint costs must be assigned in order to derive full product costs for production branches. For this, factors or items which are available for all production branches (e.g. area or working hours) are typically used (AAEA 2000). In our case, budgeted or forecasted costs for all joint-cost items and production branches are available at the production-unit level (e.g. hectare or livestock unit). From the FADN, we know the number of hectares or livestock units for all production branches. Consequently, we can calculate the farm-wide costs for joint-cost items such as machinery. In doing so, and assuming that the farm is perfectly in line with the budgeted costs from the farm-management literature, we arrive at the machinery costs of a particular farm, which can be compared to the farm's actual machinery costs as reported by the FADN system. Based on these two figures, an adjustment factor can be calculated to allow adjustment of the budgeted machinery costs per production branch to the absolute size of the farm-wide machinery costs. In other words, the adjustment factor represents the ratio of the observed farm-level costs to the budgeted farm-level costs. Thus, when taken together, the budgeted costs of all production branches form the allocation key which is applied proportionally.

Although the proportional cost allocation outlined above is widely applied for joint-cost items, it has several major drawbacks. Firstly, all production branches are adjusted in the exact same manner. Consequently, the proportions between production branches remain constant. Secondly, all farms under consideration are treated equally.

As an alternative, Lips (2012) suggested a non-proportional joint cost allocation based on maximum entropy. As a precondition, the approach requires budgeted costs from the literature for all production branches and all joint-cost items. Furthermore, the approach is based on the assumption that the resultant joint costs at production-branch level lie in an interval between zero and twice the budgeted costs from the literature. Both interval boundaries are assigned with probabilities adding up to one – for instance, if both boundaries have a probability of 0.5, this yields the value from the literature. If farm-wide costs are greater than suggested in the farm-management literature, the costs resulting after joint cost allocation lie above the budgeted costs for all production branches of the farm. In other words, the probabilities of the upper boundary are higher than 0.5, whilst the lower boundaries have probabilities below 0.5. The 'maximum entropy' approach provides the best probability distribution for all boundaries subject to a total allocation of actual joint costs at the farm level. There is a single solution, the typical outcome of a 'maximum entropy' application which is suitable for overcoming data gaps[2]. This approach leads to a non-proportional adjustment, meaning that production branches with high budgeted costs undergo a more marked adjustment than branches with lower budgeted costs. Generally speaking, maximum entropy provides a probability distribution in which the adjustment of high budgeted costs is more likely than the adjustment of low costs. This corresponds perfectly to agricultural reality, in which the higher the absolute costs, the higher the possibility of cost adjustment. In addition, since the non-proportional joint cost approach is applied separately for each farm, a farm-specific joint cost allocation is provided.

2.2. Definition of production branches

Whereas Lips (2012) focused exclusively on farms with crop production, dairy farms in the mountain region include both animal and plant-production branches. Thus, to allow us to compare several types of animal production, another reference base besides hectares for plant-production branches must be introduced. Given that the necessary inputs for a single animal differ greatly (e.g. laying hen versus dairy cow), the number of animals would be misleading. The livestock unit (LU) is a potentially useful reference base, since necessary inputs have a similar magnitude, an important requirement for joint cost allocation. Accordingly, two reference units – hectares and LU units – are applied for the joint cost allocation.

The definition of production branches is of great importance. For instance, defining just two production branches – dairy production and the rest – does not take full account of deliveries within dairy production (e.g. hay to dairy cows). The fodder produced on-farm for the winter period, such as silage or roughage, can be used to feed dairy cows as well as sheep. Accordingly, we define roughage and silage maize as 'own production' branches[3]. For dairy livestock, we distinguish two production branches: on the one hand, dairy-cow husbandry, including labour-intensive milking; on the other, the breeding of future dairy cows. This distinction is motivated by the substantial variation that exists between farms in terms of organisation. Some farms may outsource breeding, whilst others breed their own future dairy cows on-farm. In total, four production branches are directly connected with dairy production: Silage maize, roughage, dairy-cow husbandry, and breeding.

2.3. Results per kilogram of milk

In order to derive the full product cost per kilogram of milk – an important piece of information for dairy farmers and farm consultants – several steps must be taken to transform the full product cost of the dairy-related production branches. For this, we take advantage of additional data provided by the Swiss FADN, such as quantity of milk produced in kilograms.

As a first step, and based on the full product costs per hectare of silage maize and roughage, we calculate total costs for in-house fodder production by multiplying these values by the corresponding number of hectares. Next, we take the sum of both branches. Assuming that all ruminants require the same amount of fodder per livestock unit, we multiply these costs by the percentage of total ruminants represented by breeding and dairy-cow husbandry (all measured in livestock units).

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[2] The 'true' joint cost allocation can be interpreted as a data gap.

[3] The storage costs for fodder produced on-farm are accounted for in the 'silage maize' and 'roughage' production branches.

Secondly, in order to obtain the total costs of the ‘dairy-cow husbandry’ and ‘breeding’ production branches, we multiply these full product costs per livestock unit by the corresponding number of livestock units. The resultant costs are then added to the costs from step one, yielding the total costs for milk production.

Thirdly, we must bear in mind the different outputs of the composite branch of milk production. In addition to the production of milk, old cows are slaughtered and breeding animals can be sold to other dairy farmers. Assuming a joint production of all outputs, the total costs for dairy production must be multiplied by the percentage of total milk-production turnover represented by milk sales.

Finally, the resultant total costs of milk production are divided by the total number of kilograms of milk produced, less the milk used for breeding, in order to obtain the full product cost per kilogram.

3. Data

Because of the focus on dairy production in the Swiss mountain region, we use the accounts of Swiss FADN specialist dairy farms in mountain zones 1 to 4. A total of 12 production branches are defined in order to depict the typical agricultural activities of these farms. Besides the four dairy-related production branches mentioned in section 2.2 (silage maize, roughage, dairy-cow husbandry, breeding), three further branches dealing with plant production are important: cereals (wheat and barley), forest, and other plant production including potatoes, fruits, vines and specific ecological areas. Another five production branches are devoted to animal production: fattening cattle (including calf fattening), sheep and goats, pork (pig fattening and pig breeding), poultry (poultry fattening and laying hens), and other animals (e.g. horses and donkeys).

The analysis is based on eight cost items in total, of which three are devoted to direct costs: purchased feed (feed concentrates and purchased roughage), veterinary services and products (including insemination), and other direct costs (e.g. seeds, fertilisers, and purchase of animals). Land is treated as a single cost item. Four cost items deal with joint costs: labour, machinery, buildings, and other joint costs (e.g. energy, telephone, insurance, and further training).

As regards labour, the Swiss FADN reports farm-wide labour input measured in working days. Labour is allocated to production branches in form normal working days rather than costs for labour. Working days are then rated with an opportunity cost of CHF 280 (10 hours per normal working day at CHF 28 per hour, Gazzarin, 2011). The machinery costs include depreciation and interest of invested capital as well as repair, maintenance and fuel costs. Machines associated with animal husbandry such as milking parlours are also considered part of machinery costs. Building costs take account of depreciation, interest charges and maintenance.

Since our focus here is on agricultural activities, we exclude farms involved in agriculture-related activities of over CHF 5,000 in value. Otherwise, the allocation of joint costs, especially of labour, would not be possible. Using data from the year 2010, a sample of 48 dairy farms is available. On average, these farms have 15 dairy cows and cultivate 19 hectares of land. Whilst the production branches of roughage, dairy-cow husbandry and breeding are represented on all farms, the other branches are represented by between one and thirty farms in each case (Table 1). The analysis covers 206 production branches in total.

The budgeted costs are provided for all production branches and joint-cost items (Gazzarin et al. 2013; 48 values = 12 production branches x 4 joint-cost items). The values are derived from farm- management literature and calculated at a hectare or livestock-unit level, as appropriate.

4. Results

Table 1 reports the full product costs per hectare or livestock unit for all production branches. In addition to the mean cost value, the minimum and maximum costs for the entire sample of 48 farms are reported.

Table 1. Full product costs for all production branches in CHF per hectare or livestock unit

Production Branch	Unit	Number of Observations	Full Product Costs in CHF per Unit		
			mean	minimum	maximum
Cereals	ha	5	4,245	2,778	5,463
Silage maize	ha	2	8,130	3,708	12,551
Roughage	ha	48	4,580	2,431	8,927
Forest	ha	30	1,003	684	1,315
Other plant production	ha	7	13,621	5,032	25,616
Dairy-cow husbandry	LU	48	8,220	3,515	14,477
Breeding	LU	48	4,734	2,377	10,076
Fattening cattle	LU	1	7,956	-	-
Sheep and goats	LU	6	4,196	2,239	6,369
Pork	LU	5	3,504	2,637	4,822
Poultry	LU	1	3,763	-	-
Other animals	LU	5	4,281	3,050	5,192

ha = hectare; LU = livestock unit

On average, the full product costs of dairy-cow husbandry amount to CHF 8,220 per livestock unit. Among the 48 farms, costs vary between CHF 3,515 and CHF 14,477 per livestock unit, i.e. by a factor of 4.1, thus indicating an enormous heterogeneity between farms. The differences for roughage (factor of 3.7) and breeding (factor of 4.2) are also substantial.

The full product costs derived per kilogram of milk are depicted in Table 2. In the mean of the sample, costs come to CHF 2.49, of which CHF 1.54 or 62% relates to labour, the main cost item. In second place, machinery costs account for CHF 0.36 per kilogram (14%). Cost positions three and four, purchased feed and buildings, respectively, are similar in size, accounting for around 7% each.

The resultant full product costs of three specific farms from the sample allow us to assess the heterogeneity in greater detail. Whereas the best farm has full product costs of CHF 1.23 per kilogram, the worst farm has a value six times larger, indicating an outlier. The median farm in terms of full product costs of milk has costs of CHF 2.12 per kilogram. Different production technologies might to some extent explain the differences in labour and building costs between the best and

Table 2. Full product costs in CHF per kilogram of milk

	Mean		Best Farm	Median Farm	Worst Farm
	CHF	in %			
Purchased feed	0.18	7.4	0.20	0.28	0.18
Veterinary	0.05	2.2	0.04	0.03	0.14
Other direct costs	0.06	2.4	0.02	0.05	0.12
Land	0.04	1.4	0.03	0.00	0.06
Labour	1.54	61.9	0.55	1.44	5.42
Machinery	0.36	14.4	0.19	0.19	0.83
Buildings	0.15	6.2	0.15	0.03	0.61
Other joint costs	0.10	4.1	0.05	0.11	0.20
Total	2.49	100.0	1.23	2.12	7.56

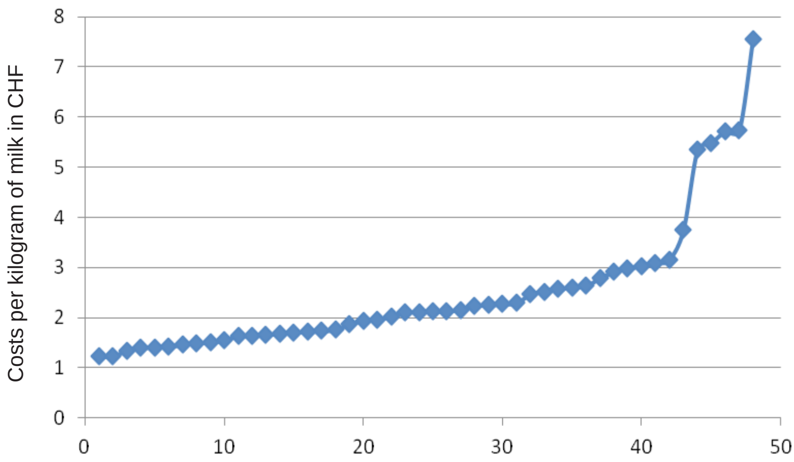

Figure 1. Distribution of full product costs for a kilogram of milk

the median farm. The best farm has probably invested in new buildings, enabling a substantial savings in working hours.

Figure 1 shows the full product costs per kilogram of milk for all farms in the sample. Between CHF 1.23 (best farm) and CHF 3.17 (42^{nd} farm) there is a line with more or less the same slope, indicating that there are not even two farms with identical costs. Otherwise, groups of farms with similar costs would lead to several areas of the line with different slopes. At the far right of the graph, six farms with costs of over CHF 3.50 per kilogram are depicted, clearly indicating that a minority of dairy farms are either subject to specific circumstances (e.g. an extreme event), or have production systems that scarcely reflect economic realities.

5. Discussion and conclusions

Our results can be compared with two analyses of Swiss dairy farms in the mountain region. A typical Swiss dairy farm with 18 cows is included in the annual dairy report of the International Farm Comparison Network (IFCN, Hemme 2012) quoting costs of USD 2.42 or CHF 2.15 per kilogram, which are very close to those of our median farm. Haas and Höltschi (2012) analyse full product costs of 26 dairy farms in the mountain region with an average of 22 cows. They found that the average full product costs come to CHF 1.54 per kilogram of milk. Two reasons may account for the differences between the full product costs observed by Haas and Höltschi (2012) on the one hand and in our study on the other. Firstly, the dairy farms of the sample investigated by Haas and Höltschi are clearly larger than ours (22 cows on average as compared to 15 cows in our sample). Secondly, in the Haas and Höltschi sample, all participating farm managers regularly calculate their full product costs per kilogram of milk and compare their results in working groups, which represents a substantial effort in farm management. The said farm managers are therefore greatly interested in production costs, and can be assumed to have implemented cost-reducing measures. Consequently, their full product costs are markedly lower than those of the FADN sample.

Comparisons with the literature show that the applied approach leads to meaningful results. Furthermore, the comparison with Haas and Höltschi (2012) highlights just how important the attitude of the dairy-farm manager is.

Bearing in mind that the average milk-producer price in Switzerland is around CHF 0.60 per kilogram, we may draw the general conclusion that dairy production of the analysed sample (average CHF 2.49, median CHF 2.12) does not even come close to covering costs. Accordingly, a substantial part of the direct payments is used to cover production costs. In 2010, direct payments averaged CHF 73,000 per dairy farm in the mountain region (Mouron and Schmid, 2012). In addition, the assumed hourly wage of CHF 28 is far higher than is usually paid in practice.

The cost structure reveals that labour is the main cost driver, being responsible for around 60% of full product costs. In order to cope with the additional price pressure that would result from a potential free-trade agreement between Switzerland and the European Union, the labour input per kilogram of milk must be reduced substantially. In addition, costs for purchased feed and machinery, both accounting for between 30 and 60% of the producer milk price, must be reduced.

Consequently, there are two main conclusions for dairy farmers and farm consultants. Firstly, the efficiency of purchased feed must clearly be increased. Secondly, and more importantly, labour and machinery inputs must be reduced – an objective which would appear to be possible, to judge by the dairy farm with the lowest costs in the sample. For this purpose, taking advantage of economies-of-scale effects by e.g. starting a cooperation with other farmers should prove a promising strategy.

6. References

AAEA, 2000. Commodity Costs and Returns Estimation Handbook, a report of the AAEA Task Force on Commodity Costs and Returns, American Agricultural Economics Association, Iowa State University, Ames.

Agrarmarkt Austria, 2011. Marktbericht Milch und Milchprodukte Oktober 2011, 10th edition, Vienna. http://www.ama.at/Portal.Node/ama/public?gentics.rm=PCP&gentics.pm=gti_full&p.contentid=10008.97020&10_Marktbericht_Milch_Milchprodukte_10_2011.pdf [accessed 15 February 2013].

Federal Office for Agriculture, 2011. Marktbericht Milch, Bundesamt für Landwirtschaft (Federal Office for Agriculture), November 2011, Bern.

Gazzarin C., 2011. Maschinenkosten 2011, ART-Bericht 747, Agroscope Reckenholz-Tänikon Research Station ART, Ettenhausen.

Gazzarin C., Mouron P., Anspach V., 2013. Übersicht Ausgangswerte, internal working document, Agroscope Reckenholz-Tänikon Research Station ART, Ettenhausen.

Haas T., Höltschi M., 2012. Vollkosten-Auswertung 2012, Agridea und BBZN Hohenrain, Hohenrain.

Hemme T. (Ed.), 2012. IFCN Dairy Report 2012: for a better understanding of milk production worldwide. International Farm Comparison Network Dairy Research Center, Kiel.

Lips M., 2012. Joint Cost Allocation by Means of Maximum Entropy, 28th International Conference of Agricultural Economists, Foz do Iguaçu, Brazil, August 18-24.

Mouron P., Schmid D., 2012. Grundlagenbericht 2011, Agroscope Reckenholz-Tänikon Research Station ART, Ettenhausen.

FACTORS CONSTRAINING PARTICIPATION OF SWAZILAND'S MUSHROOM PRODUCERS IN MAINSTREAM MARKETS

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Abstract

Mushrooms have been cultivated in Swaziland since 2001 as part of a long-term programme which seeks to improve rural livelihoods through commercial production of non-conventional high-value commodities. Despite the availability of niche markets and various forms of support received by producers, Swaziland is still a net importer of locally consumed mushrooms. This study uses a value chain approach to identify the underlying factors constraining local production and producers' participation in mainstream markets. Understanding the nature of these constraints is very important from a policy perspective as this process will inform the formulation of improved market access strategies required to achieve the programme's overall objective. The findings indicate that availability of marketable surplus is affected by production constraints emanating from lack of access to key inputs and services, which are more centralised and fully controlled by the government. While producers currently receive a minimum of about 64% share of the consumer price, their efforts to participate more profitably in mainstream markets are hampered by poor value chain governance and lack of vertical coordination, subjecting both producers and buyers to various forms of transaction costs. In attempting to address the identified constraints, this study makes several recommendations, which are reflective of producers' socio-economic status and Swaziland's institutional environment.

Key words: mushrooms, market participation, value chain, Swaziland

1. Introduction

Prior to 2001 mushrooms were not cultivated in Swaziland and their introduction was part of a United Nations Development Programme (UNDP)-funded initiative meant to assist Swaziland towards diversifying its agricultural base and improving rural livelihoods. The adopted strategy promotes the production of non-conventional high-value commodities (HVCs) that have not been explored by local farmers despite having a relatively high market demand in local and international markets. Currently, Swaziland's priority is placed on the oyster mushroom (*Pleurotus* spp) because it is the easiest and least expensive to grow (Chang and Miles, 2004). In contrast to other high-value food commodities (e.g., vegetables), mushrooms have relatively high levels of proteins, vitamins, dietary fibre and inorganic minerals (Guillamón *et al*., 2010). More importantly, they are effective in enhancing the human body's defence against various types of cancers, viral infections (including HIV), diabetes, constipation and cardiovascular diseases (Roupas *et al*., 2012). Typical of HVCs, which are known for having a relatively high income elasticity of demand (Jaffee, 1995), cultivated mushrooms are largely consumed by the urban working class and people with special diet preferences. These consumers usually purchase mushrooms from supermarket chain

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stores, whose procurement policies provide an opportunity for small-scale farmers to participate in mainstream markets, enabling them to generate substantial returns (Emongor and Kirsten, 2009). With over 63% of Swazis living below the US$2/day poverty line, of whom 75% reside in the rural areas (Government of Swaziland (GoS), 2011a), integration of rural-based small-scale producers into mainstream supply chains can enhance Swaziland's fight against poverty, food insecurity and rural-urban migration.

Despite the availability of niche markets for local producers, over 95% of mushrooms consumed in Swaziland are currently imported (Mamba, 2010). Since the mushroom development programme was incepted in 2001, no research has been done to study the underlying factors constraining local production and producers' access to markets, an objective that this study seeks to accomplish. While a considerable number of studies have been done in Southern Africa on this subject (see Ortmann and King, 2010, for a review), mushrooms have not featured in the debate and previous findings and recommendations cannot be generalised because of different commodity characteristics and institutional environments. Another point of departure is the use of a value chain approach (VCA), which enables the study to better identify unexploited opportunities and in response prioritise interventions that could improve operations at various stages of the entire chain. The following section outlines the data collection procedures. The results are presented in section 3, while section 4 concludes the article with policy recommendations.

2. Data collection

A "snowball" method (Goodman, 1961) was used to collect data from value chain actors. Initially, data were collected from a sample of 91 mushroom producers located in all the country's four agro-ecological regions who identified sources of inputs and mushroom buyers. Interviews with input suppliers and market intermediaries also identified other actors and institutions influencing the value chain. Given the very low number of identified input suppliers and market intermediaries, it was not necessary to generate samples beyond the production stage. Therefore, interviews were conducted with representatives from all organisations identified by producers and other interviewees. The organisations comprised of three suppliers of production inputs, three mushroom training and extension service providers , six suppliers of marketing inputs, 19 mushroom buyers (five hotels, three restaurants, 11 supermarket chain stores, and two fruit and vegetable traders), and three public institutions responsible for enforcing agricultural marketing and trade regulations in Swaziland. Data from producers were gathered between December 2011 and January 2012, whereas interviews with other value chain actors were conducted between June and July 2012. Additional information came from site visits where activities related to mushroom production and marketing were directly observed. The next section presents the study results in a format that follows the mushroom value chain, highlighting the main activities and constraints encountered in every stage.

3. Results

3.1. Production of oyster mushrooms

The first activity in mushroom production relates to spawn (seed) development, which is currently done by the government through the Mushroom Development Unit (MDU). Government's justification for having one supplier is that, as the industry is relatively new, consumers need to be protected from poisonous types of mushrooms, and producers from unscrupulous suppliers who may provide them with a low quality product. The substrate bags, from which the mushrooms are grown, are donated by the government of Thailand and distributed by the MDU to producers for free. Substrate materials are readily available countrywide. However, the technology used to prepare the material, also donated by the government of Thailand, is available in four areas countrywide and not easily accessible to producers. After inoculation (planting), the bags are kept in an incubation room for about three to four weeks and will thereafter be ready to produce mushrooms. The incubation room is only available in one location and can only accommodate a limited number of bags at a time. After this period, the bags are withdrawn and transported by the MDU to producers' growing houses. Currently, producers are not charged for transportation of inoculated bags. While some producers have managed to construct their own incubation houses, the limited number of access points for spawn and substrate preparation technology makes it difficult to increase production capacities.

3.2. Marketing of oyster mushrooms

Currently, no cultivated mushrooms are exported from Swaziland and producers have not yet engaged in any form of mushroom processing. Instead, from what they harvest, about six to ten percent is consumed at household level and the remainder sold through four channels identified as:
- Channel I (Farm gate): Producers → Consumers;
- Channel II (Retail market): Producers → Supermarkets → Consumers;
- Channel III (Middlemen): Producers → Middlemen → Supermarkets → Consumers;
- Channel IV (Food services industry): Producers → Restaurants/hotels → Consumers.

About 528 kg of fresh oyster mushrooms were traded by the sampled producers between November 2011 and January 2012 through the identified channels. Further analysis indicated that 42% was sold through the farm gate and 52% through the retail market, whereas 2 and 4%, respectively, were sold through middlemen and the food services industry. Consumers at the farm gate are generally comprised of rural community members, whereas in the retail market and food services industry they include the urban working class, tourists and customers with special diet preferences. Restaurants and hotels sell processed mushrooms unlike retail outlets where raw mushrooms are marketed.

Middlemen consist of "entrepreneurial" mushroom producers who are able to negotiate better deals with some retail outlets. These producers buy already-packed mushrooms from their counterparts at the farm gate price for onward sale at a better price; hence, benefitting from the margin. Because of low locally-produced volumes, supermarket chain stores, the major mushroom traders, often source a relatively large proportion of their mushroom stock through their South African-based distribution centres. Together with restaurants and hotels, supermarkets also buy from local fruit and vegetable traders who import mushrooms from South African fresh produce markets. In the absence of stock from private traders, restaurants and hotels buy imported mushrooms from local supermarkets. Details on imports from traders could not be obtained due to the sensitivity of such proprietary information. However, information gathered from mushroom traders indicates that because its flavour and appearance, the button mushroom (A*garicus* spp), currently not produced in Swaziland, has a relatively high consumer demand compared to the oyster. Marketing margins and market intermediaries' share of consumer price are discussed in the next section.

3.3. Marketing margins and intermediaries' share of consumer price

Following Hardesty and Leff (2009), marketing costs and returns, as shown in Table 1, were estimated using value chain actors' description of the chronological sequence of activities performed from the period when mushrooms are harvested to the point when they are finally sold to consumers.

Computations were made on a per unit basis (kg of fresh mushrooms) for a producer who manages an enterprise of 400 substrate bags, the minimum enterprise size for sampled producers, assuming he/she supplies the same amount of mushrooms to the identified alternative marketing channels. Marketing costs comprise of costs of packaging materials, labour and transportation costs. Even though producers do not use hired labour, labour costs were estimated based on the average time taken to perform each marketing activity and Swaziland's official minimum wage rates.

Upon receiving the already-packed mushrooms, supermarkets screen them for quality using their own procedures which are based on visual inspection for browning, weight loss and microbial spoilage. The mushrooms are then displayed in refrigerators and generally sold out within a day. Restaurants and hotels add value by cooking the mushrooms as part of different recipes. However, given that mushrooms are rarely cooked alone, but in combination with various food products and ingredients, costing the value added by the food services industry proved to be an insurmountable challenge. Hence, the analysis for channel IV could not be included in this discussion.

Table 1. Market intermediaries' share of oyster mushroom consumer price in Swaziland, 2012

Marketing channels[*]	Market intermediaries	Particulars of marketing	E/kg[**]	Share of consumer price[***]
I	Producer	Marketing costs (MC)	5.67	100%
		Sale price (SP) to consumer	41.00	
II	Producer	Marketing costs (MC)	10.34	80.3%
		Sale price (SP) to retailer	51.80	
	Retail	Purchase price (PP)	51.80	19.7%
		Marketing costs (MC)	0.25	
		Sale price (SP) to consumer	64.53	
		Marketing margin (MM = SP - PP)	12.73	
III	Producer	Marketing costs (MC)	5.09	63.5%
		Sale price (SP) to consumer	41.00	
	Middlemen	Purchase price (PP)	41.00	16.7%
		Marketing costs (MC)	9.38	
		Sale price (SP) to retailer	51.80	
		Marketing margin (MM = SP - PP)	10.80	
	Retail	Purchase price (PP)	51.80	19.7%
		Marketing costs (MC)	0.51	
		Sale price (SP) to consumer	64.53	
		Marketing margin (MM = SP - PP)	12.73	

Notes:
[*] Channel IV is not included for reasons explained in the text.
[**] 'E' denotes Emalangeni, the Swaziland currency. E1 = US$ 0.1086 on 18th April 2013 (Central Bank of Swaziland, 2013).
[***] Share of consumer price indicates the magnitude of returns earned by different market intermediaries in each channel. It is expressed as a percentage of the price paid by the final consumer. See Shepherd (2007) for details on the methodology.
Source: Survey data (2011/12)

Under the current programme, where farmers are supported with free substrate bags and transportation of inoculated bags, the cost of producing oyster mushrooms was estimated at E8.99/kg, with returns over variable costs of about E27.91/kg. Without the support, production costs would increase by approximately E3.57/kg. Table 1 shows that producers' share of the consumer price in all marketing channels are relatively larger than shares of other market intermediaries. In terms of net returns, producers earn E25.35/kg from selling at the farm gate, E25.92/kg from selling through middlemen and E20.67/kg from selling directly to the retail market. Even though the net returns are comparatively lower from selling directly to the retail market, mainly as a result of transportation costs, producers prefer this option as it offers a relatively more stable and dependable market. Besides the absence of written marketing contracts and having less bargaining power in setting exchange prices, producers do not have to rely on unpredictable buyer turnout as is the case with the farm gate option. Major institutional factors constraining mushroom production and value-addition are discussed in the following section.

Marketing institutional environment

When the mushroom programme was incepted, a formal market was established with the National Agricultural Marketing Board (NAMBoard), which collected mushrooms from producers using a refrigerated van. However, because of the limited production capacity and inconsistent supply, NAMBoard (a government parastatal) withdrew its support after two years, leaving producers to establish their own informal marketing arrangements. Ironically, mushrooms are listed under NAMBoard's scheduled products, implying that for every import of mushrooms, the parastatal receives a levy equivalent to 7.5% of the total value. Government's regulations dictate that NAMBoard should use the levy to develop local capacity to produce the same commodity (GoS, 2011b). However, in spite of Swaziland importing over 95% of locally consumed mushrooms valued at about E2.4 million annually (NAMBoard, 2012), no tangible investment has been made by NAMBoard in the mushroom industry thus far.

Despite the various forms of mushroom processing opportunities (see Rai and Arumuganathan, 2008), substantial investment in commercial processing and value-addition in Swaziland is partly constrained by the unfavourable regulatory framework. For instance, Swaziland's Canning Control Act (GoS, 1961) gives the power for controlling the development of food processing and marketing to the Minister of Agriculture through issuing of licences. This Act, which also gives the Minister the prerogative to issue an exclusive "canning" licence to "any person for such period as he may deem fit", hinders the participation of prospective investors. In view of the possible increase in market supply (as a result of diversification, improved production capacity and staggered production schedules), parallel plans are required to establish an integrated value chain governance system. Drawing from the identified constraints, the next section presents possible options that could be considered in fulfilling the above expectations.

Possible interventions for upgrading the mushroom value chain governance and coordination system

While Swaziland currently prioritises the oyster mushroom, this study highlights the importance of other types of mushrooms, especially the button. Diversification could create a demand for more inputs. Substrate availability should not be a major challenge given the abundance of agricultural and industrial waste in Swaziland. However, considering that training, spawn production and the technology used for substrate preparation are centralised and only offered by the government, it would benefit the entire industry if such services are privatised allowing the government to assume a monitoring role. Despite that buyers did not identify quality as one of their major concerns, the absence of measurable quality standards subjects producers to having their mushrooms bought at lower prices or even rejected without justification. Furthermore, as the industry expands, parallel trade in wild mushrooms is likely to emerge. In the absence of mushroom food safety standards, this kind of trade could compromise the lives of consumers and the industry's reputation as desperation for income could lead to opportunists selling even the poisonous type of mushrooms to unsuspecting consumers.

With the current lack of coordination in mushroom marketing, major buyers are not spared from encountering transaction costs, given the small-scale exchanges they engage in with individual producers. However, changes that could allow the same volume of business to be concentrated in a smaller number of relatively larger and more secure transactions would benefit buyers and producers alike. This can be made possible by promoting collective marketing through farmer groups. In view of the sparse distribution of producers, marketing and transaction costs could also be reduced by establishing collection centres (fitted with cold storage facilities) in strategic areas and using refrigerated vans to convey mushrooms from these centres to mainstream markets. These assets would be important in preserving product quality and freshness.

Considering that current mushroom producers have limited agribusiness exposure, some form of assistance would be required to improve their competitiveness in the value chain. Engaging a facilitator who would, among other expectations, provide information and technical assistance could enhance producers' prospects to even venture into export markets. While a number of agencies, such as NGOs, could be considered, NAMBoard would be better suited for this role. Despite their subdued performance since establishment in 1985, some positive lessons could be drawn from NAMBOARD's recent experience in linking local vegetable producers with export markets and the attainment of Global Good Agricultural Practice (Global G.A.P) certification. Hence, an option that could be viable under the current environment would be to use the revenue generated from mushroom import levies to fund the establishment of collection centres and purchase of refrigerated vans, which would operate under joint management of NAMBoard and mushroom producing groups. NAMBoard, working jointly with farmer groups, would assume the responsibility to find remunerative markets. In order to sustain the groups' activities and cover recurrent expenses, a small fee per kg of mushrooms sold could be deducted from individual sales. Similar strategies were successfully implemented to assist Kenyan small-scale milk and banana producers (Staal *et al.*, 1997; Fischer and Qaim, 2012).

4. Conclusions and policy recommendations

This study sought to identify the underlying factors constraining mushroom production and producers' access to markets in Swaziland. Using a value chain approach, the results indicate that producers' plans to expand production capacities and improve consistency in market supply are hampered by the difficulty in accessing key inputs such as spawn, substrate preparation technology and incubation services. Other constraints relate to the lack of diversification as farmers currently produce the oyster mushroom, yet major buyers are interested in the button, which has a relatively high consumer demand. Although producers currently realise a relatively larger share of the consumer price, more benefits could be realised if certain services currently offered by the government could be privatised. In view of the possible increase in market supply, it is important that an integrated value chain governance system is established in an attempt to enhance market access and facilitate the movement of mushrooms from producers to consumers.

5. References

Central Bank of Swaziland, 2013. Currency rates. Available at http://www.centralbank.org.sz/ (Accessed 18 April 2013).

Chang S.T., Miles P.G., 2004. *Mushrooms: Cultivation, Nutrition Value, Medicinal Effect, and Environmental Impact*. Second edition, Florida, USA: CRC Press.

Emongor R., Kirsten J., 2009. The impact of South African supermarkets on agricultural development in the SADC: A case study in Zambia, Namibia and Botswana. *Agrekon* 48(1):60−84.

Fischer E., Qaim M., 2012. Linking smallholders to markets: Determinants and impacts of farmer collective action in Kenya. *World Development* 40(6):1255-1268.

Goodman L.A., 1961. Snowball sampling. *The Annals of Mathematical Statistics* 32 (1):148−170.

Government of Swaziland (GoS), 1961. Canning Control Act of 1961. Ministry of Justice, Mbabane.

GoS, 2011a. Poverty in a decade of slow economic growth: Swaziland in the 2000's. Central Statistics Office, Ministry of Economic Planning and Development, Mbabane.

GoS, 2011b. Swaziland's notification on import permits required for importation of certain products and levies charged. Ministry of Commerce, Industry and Trade, Mbabane.

Guillamón E., García-Lafuente A., Lozano M., D'Arrigo M., Rostagno M.A., Villares A., Martínez J.A., 2010. Edible mushrooms: Role in the prevention of cardiovascular diseases. *Fitoterapia* 81(7):715-723.

Hardesty S.D., Leff P., 2009. Determining marketing costs and returns in alternative marketing channels. *Renewable Agriculture and Food Systems* 25(1):24-34.

Jaffee S., 1995. Transaction Costs, Risks and the Organisation of Private Sector Food Commodity Systems, in *Marketing Africa's High-Value Foods*, edited by S. Jaffee and J. Morton, Iowa, USA: Kendall/Hunt Publishing Company, pp.21-62.

Mamba S., 2010. Jobs galore in mushroom farming. Business and Farming, Swazi Observer, Friday, 10 September 2010.

National Agricultural Marketing Board (NAMBoard), 2012. Trade Commodities and Levy Charges report for 2012 financial year, NAMBoard, Manzini.

Oei P., 1991. *Manual Cultivation: Techniques, Species and Opportunities for Commercial Applications in Developing Countries*. Leiden: Tool Publications.

Ortmann G.F., King R.P., 2010. Research on agri-food supply chains in Southern Africa involving small-scale farmers: current status and future possibilities. *Agrekon* 49(4):397-417.

Rai R.D., Arumuganathan T., 2008. Post-harvest technology of mushrooms. Technical Bulletin. National Research Centre for Mushrooms, Indian Council of Agricultural Research, Chambaghat, India.

Roupas P., Keogh J., Noakes M., Margetts C., Taylor P., 2012. The role of edible mushrooms in health: Evaluation of the evidence. *Journal of Functional Foods* 4(4):687-709.

Shepherd A.W., 2007. A guide to marketing costs and how to calculate them. Rural Infrastructure and Agro-Industries Division, Rome: Food and Agriculture Organisation.

Staal S., Delgado C., Nicholson C., 1997. Smallholder dairying under transaction costs in East Africa. *World Development* 25(5):779-794.

PRICE TRANSMISSION IN THE BEEF VALUE CHAIN – THE CASE OF BLOEMFONTEIN, SOUTH AFRICA

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Abstract

A concern that is frequently raised by livestock farmers is the relationship between the producer- and retail prices. A perception also exists among producers that the market prices are set by the retailers. The objective of this study thus is to determine if these problems do exist. According to the results obtained from the statistical analysis it is clear that the allegations of the red meat farmers and feedlots is not true in most of the cases. The analysis indicated that three of the four investigated retailers do follow the same price trend and that there is a bi-directional relationship between the retail and carcass prices in two of the instances. It is however recommended that asymmetry in price transmission in the Bloemfontein beef value chain be tested as more data becomes available.

Keywords: beef, value chain, price transmission

1. Introduction and problem statement

Since the deregulation of the agricultural markets in South Africa there has been an increasing trend of concentration in certain businesses in agricultural value chains and in turn could result in anti-competitive behaviour. A frequently proxy used for oligopolistic or monopolistic behaviour is the nature of price transmission in a particular value chain (Spies, 2011).

Due to the above, a concern that is frequently raised by livestock farmers is the relationship between the producer- and retail prices, or the variation in the price margin between the carcass price that the farmer or feedlot receive and the retail price that the consumer pays. A perception also exists among producers that the market prices are set by the retailers. The Free State Red meat Producers Organisation (FSRPO) has tasked the department of Agricultural Economics at the University of the Free State to investigate the price transmission in the Bloemfontein area of the Free State Province, South Africa.

The objective of this study is to determine if the retail prices are derived from the carcass price and if these prices follows the same trend. To achieve the above mentioned the following have to be done:

- determine the order of integration of price variables,
- determine the long run relationship between carcass and retail prices,
- determine the direction of causality between the price variables.

2. The South African beef value chain and price formation

The South African beef value chain is represented in Figure 1. Although there may be some parts of the value chain that was not included in the figure, this version was simplified to focus more specifically on the problem of price transmission and the specific linkages that are addressed in this study. The main role players in the South African beef value chain are the:

- **Farmers (Producers).** There are approximately 37 500 commercial, 240 000 emerging and 3 million subsistence beef cattle farmers in the country (Spies, 2011). The breeds and production methods differ between farms and production regions. Most of the farmers make use of the weaner production system, where the weaned calves of approximately 7 months of age are sold to a feedlot. Some of the indigenous breeds can however be raised on the natural grazing and are directly send to an abattoir for slaughtering.
- **Feedlot sector.** Between 65 and 70% of all cattle that are slaughtered in South Africa come from the feedlot sector. Feedlots buy the weaned calves at an approximate weight of 230kg (live) and then increase the weight to 400kg (live) over a period of approximately 113 days before it is slaughtered. Feedlots with different standing capacities, from a few animals to more than 110 000 animals, exist in South Africa. The total standing capacity of the feedlot industry is about 450 000 animals at any given point in time, delivering approximately 1.5 million animals annually (Spies, 2011).

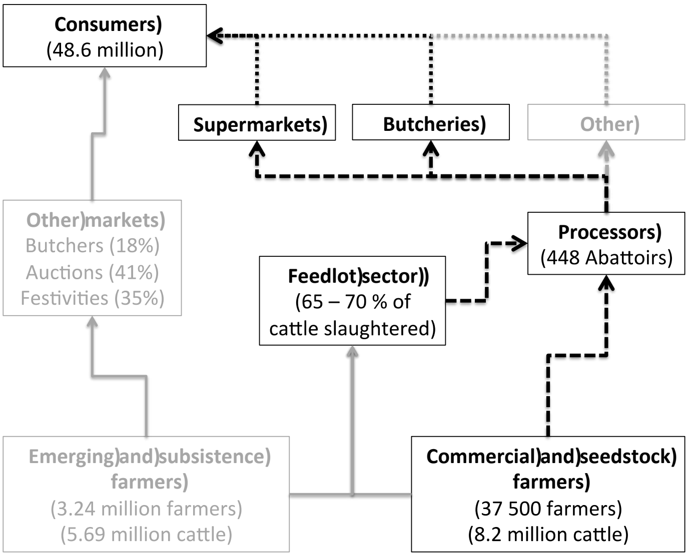

Figure 1. South African beef value chain
Source: Adapted from Spies 2011

- **Other markets.** The other markets in the beef value chain include, but are not limited to, informal butchers (18%), auctions (41%) and festivities (35%). Most of the cattle from the emerging or small-scale sector enter these markets but some animals from commercial farmers may also be sent through these channels.
- **Abattoirs (Commodity processors).** The abattoir sector plays a very important role in the beef value chain as it transforms live animals to meat. Throughout South Africa there are approximately 488 red meat abattoirs slaughtering from 2 to 1500 units per abattoir per day (Spies, 2011). Many of the large feedlots own their own abattoirs and are thus vertically integrated.
- **Retailers (Food product processors).** Retailers in this study are considered as all outlets selling red meat products and include, but is not limited to, supermarkets and butcheries. There are 4 large supermarket chains in South Africa and numerous independent butcheries and other outlets of beef. The supermarkets usually have a butchery that processes the carcasses

to different cuts of meat and other products. The consumer buys the final product direct from one of the retailers.

- **Consumers.** In South Africa there are approximately 48.6 million consumers of beef with an average per capita consumption of 17,96 kg / year.

The black areas and linkages in Figure 1 are those that form part of this study while the grey areas were omitted. The one set of price data that was used for this study was received from the Red Meat Abattoir Association (RMAA) and are the carcass prices that they pay to the producer or feedlot. The abattoir then sells these carcasses to the supermarkets and butcheries for the same price they bought it for as their profit comes from the fifth quarter of the carcass that is sold separately. The other set of price data is the retail prices for meat that was collected on a weekly basis at three supermarkets and a butchery in Bloemfontein. The supermarkets and butchery process the carcasses and then sell the individual cuts at a price that reflects the value of the specific cut, the margin of the supermarket and the Value Added Tax (VAT) on the product.

If the carcass price and the retail price rump steak are compared in a graph it is clear to see that there seems to be a problem. Figure 2 indicates that the retail price of rump steak do not follow the same trend as the carcass price. The retail price used in the graph is only representative of one supermarket, but allowing small differences the prices of the other supermarkets and butchery basically looks the same.

It must however be remembered that a carcass consists of more than one cut and that assumptions cannot be made on the comparison of only one of the higher value cuts. The representative retail price of the carcass that the supermarket sells it for must be calculated using the retail prices of different (high and low value) cuts.

Table 1 gives an indication of the standard "Block Test" that is used by abattoirs to determine the retail prices for the different cuts. The factor assigned to each cut gives an indication of the value of the specific cut. The percentage of the cut as related to the total carcass stays the same, but retailers may vary the factor according to the demand for the product. The factor multiplied

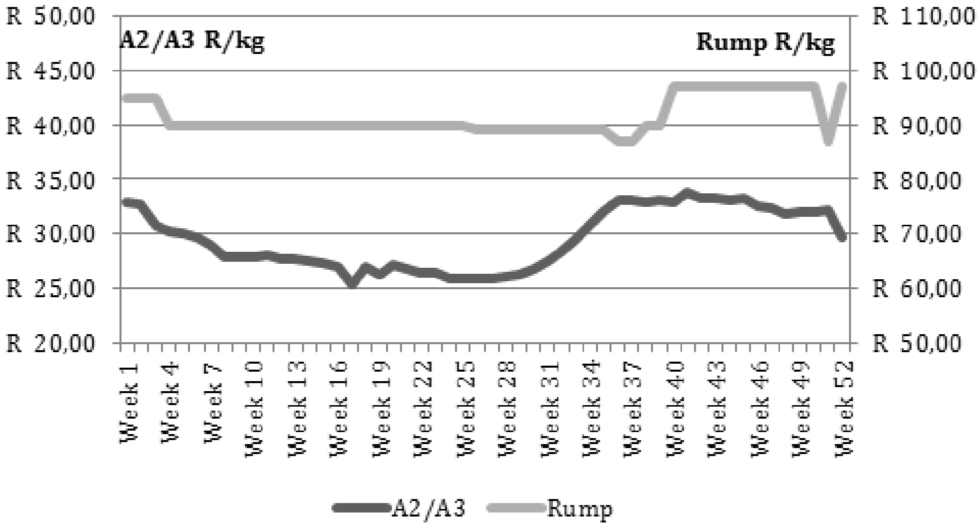

Figure 2. Comparison between the carcass price and retail price of rump
Source: RMAA (2012) and own data

Table 1. Block test for beef price formation

Carcass	R32.86/kg	220 kg									
Fore quarter 52%						Hind quarter 48%					
Cut	%	Kg	Factor	R/kg	R/kg 30% Margin Incl. VAT	Cut	%	Kg	Factor	R/kg	R/kg 30% Margin Incl. VAT
Whole quarter/Kg	100	114.4	1	R 23.82	R 35.31	Whole quarter/Kg	100	105.60	1.00	R 41.90	R 62.09
Body fat	2.82	3.23	0.5	R 11.91	R 17.65	Body fat	3.73	3.94	0.52	R 21.79	R 32.29
Shoulder	34.66	39.65	1.6	R 38.12	R 56.49	Bone lean	14.7	15.52	0.12	R 5.03	R 7.45
Bone lean	19.77	22.62	0.2	R 4.76	R 7.06	Bone with meat	2.42	2.56	0.97	R 40.64	R 60.23
Bone with meat	0	0.00	0.5	R 11.91	R 17.65	Cutting loss	1	1.06		R -	R -
Brisket	14.5	16.59	0.9	R 21.44	R 31.78	Fillet	2.4	2.53	2.62	R 109.77	R 162.68
Chuck	0	0.00	1.3	R 30.97	R 45.90	Short loin	0	0.00	1.80	R 75.41	R 111.76
Cutting loss	1	1.14		R -	R -	Rump	5.14	5.43	1.96	R 82.12	R 121.70
neck,bone in	1	1.14	1.3	R 30.97	R 45.90	Shin	4.13	4.36	0.97	R 40.64	R 60.23
Prime rib	3.76	4.30	1.3	R 30.97	R 45.90	Silverside	9.82	10.37	1.50	R 62.84	R 93.14
Back fillet	0	0.00	2.5	R 59.56	R 88.27	Sirloin	4.48	4.73	1.95	R 81.70	R 121.08
Shin bone in	0	0.00	0.8	R 19.06	R 28.25	Short rib	5.79	6.11	0.97	R 40.64	R 60.23
Short rib	4.93	5.64	0.8	R 19.06	R 28.25	T-bone	7.58	8.00	1.80	R 75.41	R 111.76
Bolo	1	1.14	1.3	R 30.97	R 45.90	Thick flank	3.69	3.90	1.40	R 58.66	R 86.93
Trimmings	16.56	18.94	0.89	R 21.20	R 31.42	Topside	7.59	8.02	1.50	R 62.84	R 93.14
						Trimmings	27.53	29.07	0.52	R 21.79	R 32.29
Closing balance	100	114.4		R 2 726.51	R 4 040.69	Closing balance	100	105.60		R 4 424.82	R 6 557.58
						Total (Carcass)				R 7 151.33	R 10 598.27

Source: Spies (2011) and own calculations

with carcass price calculates the price the retailer will sell the specific cut for after including a margin (approximately 30%) and Value Added Tax (14%).

3. Data and methods

The carcass price in Table 2 of grade A2/A3 carcasses was received from the RMAA on a weekly basis for the year 2012. These prices represent the average price that abattoirs paid producers (farmers/feedlots) for the carcasses in South Africa. Although these prices may differ a bit between regions the difference is relative small and the country average price thus remains a good indication.

The retail prices in Table 2 were collected from three supermarkets (S1, S2 & S3) and a butchery (B) in Bloemfontein on a weekly basis by visits to these outlets once a week. The retailers that were used are all situated in one extension of Bloemfontein and thus attract buyers with more or less the same purchasing power and preferences. The prices of three different cuts were used in the analysis. To calculate good representative carcasses price the data for fillet (high value), rump (medium value) and stew (low value) were used. The prices of the individual cuts were divided by the factor and the average calculated price then serves as the carcass price the retailer sells the beef for. The data is already adjusted for a two-week lag interval between the carcass price and the retail price allowing for the time it takes to process the carcasses and get the individual cuts on the shelves.

The methodology employed in this paper entailed three steps. The first step was the unit root test. This step is to confirm the order of integration of the variables used. The unit root test was conducted by the Augmented Dickey-Fuller (ADF) test statistics under the assumption that the series in question is non- stationary around fixed time trend (Dickey and Fuller, 1981). If the hypothesis cannot be rejected then a single difference will be performed to ensure that all variables are stationary.

The second step, once statistical properties of variables are confirmed, is to conduct the co-integration tests. The Johansen (1998) methodology is applied in this study. The test is about testing the rank of π in equation1:

$$\Delta x_t = \pi x_{t-1} + \sum_{i=1}^{k} \Delta x_{t-i} + \psi_t \tag{1}$$

Table 2. Abattoir carcass and calculated retail carcass prices

Week	A2/A3	S1	S2	S3	Butchery	Week	A2/A3	S1	S2	S3	Butchery
1	R32.86	R55.81	R51.15	R54.59	R49.24	27	R25.95	R50.36	R52.01	R48.97	R44.95
2	R32.74	R55.81	R51.15	R54.59	R49.24	28	R26.05	R50.36	R46.92	R48.97	R44.95
3	R30.86	R55.46	R51.14	R54.59	R49.24	29	R26.23	R50.36	R46.92	R48.97	R44.95
4	R30.29	R55.44	R51.15	R51.68	R50.53	30	R26.90	R50.36	R46.92	R48.97	R44.95
5	R30.00	R55.44	R51.17	R52.37	R50.53	31	R27.53	R50.36	R46.92	R48.97	R45.60
6	R29.70	R55.44	R51.17	R52.37	R48.54	32	R28.36	R51.39	R46.92	R48.97	R46.01
7	R29.04	R55.44	R51.17	R52.37	R48.54	33	R29.53	R51.39	R46.92	R48.97	R46.01
8	R27.97	R55.44	R51.17	R52.37	R48.54	34	R30.85	R54.10	R48.64	R48.97	R49.12
9	R27.96	R55.44	R51.93	R52.37	R48.54	35	R31.96	R54.10	R48.64	R53.11	R49.12
10	R27.96	R54.41	R53.65	R52.37	R46.48	36	R33.03	R54.10	R48.64	R52.77	R52.10
11	R28.00	R54.41	R51.93	R51.22	R46.48	37	R33.18	R55.08	R50.09	R52.37	R52.10
12	R27.70	R53.38	R51.93	R51.22	R46.48	38	R32.98	R55.42	R49.05	R53.60	R52.22
13	R27.65	R53.00	R51.93	R51.22	R46.48	39	R33.14	R55.42	R49.05	R53.60	R51.11
14	R27.57	R53.01	R51.93	R51.22	R46.48	40	R33.01	R55.42	R50.09	R56.83	R51.11
15	R27.35	R51.73	R51.93	R49.16	R45.43	41	R33.79	R56.44	R50.09	R57.08	R51.11
16	R26.98	R51.73	R51.93	R49.16	R45.43	42	R33.26	R56.44	R49.05	R56.83	R51.11
17	R25.41	R51.73	R48.62	R49.16	R45.43	43	R33.30	R56.44	R50.09	R56.83	R51.11
18	R27.01	R51.73	R48.62	R50.53	R45.43	44	R33.07	R56.44	R49.05	R56.49	R51.11
19	R26.20	R51.73	R48.62	R50.53	R46.48	45	R33.22	R56.44	R49.05	R56.49	R52.22
20	R27.19	R51.73	R53.71	R50.53	R46.48	46	R32.60	R56.44	R49.05	R56.49	R52.22
21	R26.88	R51.73	R53.71	R50.53	R46.48	47	R32.38	R56.44	R49.05	R56.49	R52.22
22	R26.49	R51.73	R53.71	R49.16	R46.48	48	R31.89	R56.44	R49.05	R56.49	R52.22
23	R26.49	R51.73	R53.71	R49.16	R46.48	49	R31.96	R55.76	R49.05	R56.49	R52.22
24	R25.99	R51.63	R50.82	R47.76	R46.48	50	R32.05	R55.76	R49.05	R56.49	R52.22
25	R25.94	R51.63	R50.31	R47.76	R46.48	51	R32.14	R56.10	R49.05	R54.78	R52.22
26	R25.87	R50.36	R50.31	R48.97	R46.48	52	R29.67	R56.10	R49.05	R56.49	R52.22

Source: RMAA (2012) and own data collection and calculations

Where x_t is an $(n \times 1)$ vector consisting of a random variable which are $I(1)$, π is an $(n \times n)$ matrix, ψ_t is an $(n \times 1)$ vector of disturbance terms, and k is lag length to be determined based on various model selection criteria such as the Bayesian information criterion (BIC) and Akaike information criterion (AIC). Co-integration is said to be confirmed when the *rank* $(\pi) \neq 0$.

The final step is the determination of causal directions among variables to identify whether causality runs from producers to retailers or vice versa using the Granger causality test (Granger, 1969). The F-statistics was employed to test the causal relationships based on the bivariate autoregressive model. The bivariate regression is of the form:

$$y_t = \alpha_0 + \alpha_1 y_{t-1} + \ldots + \alpha_l y_{t-1} + \beta_1 x_{t-1} + \ldots + \beta_l x_{t-l} + \psi_t \tag{2}$$

$$x_t = \alpha_0 + \alpha_1 x_{t-1} + \ldots + \alpha_l x_{t-1} + \beta_1 y_{t-1} + \ldots + \beta_l y_{t-l} + \varepsilon_t \tag{3}$$

For all possible pairs of (x, y) series in the group. The reported F statistics are the Wald statistics for the joint hypothesis:

$$\beta_1 = \beta_2 = \ldots = \beta_l = 0 \tag{4}$$

4. Results and discussion

By comparing the carcass price with the different retail prices (data from Table 2) on a graph (Figure 3) it is clear to see that S1, S3 and the Butchery follows more or less the same trend as the carcass price. S2 however, do not even come close to the trend of the other prices. The graph thus indicates that there may be a larger problem with price transmission between the carcass price and S2 than between the carcass price and the other retailers. To proof this statement it is necessary to discuss the findings of the statistical analysis.

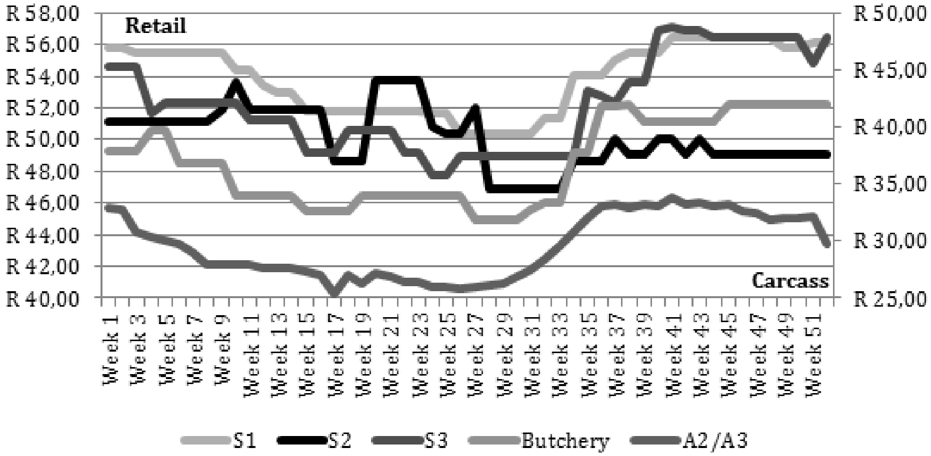

Figure 3. Comparison of carcass and retail prices
Source: RMAA (2012) and own calculations

5. Stationary test result

Table 3 shows the Augmented Dickey Fuller (ADF) tests for unit root. The null hypothesis for this test is that there is a unit root (non-stationary), with the alternative of stationarity. The test is carried out at both levels and first differences with intercept and trend components included where applicable. The results show that only S2 is stationary at levels while other prices are stationary at first difference. This means that S2 do not varies over time since the fluctuation of the price in both directions (increase and decrease) are equal. The carcass (A2/A3) price and the prices of the other retailers (S1, S3 and Butchery) do vary over time and the possibility of a long-term relationship between the carcass price and any one of these retailers does exist.

Table 3. ADF Unit root test: H_0: There is unit root

Prices	Lag Length	ADF Statistics	Critical Value (95%)	Lag Length	ADF Statistics	Critical Value (95%)
	Levels			First Difference		
A2/A3	2	-1.5514	-3.1818	1	-2.6349	-2.5992
S1	0	-1.3363	-3.1796	0	-7.0456	-3.1807
S2	0	-3.1819	-3.1796	0	-7.8780	-3.1807
S3	0	-1.9070	-3.1796	0	-7.8656	-3.1807
B	2	-2.0440	-3.1818	1	-3.9428	-3.1818

6. Johansen Co-integration tests result

The main objective of this section is to determine whether the linear combination of producer (A2/A3) and retail (S1, S2, S3 & B) prices has a long-run relationship; that is, if in the long-run, the prices move together. Johansen (1998) approach was adopted in this study. The Trace statistic and the maximal eigenvalue (λmax) statistic are used to determine the co-integrating rank, i.e. the number of co-integrating vectors. The results of the co-integration tests are presented in Table 4 below.

In Table 4, the Trace and Maximum Eigen Statistics indicate two co-integrating equations at 5% level for A2/A3 and S1 and one co-integrating equation for A2/A3 and S3 and A2/A3 and B respectively. However, there exists no cointegrating equation between A2/A3 and S2. The existence of co-integration implies that the variables have a stable equilibrium relationship(s) to which they return after short-run deviations. It also indicates that they share a certain type of behaviour in terms of their long-term fluctuations.

Table 4. Johansen Co-integration Test: Trace and Max-Eigen Statistics

Null hypothesis	Trace statistic	5% critical value	Max-Eigen Statistic	5% critical value
A2/A3 and S1				
H_0: r = 0	24.6980**	15.4947	17.8020**	14.2646
H_0: r ≤ 1	6.8959**	3.8415	6.8959**	3.8415
A2/A3 and S2				
H_0: r = 0	24.4836	25.8721	18.0045	19.3870
H_0: r ≤ 1	6.4791	12.5180	6.8959	12.5180
A2/A3 and S3				
H_0: r = 0	26.7912**	25.8721	20.4643**	19.3870
H_0: r ≤ 1	6.3269	12.5180	6.3270	12.5180
A2/A3 and B				
H_0: r = 0	28.1932**	25.8721	20.2079**	19.3870
H_0: r ≤ 1	7.9853	12.5180	7.9853	12.5180

** denotes rejection of the hypothesis at the 5% significance level

The results thus indicate that of the four retailers only S2 do not have a long term stable equilibrium relationship with the carcass price.

7. Granger Causality test result

This section aims at determining the direction of causality between the retail and carcass prices. Table 5 presents the result of the test. It is clear from the table that Granger causality ran both ways for A2/A3 and S1, one way for A2/A3 and S2, both ways for A2/A3 and S3 and finally one way for A2/A3 and B. The retail prices of S1, S3 and B do thus follows the same trend as the carcass price, while the price of S2 does not. The bi-directional behaviour of the beef market shows

Table 5. Granger Causality Test Results

Null Hypothesis	F Statistic	Probability
A2/A3 $\nRightarrow$ S1	11.6040	0.0000*
S1 $\nRightarrow$ A2/A3	3.6811	0.0331**
A2/A3 $\nRightarrow$ S2	0.8216	0.4462
S2 $\nRightarrow$ A2/A3	7.9235	0.0011*
A2/A3 $\nRightarrow$ S3	4.4399	0.0174**
S3 $\nRightarrow$ A2/A3	7.9235	0.0015*
A2/A3 $\nRightarrow$ B	10.0581	0.0002*
B $\nRightarrow$ A2/A3	1.8487	0.1692

* and ** denote significance at 1 and 5% significance level respectively.

that the perception of farmers that the retailers set the market price is not entirely true. The retail price is determined by the carcass price and the bi-directional behaviour comes from supply and demand differences in the beef market throughout the year.

8. Conclusions and recommendations

According to the results obtained from the statistical analysis it is clear that the allegations of the red meat farmers and feedlots is false in most of the cases. The analysis indicated that only one of the four retailers who's data was used do not maintain a steady price margin over time and thus do not follow the same price trend as the carcass prices. It further indicates that the perception of retailers setting the market price is false as well as the results indicated that there are a bi-directional influence between the carcass and retail prices that are brought about by the changes in the demand and supply of the beef market through the year.

The results of the study do not provide any direct solutions for the producers of beef, as they receive the same price for their product no matter in through witch retailer it will be sold. It does however shows that the largest part of the retail market do not indicate on any sign of problems with the price transmission from the producer to the consumer. The one retailer that do show problems with price transmission should however be brought under the attention of consumers. By educating consumers on the pricing mechanism of meat and the differences that exist between the prices of the different retailers the consumers will be able to make a more informed purchasing decision.

The data set that was used for this study only contains the weekly price data for a year (52 observations) and was too short to test for asymmetric price transmission. It is however recommended that it should be done as more data sets become available.

9. References

Dickey D.A., Fuller W.A., 1981. Likelihood ratio statistics for autoregressive time series with a unit root. *Econometrica,* 49(4):1057-1072.

Granger C.W.J., 1969. Investigating causal relationships by econometric models and cross-spectral methods. *Econometrica,* 37:424-438.

Johansen S., 1998. Statistical analysis of cointegrating vectors. *Journal of Economic Dynamics and Control,* 12:231-254.

Spies D.C., 2011. Analysis and quantification of the South African red meat value chain. *Thesis submitted for the degree Philosophiae Doctor.* University of the Free State.

RMMA, 2012. Red Meat Abattoir Association. Available from: www.rvav.co.za

EXPORT INSTABILITY WHEN INTERNATIONAL AGRICULTURAL MARKETS OPERATE UNDER OLIGOPOLY

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Abstract

This article uses a theoretical model to show that instability in international markets of agricultural commodities may increase as a consequence of power imbalance exiting in the food chain supply. This instability, in turn, may cause negative impacts on the environment. The article argues that in order to minimize this problem, informational strategies should be implemented at the farming level.

Keywords: export instability, oligopolistic international markets, farming sector

1. Introduction

The issue of export instability has been studied for more than three decades. According to some empirical works, export instability is caused mainly by fluctuations in imports and exports of commodities. For example, Adebusuyi (2004) found that cyclical change in consumers' income is one of the factors that have increased import fluctuations. A related result was found by Wong (1986). According to this researcher, variability in GDP per capita is strongly significant in explaining export instability, although this factor is not dominant. On the other hand, Jansen (2004) and Malik and Temple (2005) found that export concentration is a strongly predictor of terms of trade volatility. Finally, Prasad (2000) found that short term fluctuations in export are dominated by the supply side shock.

Different negative effects of export instability have been identified. Empirical evidence has revealed that economic growth is negatively impacted by this instability (see for example Gymah-Brempong, 1991; Lutz, 1994; Turnovsky and Chattopadhyay 2003; Jansen, 2004; and Malik and Temple, 2005). In relation to this effect, Ramey and Ramey (1991) argue that income fluctuation caused by export instability can affect firms' commitment to invest in technology reducing, in this way, economic growth. This argument was confirmed by Ramey and Ramey (1995). Another negative effect of export instability is related to farmers' welfare. According to Bourguignon et al (2004), developing countries depend strongly on agricultural export which is subject to external volatility. Nonetheless, households can smooth consumption when this instability is transitory. The problem is that farmers in these countries normally face capital restrictions and lack of credit facility making consumption smoothing difficult.

The standard policy recommendation that has been proposed to reduce export instability is export diversification. This is because the instability of portfolios composed of commodities with prices that are negatively correlated is reduced (for a discussion, see Stanley and Bunnag, 2001; Adebusuyi, 2004; and Chami Batista, 2004).

While these investigations have been useful in identifying some sources of export instability, they have neglected the existing power imbalance that is present in the food supply chain in several countries. As a consequence of this power imbalance, international markets of agricultural commodities operate now under oligopoly.

Different evidence and arguments has been used to inform about the existence of oligopolistic competition in international markets of agricultural commodities. One of them postulates that the industrialization of agricultural markets has generated larger firms that are more tightly aligned across the production chain and more concentrated due to their larger scale. According to Boehlje and Doering (2000), this concentration can be sufficient to exercise oligopolistic power. For example, it is recognized that the vertical relationship between suppliers and retailers of fresh produce in the UK is dominated by nine large retailers, Tesco being the largest of these (White, 2000; and Duffy et al., 2003). McCorriston (2002) argues that this is one of the reasons of why researchers should consider the assumption of oligopoly when studying international markets of agricultural commodities. In particular this author points out: "*Arguably, it is the high and increasing concentration in food retailing that is the most distinguishing feature of the European food chain. Taken together with the oligopolistic nature of food manufacturing in many European countries, the food chain is perhaps best described as a successive multi-stage oligopoly. In this case, an oligopolistic sector sells its output to another oligopolistic sector that distributes the final good to consumers*" (p. 354). Imperfect competition has also been identified in other contexts. For example, the State Trading Enterprises and the Australian Wheat Board manage the total amount of exports of cereals of some countries such as Canada and Australia. According to Sckokai and Soregaroli (2008), imperfect competition is likely to arise from these enterprises a fact that has been supported by empirical academic works (see for example Reimer and Stiegert 2006; and McCorrisnton and MacLaren, 2007a,b). Imperfect competition has also been identified in other markets. For example, Lloyd et al. (2006) in the UK beef chain; Saitone et al. (2008) in the U.S. corn sector in relation to the U.S. corn ethanol subsidy; and Byeong-Il and Lee (2010) found evidence of oligopoly in the Korean market of milk.

The objective of this article is to show, using a theoretical model, that the existence of oligopolistic markets of agricultural commodities may amplify export instability in the short run. Moreover, this problem may be persistent if farmers do not have reliable information to make predictions about future market conditions, a fact that may cause significant negative effects on the environment

The article is organized as follows. Section 2 presents the theoretical model. Section 3 shows key results that are obtained when solving the theoretical model. Section 4 presents evidence that is consistent with the predictions made by the theoretical model. Finally, Section 5 concludes the paper.

2. The model

In order to study the effects of oligopolistic competition on export instability, a dynamic model is proposed. Two versions of this model were adopted in this article. The first one is a simplified version that assumes a world composed of three countries. The objective of considering this simplification is to explicitly identify the dynamic process that is associated with export instability. In order to investigate how this process is influenced by available information on the strategy adopted by competitor countries, this version considers two extreme cases, namely: (i) when countries have perfect information about the strategy adopted by the competitor countries; and (ii) when countries have completely imperfect information. The second version of the model is a generalization that considers a world composed of *n* countries. This model also investigates the case when countries have partial information about the strategy adopted by the competitor countries.

2.1. The simplified version of the model

The model assumes a world composed of 3 countries denoted by *i, j* and *k*. Each country *i* has a rural sector that produces a homogeneous crop . Because this output is exported by an intermediary who has oligopolistic power, countries *i, j* and *k* play Cournot in each market where they compete. It is assumed that farmers face the same marginal cost *c*. In order to simplify the analysis it is assumed without losing generality that the intermediary is also the only farmer in the country. This simplification does not lose generality because what it is highlighted in this model is the existing oligopolistic structure in the food supply chain.

The inverse demand function for agricultural good in an arbitrary country *k* and in period *t* + 1 is given by:

$$p^k_{t+1} = \alpha - q^i_{t+1} - q^j_{t+1} + q^k_{t+1} \tag{1}$$

Because the agricultural output that will be harvested in period *t* + 1 is established in period *t*, the farmer in country *k* maximizes the following expected profit:

$$\max_{q^k_{t+1}} E^k_t(\pi^k_{t+1}) = \left[E^k_t(P^k_{t+1}) - c\right] q^k_{t+1} \tag{2}$$

The expected value in period *t* of the price in country *k* in period *t* + 1 is:

$$E^k_t(P^k_{t+1}) = \alpha - q^k_{t+1} - E^i_t(q^i_{t+1}) - E^i_t(q^j_{t+1}) \tag{3}$$

According to this equation, the expected value of the future price depends on the expectation that farmer *k* has on the output that will be exported by countries *i* and *j* to country *k*. It is assumed that the expectation on each of these outputs is given by:

$$E^k_t(q^i_{t+1}) = \lambda q^i_t + (1-\lambda) q^i_{t+1} \tag{4}$$

In this equation when the farmer does not have any information about the future output that will be exported by the competitor country, then *l* = 1. That is, in this case the farmer considers the current output exported by this country as a proxy of future export. In contrast, if the farmer can perfectly anticipate the future output that will be exported by this competitor, then *l* = 0. By using Equation 4 the maximization problem of the farmer in country *k* becomes:

$$\max_{q^i_{t+1}} E^i_t(\pi^i_{t+1}) = \left[\alpha - c - q^i_{t+1} - \lambda q^j_t - (1-\lambda) q^j_{t+1}\right] q^i_{t+1} \tag{5}$$

After solving this maximization problem, the following reaction functions are obtained:

$$q^i_{t+1} = \frac{\alpha - c}{2} - \frac{\lambda q^j_t}{2} - \frac{(1-\lambda) q^j_{t+1}}{2} - \frac{\lambda q^k_t}{2} - \frac{(1-\lambda) q^k_{t+1}}{2} \tag{6}$$

$$q^j_{t+1} = \frac{\alpha - c}{2} - \frac{\lambda q^i_t}{2} - \frac{(1-\lambda) q^i_{t+1}}{2} - \frac{\lambda q^k_t}{2} - \frac{(1-\lambda) q^k_{t+1}}{2} \tag{7}$$

$$q^k_{t+1} = \frac{\alpha - c}{2} - \frac{\gamma q^i_t}{2} - \frac{(1-\gamma) q^i_{t+1}}{2} - \frac{\lambda q^j_t}{2} - \frac{(1-\lambda) q^j_{t+1}}{2} \tag{8}$$

Using substitution, the following system of two dynamic equations is obtained:

$$\begin{bmatrix} \zeta_0 & -\zeta_1 \\ \varphi_0 & -\varphi_0 \end{bmatrix}\begin{bmatrix} q_{t+1}^{j} \\ q_{t+1}^{i} \end{bmatrix} = \begin{bmatrix} \zeta_2 \\ 0 \end{bmatrix} + \begin{bmatrix} \zeta_3 & \zeta_4 \\ \varphi_1 & -\varphi_1 \end{bmatrix}\begin{bmatrix} q_{t}^{j} \\ q_{t}^{i} \end{bmatrix} + \begin{bmatrix} \zeta_5 & \zeta_5 \\ 0 & 0 \end{bmatrix}\begin{bmatrix} q_{t-1}^{j} \\ q_{t-1}^{i} \end{bmatrix} \tag{9}$$

where $\zeta_0 = 3 + 2\lambda - \lambda^2$; $\zeta_1 = \lambda^2 - 1$; $\zeta_2 = \alpha - c$; $\zeta_3 = 2\lambda - 2\lambda^2$; $\zeta_4 = -2\lambda^2$; $\zeta_5 = \lambda^2$; $\varphi_0 = 1 + \lambda$; and $\varphi_1 = \lambda$.

Note that the long run Nash equilibrium output that is obtained from this system is equal to $\frac{\alpha - 2}{4}$ and is the same for each country. This long run equilibrium is important to determine how the system evolves throughout time. This is referred to as the dynamic process around the long run Nash equilibrium. In order to analyze this process, the roots that equal to zero the following expression are needed[1]:

$$\begin{aligned} &b^3(\zeta_1\varphi_0 - \zeta_0\varphi_0) + b^2(\zeta_3\varphi_0 + \zeta_4\varphi_0 - \zeta_1\varphi_1 + \zeta_0\varphi_1) + \\ &b(\zeta_5\varphi_0 - \zeta_3\varphi_1 + \zeta_5\varphi_0 - \zeta_4\varphi_1) - \zeta_5\varphi_1 - \zeta_5\varphi_1 \end{aligned} \tag{10}$$

2.2. The general version of the model

This model is a generalization of the model described in the previous section and is based on the same general assumptions. In particular, it is assumed that farmer in country *k* considers the following expected value in period *t* of the price in *k* and in period *t* + 1:

$$E_t^k\left(P_{t+1}^k\right) = \alpha - q_{t+1}^k - E_t^k\left(\sum_{j \neq k} q_{t+1}^j\right) \tag{11}$$

Where is the output exported by county *j* to country *k*. Note that this expression is similar to Expression 3 above. The only difference is that Expression 11 considers *n* competitor countries while Expression 3 only considers three competitors. Assuming the same expectation process described in equation 4, the maximization problem faced by farmer in country *k* is given by:

$$\max_{q_{t+1}^i} E_t^k(\pi_{t+1}^k) = \begin{bmatrix} \alpha - c - q_{t+1}^k - \lambda \sum\limits_{j \neq k} q_t^j \\ -(1-\lambda)\sum\limits_{j \neq k} q_{t+1}^j \end{bmatrix} q_{t+1}^i \tag{12}$$

The solution of this problem gives the following reaction function of farmer in country *i*:

$$q_{t+1}^k = \frac{\alpha - c}{2} - \frac{\lambda \sum_{j \neq k} q_t^j}{2} - \frac{(1-\lambda)\sum_{j \neq k} q_{t+1}^j}{2} \tag{13}$$

The following matrix system considers the reaction function of all the countries competing in country *k* altogether:

$$Q_{t+1}^k = A + BQ_{t+1}^k + \Phi Q_t^k \tag{14}$$

[1] Expression 10 was obtained assuming that and, where m and n are arbitrary constants.

where,

$$Q^k_{t+1} = \left[q^j_{t+1} \quad q^k_{t+1} \quad \cdots \quad q^n_{t+1} \right]^T$$

$$A = \left[\frac{\alpha - c}{2} \quad \frac{\alpha - c}{2} \quad \cdots \quad \frac{\alpha - c}{2} \right]^T$$

$$B = \begin{bmatrix} 0 & -\frac{(1-\lambda)}{2} & -\frac{(1-\lambda)}{2} & \cdots & -\frac{(1-\lambda)}{2} \\ -\frac{(1-\lambda)}{2} & 0 & -\frac{(1-\lambda)}{2} & \cdots & -\frac{(1-\lambda)}{2} \\ -\frac{(1-\lambda)}{2} & -\frac{(1-\lambda)}{2} & 0 & \cdots & -\frac{(1-\lambda)}{2} \\ \cdot & \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot & \cdot \\ -\frac{(1-\lambda)}{2} & -\frac{(1-\lambda)}{2} & -\frac{(1-\lambda)}{2} & \cdots & 0 \end{bmatrix}$$

$$\Phi = \begin{bmatrix} 0 & -\frac{\lambda}{2} & -\frac{\lambda}{2} & \cdots & -\frac{\lambda}{2} \\ -\frac{\lambda}{2} & 0 & -\frac{\lambda}{2} & \cdots & -\frac{\lambda}{2} \\ -\frac{\lambda}{2} & -\frac{\lambda}{2} & 0 & \cdots & -\frac{\lambda}{2} \\ \cdot & \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot & \cdot \\ -\frac{\lambda}{2} & -\frac{\lambda}{2} & -\frac{\lambda}{2} & \cdots & 0 \end{bmatrix}$$

3. Solving the model

3.1. Solution of the simplified version of the model

This section solves the simplified version of the theoretical model described in Section 2.1 assuming both completely imperfect and perfect information about the future output that will be exported by the competitor countries.

When countries are completely uncertain about the output that the competitor countries will export in period $t + 1$ (i.e. $l = 1$), Expressions 9 and 10 converge to:

$$\begin{bmatrix} 4 & 0 \\ 2 & -2 \end{bmatrix} \begin{bmatrix} q^j_{t+1} \\ q^i_{t+1} \end{bmatrix} = \begin{bmatrix} \alpha - c \\ 0 \end{bmatrix} + \begin{bmatrix} 0 & -2 \\ 1 & -1 \end{bmatrix} \begin{bmatrix} q^j_t \\ q^i_t \end{bmatrix} + \begin{bmatrix} 1 & 1 \\ 0 & 0 \end{bmatrix} \begin{bmatrix} q^j_{t-1} \\ q^i_{t-1} \end{bmatrix} \tag{15}$$

$$-8b^3 + 6b - 2 = 0 \tag{16}$$

By using these expressions, the following solution of the system is obtained[2]:

$$q^i_t = \frac{1}{9}\left[q^i_0 - q^N\right](-1)^t + \frac{8}{9}\left[q^i_0 - q^N\right](0.5)^t + \frac{4}{3}\left[q^i_0 - q^N\right]t\,(0.5)^t + q^N \tag{17}$$

where $q^N = \dfrac{\alpha - c}{4}$ is the long run Nash equilibrium and q^i_0 is the initial condition.

[2] A similar expression can be derived for countries j and k as a consequence of the symmetrical countries assumption.

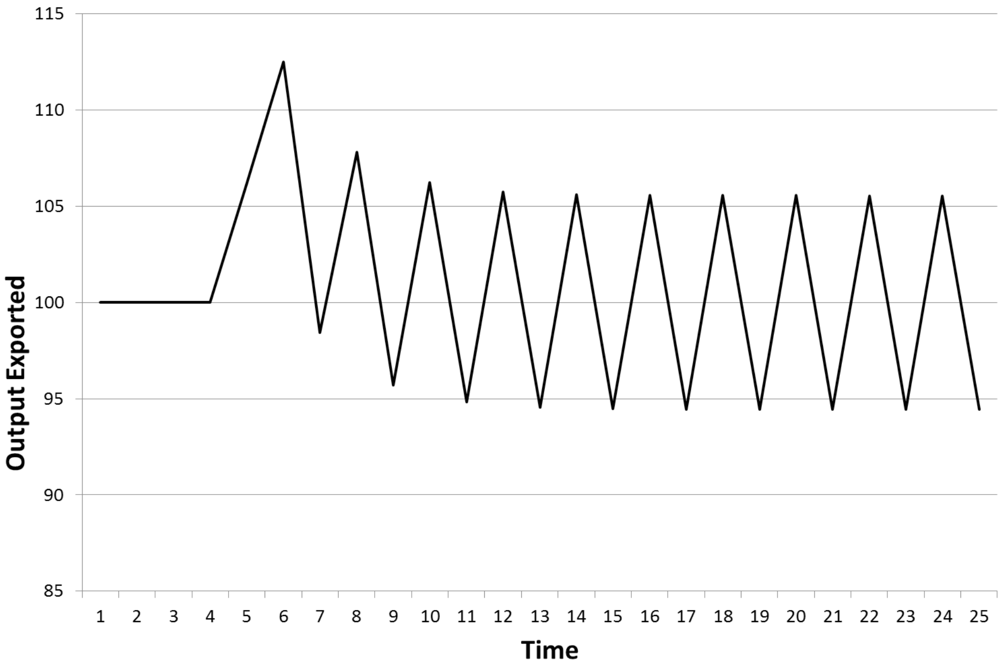


Figure 1. Export instability

- **Proposition 1:** *If farmers are completely uncertain about the output that the competitor countries will export in the next period, then export instability in each country will consist of an oscillatory and persistent change of exported output around the long run Nash Equilibrium.*
- **Proof:** Because equation 17 has a root equal to -1, it is concluded that the model oscillates around the long run Nash Equilibrium and does not converge to this equilibrium.

This is an impressive result that proves the fact that lack of reliable information in a world characterized by oligopolistic international markets of agricultural commodities may be associated with high levels of instability and uncertainty. In order to see how this instability behaves, a simulation based on Equation 17 is presented in the following figure.

In this simulation it was assumed an initial Nash equilibrium equal to 100. After an exogenous shock is introduced in period 4, the long run equilibrium is broken with persistent fluctuations around this equilibrium.

There is an important environmental implication associated with this result. That is, researchers have found that the most important factor causing natural habitat loss is agricultural expansion induced by international trade (see, for example, Angelsen and Kaimowitz, 1999; and Barbier, 2004). This is because the agricultural land that is needed to produce additional output for exportation is obtained from natural habitats. This is why researchers in this area argue that the loss of natural habitats is positively related to the output produced in the farm (Polasky et al., 2004). In terms of the result presented in Proposition 1, this means that the positive fluctuations with respect to the long run Nash equilibrium may be associated with significant loss of natural habitats in some countries. To see this, consider again the simulation present in Figure 1. Before the exogenous shock in period 4, the output produced in this country was 100 and this output was associated with a determined level of habitat destruction. After the shock, there was a huge increase in output which may be coupled with a significant increase in habitat destruction and, therefore, with biodiversity loss.

Suppose now that countries have perfect information about the output that competitor countries will export in period $t + 1$ (i.e. $l = 0$). In this case the Expressions 9 converges to:

$$\begin{bmatrix} 3 & 1 \\ 1 & -1 \end{bmatrix} \begin{bmatrix} q^{j}_{t+1} \\ q^{i}_{t+1} \end{bmatrix} = \begin{bmatrix} \alpha - c \\ 0 \end{bmatrix} \tag{18}$$

- **Proposition 2:** *If farmers know with certainty the output that the competitor countries will export in the next period, then export instability in each country is eliminated.*
- **Proof:** This result is inferred from Expression 18. The unique result that is obtained from this expression is $(a - c)/4$ which corresponds to the long run Nash equilibrium.

According to this proposition, the instability problem identified in the case of imperfect information is completely eliminated when farmers can anticipate with certainty the output that will be produce by the competitor countries in the next period. This offers an interesting possibility for policymakers. That is, the design of policy programs aimed to improve the flow of relevant information in the farming sector. In theory these programs have the potential of generating positive externalities in terms of reducing export instability in international markets of agricultural commodities.

3.2. Solution of the general version of the model

Let us now solve the general version of the model. The results are presented in the following proposition:

- **Proposition 3:** *If l* £ 0.5*, then the system described in Expression 14 converges to a stable equilibrium. If this is not the case, then the stability depends on the number of firms competing in country k.*
- **Proof:** Note that Expression 14 can be represented as the following VAR(1) model:

$$Q^{k}_{t+1} = \tilde{A} + \tilde{\Phi} Q_t \tag{19}$$

where $\tilde{A} = [I - B]^{-1} A$; and $\tilde{\Phi} = [I - B]^{-1} \Phi$. The model described in Expression 19 is stable if and only if the roots of the system $[I - \tilde{\Phi} Z]$ lie outside of the unit circle. That is, if and only if $|Z| > 1$. The model has $n - 1$ identical roots equal to $Z = 1 + 1/l > 1$. The other root is equal to $Z = -[2 + (1 - l)(n - 1)]/[l(n - 1)]$. This expression is smaller than -1 when $1/(n - 1) > l - ½$.

This condition is satisfied for all $\lambda \leq 0.5$. In contrast, if $l > 0.5$, then Expression 19 converges to an equilibrium only when $n < (l + 0.5)/(l - 0.5)$. This completes the proof.

According to this model, even if farmers have partial information about the output that competitors will export in the next period, an unstable system can be originated. For example, if $l = 0.4$ and if the number of competitors is larger than 11, then export instability arises. Moreover, this instability is explosive meaning that in the short run lack of information can cause a significant impact on export instability. This, in turn, can have important negative impacts on the environment when agricultural production is associated with loss of natural habitats.

4. Some evidence

According to the results obtained from the theoretical model, imperfect information about the strategy adopted by competitor countries might cause high export instability when countries compete in oligopolistic markets. This result suggests that countries involved in free trade agreements may face high levels of export instability as a consequence of being participating in international oligopolistic agricultural markets with imperfect information.

The aim of this section is to show some evidence of how export instability has indeed increased after a particular country signed a number of free trade agreements. A suitable country that can inform about the effect of free trade liberalization on export instability is Chile. This country is one of the most opened countries in the world and is currently involved in 19 agreements. These agreements and the dates of their implementation are presented in the following table.

This table shows that Chile signed two agreements between 1995 and 2000; seven agreements between 2001 and 2005; and eight agreements between 2006-2010. In order to determine whether these agreements have increased export instability, the standard deviation of the output of some selected agricultural goods exported by this country is analysed. Because Chile is an important exporter of fresh fruits, the following goods are considered: apples; apricots; cranberries; grapes; lemons and limes; oranges; peaches and nectarines; raspberries; and strawberries. Information of the change of standard deviation in different periods of time is presented in Appendix A.

According to the figures presented in this appendix, export instability increased after Chile started signing free trade agreements in 1997. After that, export instability has remained high for all the goods considered in the appendix. In some cases export instability decreased in the period between 2006 and 2010 which may reflect the fact that farmers have learned to some extent the

Table 1. Free Trade Agreements signed by Chile

Free Trade Agreements	Date of Implementation
Chile-Canada	05-Jul-1997
Chile-Mexico	01-Aug-1999
Chile-Costa Rica (Central America)	15-Feb-2002
Chile-Guatemala (Central America)	23-Mar-2002
Chile-El Salvador (Central America)	01-Jun-2002
Chile-European Union	18-Nov-2002
Chile-United States	01-Jan-2004
Chile-Republic of Korea	01-Apr-2004
Chile-EFTA	01-Dec-2004
Chile-New Zealand-Singapore	28-May-2006
Chile-China	10-Oct-2006
Chile-Japan	03-Sep-2007
Chile-Panama	07-Mar-2008
Chile-Honduras (Central America)	19-Jul-2008
Chile-Peru	01-Mar-2009
Chile-Australia	06-Mar-2009
Chile-Colombia	08-May-2009
Chile-Turkey	01-Mar-2011
Chile-Malaysia	25-Feb-2012

Source: World Trade Organization, 2013

strategy adopted by partners. However, the level of instability in this period is higher than before the country was involved in free trade supporting the results obtained from the theoretical model proposed in this article.

5. Conclusions

This article uses a theoretical approach to show that export instability can be amplified when international markets of agricultural commodities operate under oligopoly and when farmers have imperfect information about the output that will be exported by competitor countries. This instability consists of persistent fluctuations of exported output around the long run Nash equilibrium. This result suggests that countries involved in free trade agreements may face high levels of export instability as a consequence of being participating in oligopolistic markets with imperfect information. Partial evidence obtained from Chile seems to support this prediction.

This problem may be solved by means of policy programs that favor the flow of relevant information in the farming system. The way in which this strategy might be implemented is left for future research.

6. References

Adebusuyi B.S., 2004. Stabilization of commodity market of interest to Africa. Paper presented at the workshop on Constraints to Growth in Sub-Sahara Africa. Intergovernmental Group of Twenty-Four in Pretoria, South Africa.

Angelsen A., Kaimowitz D., 1999. Economic models of tropical deforestation a review, Center for International Forestry Research CIFOR.

Barbier E., 2004. “Explaining agricultural land expansion and deforestation in developing countries”, *American Journal of Agricultural Economics* 86(5): 347-1353.

Boehlje M., Doering O., 2000. “Farm policy in an industrialized agriculture”, *Journal of Agribusiness* 18(1): 53-60.

Bourguignon F., Lambert S., Suwa-Eisenmann A., 2004. “Trade exposure and income volatility in cash-crop exporting developing countries”. *European Review of Agricultural Economics* 31(3), 369-387.

Byeong-Il A., Lee K., 2010. “An Equilibrium Displacement Approach to Oligopoly Market Analysis: an Application to Trade to Trade in the Korean Infant Formula Market”, *Agricultural Economics* 41: 101-109.

Chami Batista J., 2004. “Latin American export specialization in resource-based products: implications for growth”. *The developing Economies* XLII(3): 337-370.

Duffy R., Fearne A., Hornibrook S., 2003. “Measuring distributive and procedural zustice: an exploratory investigation of the fairness of retailers-suppliers relationships in the UK food industry”, *British Food Journal* 105(10): 682-694.

Gymah-Brempong K., 1991. “Export instability and economic growth in sub-Saharan Africa”. *Economic Development and Cultural Change* 39: 815-828.

Jansen M., 2004. Income volatility in small and developing economies: export concentration matters. Discussion papers No 3. World Trade Organization.

Lloyd T.A., McCorriston S., Morgan C.W., Rayner A.J., 2006. “Food scares, market power and price transmission: the UK BSE crisis”, *European Review of Agricultural Economics* 33(2):119–147.

Lutz M., 1994. “The effects of volatility in the terms of trade on output growth: new evidence”. *World Development* 22(12), 1959-1994.

Malik A., Temple J.R.W., 2005. The geography of output volatility. Working Papers Series 2005-06. Centre for the Study of African Economies, Oxford University.

McCorriston S., 2002. “Why should imperfect competition matter to agricultural economists?”, *European Review of Agricultural Economics* 29(3):349–371.

McCorrisnton S., MacLaren D., 2007a. “Do State Trading Exporter Distort Trade? *European Economic review* 51: 225-246.

McCorrisnton S., MacLaren D., 2007b. “Deregulation as (Welfare Reducing) Trade Reform: The Case of the Australian Wheat Board”, *American Journal of Agricultural Economics* 89: 637-650.

Polasky S., Costello C., McAusland C., 2004. “On trade, land use, and biodiversity”, *Journal of Environmental Economics and Management* 48: 911-925.

Prasad S., 2000. Determinants of Exports in Fiji. Working Paper 2000/04. Reserve Bank of Fiji.

Ramey G., Ramey V., 1991. Technology commitment and the cost of economic fluctuations. Working Paper No 3755. National Bureau of Economic Research (Cambridge, MA).

Ramey G., Ramey V., 1995. “Cross-country evidence on the link between volatility and growth”. *American Economic Review* 85: 1135-1151.

Reimer J.J., Stiegert K.W., 2006. “Imperfect competition and strategic trade theory: evidence for international food and agricultural markets”, *Journal of Agricultural Food & Industrial Organisation* 4(1): Article 6.

Saitone T.L., Sexton R.J., Sexton S.E., 2008. “Market Power in the Corn Sector: How Does It Affect the Impacts of Ethanol Subsidy?”, *Journal of Agricultural and Resource Economics* 33(2): 169-194.

Sckokai P., Soregaroli C., 2008. “Imperfect Competition in International Cereal Markets”. Paper presented in the XLV Congress of SIDEA (Societa Italiana di Economia Ahraria).

Stanley D.L., Bunnag S., 2001. “A new look at the benefits of diversification: lessons from Central America”. *Applied Economics* 33: 1369-1383.

Turnovsky S.J., Chattopadhyay P., 2003. “Volatility and growth in developing economies: some numerical results and empirical evidence”. *Journal of International Economics* 59: 267-295.

White H.M.F., 2000. “Buyer-supplier relationships in the UK fresh produce industry”, *British Food Journal* 102(1): 6-17.

Wong C.M., 1986. “Models of export instability and empirical tests for less developed countries”. *Journal of Development Economics* 20: 263-285.

World Trade Organization, 2013. Participation in Regional Trade Agreements.

http://www.wto.org/english/tratop_e/region_e/rta_participation_map_e.htm?country_selected=BHS&sense=b

Appendix A

Standard deviation of export quantity of selected agricultural goods exported by Chile (information obtained from FAO statistics)

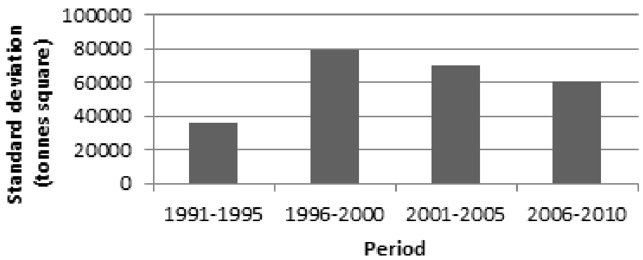


Figure A1. Standard deviation of export quantity of apples

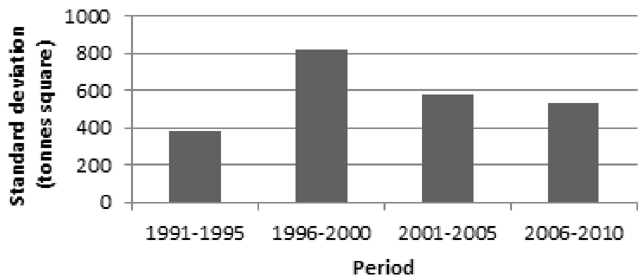


Figure A2. Standard deviation of export quantity of apricots

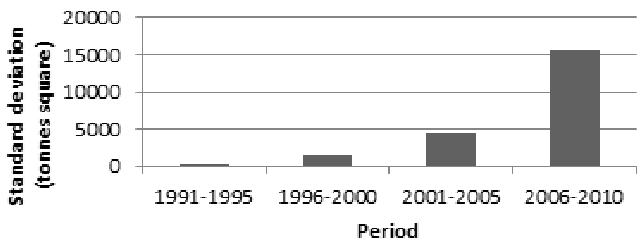


Figure A3. Standard deviation of export quantity of cranberries

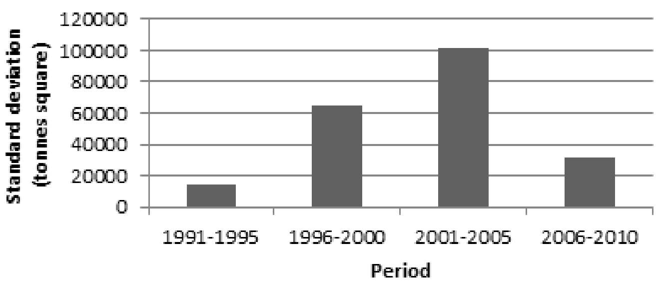


Figure A4. Standard deviation of export quantity of grapes

Figure A5. Standard deviation of export quantity of lemons and limes

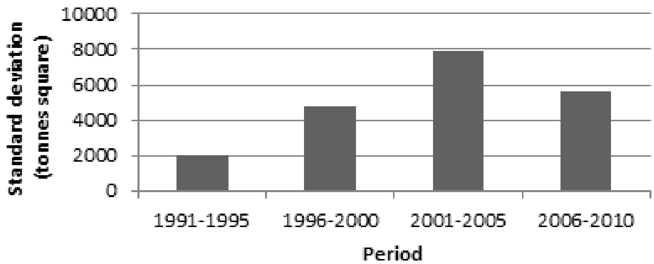


Figure A6. Standard deviation of export quantity of oranges

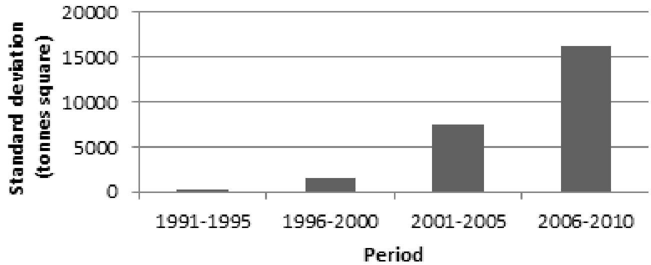


Figure A7. Standard deviation of export quantity of peaches and nectarines

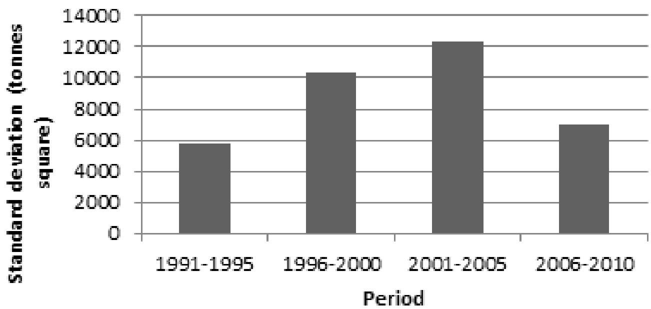


Figure A8. Standard deviation of export quantity of raspberries

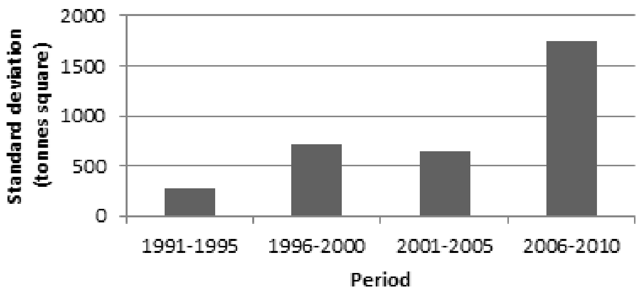
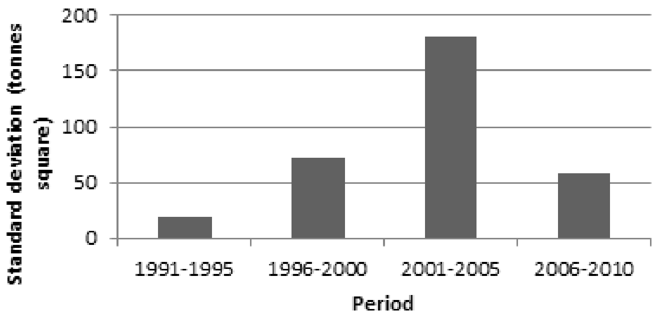


Figure A9. Standard deviation of export quantity of stawberries



CASH FLOWS IN THE OPTIMIZATION OF CAPITAL STRUCTURE IN AGRICULTURAL HOLDINGS WITH ANIMAL PRODUCTION

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Abstract

This study presents the results of a non-linear optimization of available sources of financing of agricultural holdings with animal production, which was carried out based on data obtained from the FADN-PL database for the year 2008. On the basis of the model, a capital structure was designed for the "granivores" type of holdings, which were characterised by either a low or a high debt level. On the basis of the research conducted it was observed that the optimization of sources of financing enables the operational balance and the income to increase for those family-owned agricultural holdings which maintained high levels of debt. The optimum cost of capital determined for a given available financing structure, coupled with implementation of a given investment project, contributed to an improvement of ROE in holdings employing a higher level of borrowed capital.

Keywords: farms, optimization of capital structure, cash flows, animal production

1. Introduction

The financing structure of economic entities is one of the factors which influence the current financial results, as well as the profitability of development projects which are carried out at any given time. The policy adopted by the managers in respect of capital structure design requires finding a compromise between the level of risk and such a rate of return that would ensure an optimum debt-equity ratio. In the nineteen fifties these issues were the focus of Miller's and Modigliani's research. According to capital structure theory, it is impossible to determine precisely the optimum proportions of different sources of financing. The aspects that may be identified include the scope of optimization, on the basis of which other factors are established which constitute key areas enhancing the effectiveness of the enterprises' operations. Managers of companies should select their sources of financing in such a way as to take advantage of the financial leverage effect, thus decreasing the weighted average cost of capital. One must therefore determine what the costs of particular capital components are, in what way the proportions between them change and at what point the optimum structure has been achieved.

Designing the capital structure in a dynamic way requires an approach which is focused on managing by values; small economic entities, on the other hand, make decisions based on reference to the maximization of income. In addition, managers of small entities try to use their own income by retaining it within the company and by financing their operations with this source of capital for as long as possible, thus, in the end, increasing the level of debt (Michaelas, Chittenden, Poutziouris, 1999, p. 127). This issue is related to contemporary economic theories, as well as to the behavioural and managerial concepts, the concept of ownership rights (the law of property), agency and transactional (transactions) costs and the systemic approach (Tokarski 2007, p. 15). The reason for this situation is the willingness to achieve a set of targets which will be linked to the maximization of profit, as well as satisfying other needs, e.g. social needs.

The difference between small and medium enterprises as opposed to big entities stems mainly from more restricted possibilities for growth, in relation to the trade-off theory of capital structure (Lopez-Gracia, Sogorb-Mira, 2008, p. 131). The optimization of capital structure in an enterprise should, therefore, be focused on increasing the rate of return on equity (ROE). This ratio enables the specialists to assess possibilities for growth. According to the sustainable growth model, the rate of growth of an enterprise depends on the financial effectiveness of equity (own capital) and on the dividend payout yield (Kowalczyk, Kusak 2006, p. 274). A higher level of the return on equity ratio will translate into a higher safe growth rate, which in the long term leads to a decrease in the level of borrowed capital in the financing structure. A low ROE ratio may motivate to seek external sources of financing. According to the research results of Behr and Guttler, conducted in the SME sector in Germany, a ROE ratio which does not exceed 20% may be a decisive factor motivating to seek external sources of financing (2007, p. 195). The authors have proved that increasing the level of ROE and ROS (return on sales) contributes to an improvement in the financial stability of SMEs and reduces the risk of defaulting on obligations (default risk) (Behr, Guttler 2007, p. 202).

Making use of equity in agricultural holdings often leads to its permanent tying-up and translates into accepting a low level of profitability. It is connected mainly with the pecking order theory, according to which farmers prefer, above all, to self-finance their activities (conducted performance) (Mądra 2008, s. 564-566). This approach may restrict the possibilities linked to the advantages of the financial leverage effect.

Designing the capital structure is connected with cash management through appropriate regulation of expense and receipt flows. Maintaining this equilibrium creates favourable conditions for the improvement of financial liquidity (Śnieżek 2008, p. 88). One of the detailed variations of the Markov's model determines the optimum capital structure by defining the objective function in the optimization operations as a sum of discounted clean profits (after tax) and the quantiles of the sum of discounted clean profits (after tax) in a situation when an enterprise does not pay out dividends (Kowal 2009, p. 23). An optimization in reference to planned cash flows which is conducted in this way enables us to assess the influence of alternative solutions on financial results, also when allowing for short periods. The managers' orientation towards generating a positive cash surplus in every period minimizes the risk of financial gaps for conducting business activity (Maślanka 2008, p. 28). Future cash flows also determine the value of an economic entity, hence in their current and future assessment the cost of capital, as well as risk should be taken into consideration (Michalski 2005, p. 23).

2. Research methodology

The purpose of the study is to demonstrate the links between the results obtained from an optimised capital structure and the debt level in particular agricultural holdings with animal production. Among the assumptions for optimisation the following factors have been taken into account: the seasonal character and the specificity of agricultural production, and thus the dynamic design of the capital structure through the use of cash flows for optimisation purposes.

The estimated non-linear optimisation model covers quarterly periods, while taking into consideration the dynamic interrelations in the capital structure between the inflows and outflows from the financial activity on the one hand, and the changes in expenses and the time of obtaining cash flows from operating activity on the other. The objects of study included individual agricultural holdings which provide access to data within the Farm Accountancy Data Network (FADN) system[1], which, in turn, are collected by the Institute of Agricultural and Food Economics - the National Research Institute. The FADN field of observation covers commercial holdings, which significantly contribute to creating added value in agriculture[2].

The estimation in the optimization model has been conducted for the year 2008 with regard to holdings characterised by unidirectional production typical of the "granivores" type of farming. For the purposes of the optimization model, the most frequently used and the most easily available sources of external financing were analyzed, such as: long- and short-term subsidized loans and short-term commercial loans. The purpose of constructing the model was to find such a structure of external sources of financing in relation to the level of equity in agricultural holdings as to obtain the maximisation of income in family-owned agricultural holdings. The achievement of this goal was based on the following premises: maintaining financial liquidity, increasing the profitability of the conducted activity, as well as obtaining a higher rate of return on equity (while taking into consideration the adopted financing strategy).

In the optimization model in the quarterly perspective the balance value of cash generated from operating activity was maximised, while allowing for the operating costs and expenses for contracted loans. It enabled an analysis of short-term financial decisions which could be made by farmers in a situation in which higher levels of both short- and long-term indebtedness are employed in agricultural production.

The holdings in the population studied were divided according to the value of the overall debt ratio, which is calculated as a ratio of liabilities to total assets. Four groups were distinguished:

- holdings without liabilities,
- the first quartile constituting 25% of holdings with the lowest indebtedness levels,
- the doubled quartile including 50% of holdings with an average indebtedness level, and
- the last quartile covering 25% of holdings with the highest levels of indebtedness.

For the purposes of the optimization model the following were chosen: the holdings from the first quartile constituting 25% of all holdings with the lowest indebtedness levels ("low debt group") and the fourth quartile - covering 25% of holdings with the highest levels of indebtedness. The selection of these two groups was based on the consideration of differences in the existing capital structures in these holdings. In addition, applying the above selection criteria enabled the researcher to determine the effect of employing external sources of financing, provided the investment projects are carried out and the capital structure is optimized, in holdings with different strategies in the area of financing their activity.

The selection of "standard" holdings was intentional and consisted in choosing the most typical representatives of the general population and selecting entities with average characteristics[3].

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1 The FADN system in Poland collects data for agricultural holdings whose economic power is higher or equal to 2 ESU (Economic Size Unit). The selection of a sample of agricultural holdings in the FADN database is statistically representative in a given region, based on the reference to the area of cropland and the economic power (ESU) of that region. For the purposes of this study the Mazowsze (Mazovia) and Podlasie (Podlachia) regions have been selected, as there are middle-sized agricultural holdings with an average production intensity levels (according to data from FADN) located in those regions.

2 Standard Gross Margin (SGM) is a surplus of production levels in a given agricultural activity over the level of direct costs in production conditions which represent the average conditions in a given region.

3 In compliance with the dissemination principles of FADN data, the results presented cover a "standard farm" for a group of at least 15 holdings.

The process of selection of typical entities was carried out with regard to holdings through the application of the Euclidean distance[4].

Optimization restrictions were selected on the basis of balance characteristics, correlation and regression analysis, the estimated borrowing costs for particular components of capital together with their due dates were established on the basis of cooperation with a selected cooperative bank as well as on the basis of data obtained from a commercial bank. The following were considered to be the restricting conditions in models of capital structure optimisation:

1. $B_C > 0$ – balance value of cash greater than zero

The level of cash in agricultural holdings, both at the beginning and at the end of each quarter is greater than zero.

2. $\sum_i I_{STC} \geq \sum_i O_{STC}$

where:

I_{STC} – sum of short-term credit inflows, both subsidized loans, as well as commercial loans in the *i*th quarter, O_{STC} – sum of short-term credit outflows, both subsidized , as well as commercial in the *i*th quarter.

The short-term loans of holdings may, but need not, be repaid in total in a given business year. This results from the possibility of servicing the debt in typical holdings in a given period simultaneously with carrying out the planned investment projects and in a shortfall in sources of financing. Outstanding short-term loans will contribute to the increase of the share of short-term liabilities of those holdings to the end of the year. The cash flow balance from financial activity is greater than zero in a given year because of the fact that holdings use the subsidized long-term loans for investment purposes. Interest cost was allowed for as a variable which directly influences the balance from operating activity, thus shaping the financial results of agricultural holdings.

3. $\sum_i I_{STC} \leq A$

where: *A* – average value of current assets to the beginning and to the end of the year.

In the holdings with the lowest levels of indebtedness the possibility to employ short-term borrowing was restricted by the average value of current assets in a given quarter. This reflects a more conservative approach to the strategies of financing on the part of the managers in these holdings. In the case of holdings with higher levels of debt, on the other hand, the possibility to increase the level of employment of short-term borrowings may be demonstrated as follows:

$$\sum_i I_{STC} \leq 1{,}5 * A$$

[4] The average value obtained from actual data was used in the constructed optimization models. Standardization of characteristics was assumed in order to apply the value of the measurement units used to choosing a typical entity and to ensure their comparability. Measures of the similarity of entities were established on the basis of distances which constitute nonnegative values and which equal zero for the ith entity whose distance is the same as to the jth entity (researched population constituted almost 4500 farms). These assumptions enabled the creation of a multidimensional metric space in which an increase in the distance from the pattern signifies an increase of distance, whereas a value closer to zero means that an entity is more similar to the pattern (the typical entity).

This assumption results from the fact that managers in this type of holdings adopted a more aggressive strategy of financing the activity and accepting a higher level of risk connected with the possibility to contract short-term liabilities whose value exceeds 150% of the value of current assets. This reflects the possibility to periodically finance the fixed assets with short-term loans in situations of an increased demand for external sources of financing. Determining the top limit (cap) for the sum of financial inflows from short-term loans used for conducting activity made it possible to establish the maximum operation risk in agricultural holdings and to repay current liabilities.

4. $$3 * \sum_i I_{STCL} \leq \sum_i I_{STSL}$$

where: I_{STCL} – financial inflows from short-term commercial loans in the *i*th quarter,
I_{STSL} – financial inflows from short-term subsidized loans in the *i*th quarter,

The model restrictions were complemented by a condition which allows for the diversification of the capital structure; this was done by differentiating between the subsidized and commercial short-term sources of financing in a proportion of 3 to 1, (75 to 25%), which characterized the holdings with the highest levels of indebtedness. It results from limitation to raising capital from a cooperative bank and from a possibility to finance the activity with commercial loans.

5. $$ROE > C$$

where: ROE – return on equity (%),
C – cost of raising borrowed capital.

In the case of this restriction it is assumed that the return on equity rate should be higher than the cost of employing external capital, which is connected with an increase in financial costs and debt service. This assumption makes it possible to shape the employed borrowed capital which in such a way that it will contribute to the maximization of income from a family-owned agricultural holding and the maximization of the cash balance from operating activity in given management conditions.

6. Repaying the interest on loans

The outflows for interest on short-term loans have been calculated depending on their due date. In the case of loans extended for a period of 180 days - 66% of the value of interest is repaid in the first quarter, while the remaining 36% of this value - in the second quarter together with the repayment of the loan. Whereas in the case of loans with a due date after the lapse of 270 days: 50% of the value of interest is repaid in the first quarter, when the loan was contracted, while the remaining 33% of this value - in the second quarter and 17% - in the third quarter.

7. The minimum value of a short-term loan

$$\sum_i I_{STC} \geq \min value$$

This restriction results from setting a minimum value of short-term loans, both subsidized, as well as commercial.

On the basis of a given limit for raising short-term capital, the schedule for the repayment of interest and the borrowed sum, the formula of an exponential function has been estimated. This function makes it possible to encumber each given sum (e.g. 1 PLN) with a gradually higher interest rate, which increases proportionally to the value of short-term loans (table 1). The formula

Table 1. Exponential function of the employment of short-term sources of financing in the optimization model

Sources of financing	$x_{STSL(t=180)}$	$x_{STSL(t=270)}$	$x_{STCL(t=180)}$	$x_{STCL(t=270)}$
F(x)	$(x^{0,00286}-1)x$	$(x^{0,00506}-1)x$	$(x^{0,00450}-1)x$	$(x^{0,00706}-1)x$

STSL – short-term subsidized loans, *STCL* – short-term commercial loans, *t* – period
Source: own elaboration

of this function has been estimated particularly for every external short-term source of financing. It was thus possible to shape the debt level while allowing for the cost of raising capital from a selected source of financing. This function enables an estimation of risk which results from problems in repayment of higher levels of interest on loans from the current financial surplus in a given holding in a given quarter.

3. Research results

The capital structure optimization of agricultural holdings of the "granivores" type of farming allowed the carrying out of investment projects together with employing long-term subsidized loans. The demand for capital has been estimated on the basis of the possibility to obtain subsidized loans in cooperation with a cooperative bank. It was assumed that an investment project was carried out in the holdings which required the employment of long-term subsidized loan and which consisted in an adaptation of an empty building for a pigsty. The average cost of purchasing machinery and equipment, renovating and adapting an empty building for the purpose of pig breeding has been estimated. On this basis the demand for long-term capital has been calculated allowing for the possibility to obtain a subsidized loan in cooperation with a cooperative bank. In addition to employing long-term sources of financing, the necessity to make use of short-term working capital facilities in view of shortfall in cash for purchasing livestock in the 1st and 3rd quarter of the business year.

The decision variables which were assumed in the optimization model for the holding with the "granivores" type of farming included a short-term subsidized loan contracted in the *i*th quarter for the period of 180 days and a short-term commercial loan contracted in the *i*th quarter for the period of 180 days. This resulted from adapting an assumption about an open six-month pig production cycle in those holdings. The demand for capital was lower in the 2nd and 4th quarter due to higher inflows from operating activity (sale of pigs).

The effect of employing the borrowed capital in the form of operating inflows in the holdings of the "debt" and "high debt" groups in a given quarter resulted from an expansion of the scale of activity, and thus, from an increase in the production potential. These observations were reflected by greater outlays for production, which was financed with both equity and the borrowed capital. The surge in the inflows from operating activity in the *i*th quarter due to an increased use of short-term capital was estimated on the basis of the rate of return from 1 PLN of those financial inflows in the *i*th quarter. The influence of a higher level of short-term loan employment was established on the basis of an analysis of a linear regression conducted in agricultural holdings representing the analyzed agricultural type and characterized by the highest debt level. The increase in the level of inflows from operating activity was connected with an increase in the livestock density.

Table 2 presents the aggregate optimization results for the “granivores” type of holdings in two groups differentiated on the basis of their debt levels. In the case of holdings with a lower debt level the share of external sources of financing in total liabilities in relation to actual data increased by 16.9% points. On the other hand, the level of income from a family-owned agricultural holding in the “low debt” group, both in the case of actual data and in the case of model data, approximated the same value. In the case of these holdings it resulted from a high employment level of short-term subsidized sources of financing, the cost of which did not lead to an increase in income from a family-owned holding. The obtained financial surplus was used for satisfying the demand for capital linked to covering the expenses incurred because of the greater livestock density. Nevertheless, the situation should be assessed as beneficial in comparison to the level of total assets in this group of holdings due to success in maintaining approximately the same level of income and in carrying out an investment project of high value.

In the holdings from the “low debt” group a relatively higher level of employment of short-term commercial loans was noted amounting to 9.0% in the total liabilities structure (8.8% points) as compared to model data for the “high debt” group. This resulted from restrictions in obtaining subsidized sources of financing, which depended on the size of current assets, the level of which, in turn, was a condition for maintaining financial liquidity. The loan structure in holdings with the lowest and the highest debt levels was also characterized by a proportion of 3 (commercial) to 1 (subsidized) sources of financing. In holdings with the highest debt level, the majority of commercial loans utilized in the course of the year were repaid in the last quarter.

The debt structure optimization demonstrated a dominating position of long-term subsidized loans, the share of which was 63.8% in the “low debt” group and 75.0% in the “high debt” group. In holdings with the highest debt level, the share of subsidized loans was small (0.2%). This resulted from a lower level of demand for short-term capital in this group of holdings, as compared to those with the lowest debt level. It was also linked to a higher cost of obtaining subsidized loans and a reasonable decision to pay these loans first due to this higher cost. In holdings with the highest debt level on the other hand, short-term sources of financing were used on a larger scale in the course of the production cycle as compared to the “low debt” group. In “high debt” holdings a higher level of expenses from financial activity was observed due to repayment of short-term debts in a given business year (75.8%) in comparison to the value of financial inflows. In the “low debt” group the proportion of expenses to financed inflows was 71.0%. This resulted from a larger activity scale in holdings with the highest debt level, which is linked to a higher financial burden from investment projects carried out in the current period and repayment of long-term liabilities from previous years.

In holdings with the highest debt level for carrying out planned investment projects, which enables an increase in production potential, the optimum capital structure contributed to an increase by 15.6% in income from a family-owned agricultural holding. This situation indicates an increase in production potential in those holdings, with a simultaneous possibility to carry out investment projects and to achieve higher return rates linked to an increase in the effectiveness of production. This also indicates a positive influence of the increase in the level of employment of borrowed capital for the production purposes, which resulted from insufficient recapitalization of the activity of those holdings in the previous base period.

Table 2. The capital structure optimization results for “granivores” type of holdings (end-of-the-year figures)

Details	Groups of farms according to debt level			
	Low debt		High debt	
	Actual data	Model data	Actual data	Model data
Livestock density	25.4	33.4	47.4	55.4
Total debt ratio (%)	1.7	18.6	27.7	35.7
Debt structure (%) - long-term subsidized loans	-	63.8	-	75.0
- short-term subsidized loans	-	27.2	-	24.8
- short-term commercial loans	-	9.0	-	0.2
Share of operational inflows connected with additional employment of borrowed capital (%)	-	17.2	-	10.9
Cash flow balance dynamics ratio from operating activity in the model as compared to actual data (%)	100.0	98.6	100.0	115.7
Financial inflows structure (%) - long-term subsidized loans	-	29.2	-	20.9
- short-term subsidized loans	-	53.1	-	59.3
- short-term commercial loans	-	17.7	-	19.8
Income dynamics ratio in the model as compared to actual data (%)	100.0	98.6	100.0	115.6
ROE (%)	7.8	7.7	12.7	14.7
ROA (%)	7.6	5.8	8.8	8.9

Source: own elaboration

In the group with the highest debt level the investment assumptions and the adopted financing methods contributed to obtaining an increase in the operating activity balance by 15.7% as compared to actual data. In those holdings a higher level of cash has also been observed, which ensured solvency and financial liquidity, as well as the repayment of loans incurred in the previous periods in the course of the following quarters. The reason underlying this situation was a larger activity scale, which was connected to generating a higher disposable financial surplus from operating activity in comparison to the “low debt” group of holdings.

The effect of employing borrowed capital for the purpose of increasing outlays for production contributed to an increase in operational inflows in “low debt” holdings by 17.2%, and by 10.9% in the “high debt” group. A higher share of inflows from operating activity in the “low debt” group was linked to a greater importance of the investments planned to improve the operational effectiveness as compared to the holdings with a higher debt level with a larger scale of activity, which was evidenced by a higher livestock density at the stage of actual data. In the value-based approach, the increase in those inflows was greater in holdings with the highest debt level and resulted from a higher level of employment of short-term sources of financing as compared to the “low debt” group. It was also linked to an increase in the effectiveness of capital employment in those holdings, which was achieved by increasing operational inflows for production purposes. A higher level of total indebtedness in the “high debt” group contributed to the increase in the effectiveness of production in those holdings, which is evidenced by higher rates of ROE (2.0% points) and return on assets (ROA) (0.1% points) in the data obtained for the optimization model in relation to the initial-level data.

In the “low debt” group of holdings, an increase in debt and an investment project carried out simultaneously did not contribute to an increase in income levels from a family-owned agricultural holding, as compared to the actual data (a decrease of 1.4% could be observed). It resulted from a worse financial condition of these holdings and from a higher burden on the current activity in the form of investment expenses in the first year of the project implementation. After the optimization the return ratio decreased by 0.1% points for ROE and by 1.8% points for ROA. These observations prove the low effectiveness of the operating activity of the “low debt” group of holdings.

The optimization of sources of financing in view of an investment project and the continuous complementation of the demand for capital with short-term commercial loans made it possible to increase the ROE rate, while obtaining higher income levels from a family-owned agricultural holding and maintaining the solvency level only in the “high debt” group of holdings. The increase in indebtedness to the level of 35.7%, coupled with its effective utilisation in holdings, contributed to an improvement of the financial standing and to a development of the production activity. In an optimization task thus formulated it is assumed that a higher debt level is accepted in a situation in which a set goal is achieved by striving to maximise income from a family-owned agricultural holding.

4. Conclusions

1. This study presents the results of capital structure optimization based on the analysis of cash flows in agricultural holdings with animal production, with account taken of debt levels. On the basis of the research conducted the following conclusions have been drawn:
2. The employment of borrowed capital and the achievement of an optimum capital structure with regard to effectiveness in agricultural holdings with animal production characterised by a higher debt level were shaped mainly by external sources of financing. A higher debt level did not significantly limit the stability of financing and the possibility to increase the value of equity. This resulted from an increase in income from a family-owned agricultural holding coupled with the possibility to keep this source of internal financing within the holding.
3. Complementing cash shortfalls with short-term borrowings in the course of the operational cycle enabled the expansion of the scale of activity. This resulted from both the investment expenses incurred, and higher outlays for production in the case of those holdings. This indicates an improvement in the effectiveness of activity by making use of equity and borrowed capital, thus changing the capital structure.
4. The structure of external sources of financing within the framework of optimization results was characterised by a higher share of short-term loans in liabilities of agricultural holding with lower debt levels, as compared to the ones with the highest level of borrowed capital employment. This resulted from a higher general demand for capital in the case of these holdings.
5. Among holdings with a lower debt level a greater increase in the inflows from operating activity was noted due to the employment of short-term borrowed capital in relation to those with the highest share of payables in the liabilities (structure of inflows). It was generally connected with a lower surplus of own funds in these holdings; the surplus was not sufficient to finance either the investments or the expansion of the scale of activity.

6. In holdings with a higher debt level additional employment of borrowed capital, as compared to the previous structure of sources of financing, enabled an increase in ROE. It shows a potential for using a financial leverage effect by increasing the operational profitability of assets in this group of holdings. In those holdings the optimization results pointed to the optimum capital structure which reflected the order of priority for the farmers' selection of the sources of financing, which was linked to a dominating position of subsidized loans in the debt structure. Maintaining such a capital structure contributed to the maximization of the operational balance and of the income from a family-owned holding.

5. References

Behr P., Guttler A., 2007. Credit Risk Assessment and Relationship Lending: an Empirical Analysis of German Small and Medium-Sized Enterprises. Journal of Small Business Management vo. 45(2).

Kowal R., 2009. Statystyczne modelowanie przepływów pieniężnych w przedsiębiorstwach w warunkach niepewności. Rozprawy i Studia T. DCCCXV nr 741, Wydawnictwo Uniwersytetu Szczecińskiego, Szczecin.

Kowalczyk J., Kusak A., 2006. Decyzje finansowe firmy – metody analizy. Wydawnictwo C.H.Beck, Warszawa.

Lopez-Gracia J., Sogorb-Mira F., 2008. Testing tarde-off and pecking order theories financing SMEs. Journal Small Business Economic vol. 31.

Maślanka T., 2008. Przepływy pieniężne w zarządzaniu finansami przedsiębiorstw. Wydawnictwo C.H. Beck, Warszawa.

Mądra M., 2008. Hierarchia źródeł finansowania w mikro przedsiębiorstwach rolniczych. Studia i Prace Wydziału Nauk Ekonomicznych i Zarządzania, nr 10, Wydawnictwo Uniwersytetu Szczecińskiego, Szczecin.

Michaelas N., Chittenden F., Poutziouris P., 1999. Financial Policy and Capital Structure Choice in U.K. SMEs: Empirical Evidence from Company Panel Data. Small Business Economics vol. 12.

Michalski G., 2005. Płynność finansowa w małym i średnim przedsiębiorstwie, Wydawnictwo Naukowe PWN, Warszawa.

Modigliani F., Miller M.H., 1958. The Cost of Capital, Corporate Finance and the Theory of Investment. American Economic Review, vol. 48.

Śnieżek E.M., 2008. Sprawozdawczość przepływów pieniężnych – krytyczna ocean i propozycja modelu. Wydawnictwo Uniwersytetu Łódzkiego, Łódź.

Tokarski A., 2007. Strategie finansowania działalności przedsiębiorstw produkcyjnych. Wydawnictwo Adam Marszałek, Toruń.

CHARACTERISTICS, INTENTIONS AND EXPECTATIONS OF NEW ENTRANT DAIRY FARMERS ENTERING THE IRISH DAIRY INDUSTRY THROUGH THE NEW ENTRANT SCHEME

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Abstract

As part of the gradual expansion and abolition of EU milk quotas, the Irish government has approved the allocation of milk quota to a small number of new entrants to dairy production. The objective of this study was to describe the characteristics of new entrant dairy farm businesses developing within the Irish dairy industry in terms of geographical distribution, planned production system characteristics and intended operational scale and expected profitability based on an analysis of successful applications and business plans to the Irish New Entrant Dairy Scheme over a 3 year period. A total of 230 applications and business plans of entrants who received up to 200,000 litres of milk quotas through the New Entrant Scheme from 2009-2011, were analysed for the effects of region, age, household income, previous dairy experience, and education on overall business plan expectations. The results show that a youthful, highly educated and highly resourced group of new farmers are using the New Entrant Scheme to enter the Irish dairy industry. Applicant age has a significant impact on available investment equity and expectations, as younger entrants have less owned resources, are increasingly reliant on additional borrowing and have significantly increased expectations for the productive capacity of their potential farm businesses when compared to older entrants. The results provide a further indication that quota abolition is likely to result in an increased regional polarisation of milk production within Ireland with increased intensity of production within traditional milk production areas in the south.

Keywords: new entrant dairy farmers, pasture-based, characteristics, expectations, Ireland

1. Introduction

The introduction of milk quotas as part of the European Union (EU) Common Agricultural Policy (CAP) in 1984, constrained milk supply and provided stable and high milk prices for EU producers (Whetstone, 1999). Prior to the introduction of milk quotas, Irish milk production was growing by 7% per annum through increases in herd size and improved management to increase individual animal performance (CSO, 2011). The introduction of EU milk quotas curtailed this expansion and severely restricted industry development. While Irish milk production has remained stagnant since 1985, milk production in other countries such as New Zealand has increased by 62%, between 1983 and 2003 (Dillon et al., 2005). It is now generally accepted that while milk quotas protected and supported milk production in less competitive dairy regions, as a social policy, this was achieved at the expense of the expansion potential of more efficient producers. (IPTS, 2009). The policy restricted the entry of new younger dairy farmers while maintaining existing smaller scale producers (Dillon et al., 2005). Consequently, the CAP Health Check review in 2008 resulted in a decision to abolish milk quotas by 2015.

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The temperate climate of Ireland is condusive to high productivity grassland swards and provides Irish dairy farmers with a cheap high quality food source (Dillon et al., 1995, McCarthy et al., 2011). Consequently, comparatively lower costs of milk production have been reported in Ireland in comparison with other countries (Boyle, 2002, Dillon et al., 2006) and recent studies have concluded that EU milk quota removal will result in a proportionately larger expansion in milk production in Ireland (Lips and Rieder, 2005, DAFM, 2010). However, regional variation in profitability and competitiveness of milk production systems within Ireland may influence the geographical location of and potential for industry expansion within Ireland post-EU milk quotas. Brereton (1995) observed that the Irish grass-growing season ranged from 240 to 340 days per annum with a longer growing season occurring in the south of Ireland. Brereton (1995) suggested that regional variation in pasture growth (11-15 tonnes DM/ha/yr) is large enough to impact the technical and economic efficiency on Irish farms and should be considered in terms of the development of future low cost systems of production. Regional variation in milk expansion post quota abolition has been suggested by O'Donnell et al. (2010) who hypothesised that future expansion in milk production in Ireland would originate in the south where more favourable grass production characteristics allow lower milk production costs to be achieved.

The abolition of quotas will be preceded by a gradual increase in quota to member states (2% in 2008, and a further 1% per annum thereafter) to allow for a 'soft-landing' for dairy economies (IPTS, 2009). As part of this overall quota expansion, the Irish government also decided to offer one quarter of the 1% increase in total quota on a permanent basis to new entrants to the Irish dairy industry. As part of the application process, each successful new entrant applicant provided a detailed 5 year business plan incorporating physical and financial plans in addition to information on the location of their planned enterprises. As the first opportunity for new entrants to join the Irish dairy industry since the introduction of milk quotas, this group of new dairy producers represent the initial evolution of the dairy industry in Ireland post milk quotas and provide a unique opportunity to examine the characteristics of new dairy producers entering the industry.

The objective of this study is to describe the characteristics, intensions and expectations of new entrant dairy farm businesses developing within the Irish dairy industry, in terms of geographical distribution, planned production system characteristics and operational scale and expected profitability based on an analysis of successful applications to the Irish New Entrant Dairy Scheme over a 3 year period.

2. Materials and methods

2.1. Data

The applicants for the 2009, 2010 and 2011 milk quota allocations were obliged to submit an application form detailing relevant experience and educational qualifications with an accompanying 5-year business plan and a map of the proposed dairy holding to the Department of Agriculture Food and the Marine (DAFM). The 5-year business plan included an audit of existing resources, stock requirements, the source and nature of planned capital expenditure in addition to expected income and expenditure for each year of the plan (DAFM, Accessed October 2010). There are a total of 230 successful new entrants selected over the initial 3 years of the programme based on supplying adequate information. The information submitted by successful applicants was used to describe the expectations of new entrants to the dairy industry over the five initial years of these new businesses.

2.2. Data handling

A total of 50 key variables describing the characteristics of new entrants and their future dairy farm plans were generated from the application forms and business plans data including: *3 Regional Areas; 3 Age categories; 3 Other income categories; 4 categories of Dairy Experience; 3 categories of Educational Qualifications; 8 farm descriptors; 7 expected stock and productivity variables; 12 expected income variables; 11 planned expenditure variables* and *5 expected efficiency variables.*

2.3. Statistical analysis

Each continuous variable generated in this analysis was screened for normality using the Proc UNIVARIATE (SAS, 2006). The effect of region, age, other income, previous dairy experience and educational qualifications on the collated continuous data derived from the submitted business plans and application form (farm size, cow numbers, etc.) were analysed using a generalized linear model (SAS, 1999) according to the following model:

$$R_{ijklmn} = \text{mean} + R_i + A_j + H_k + D_l + E_m + RA_{ij} + RH_{ik} + RD_{il} + RE_{im} + RAHE_{ijklm} + e_{ijklmn}$$

Where R_{ijklmn} is the result for a farmer in the region i, within the age category j, with household income k, with previous dairy experience l and educational qualifications m; R_i is the effect of the ith region of production (i = SE, SW and BMW); A_j is the age category (j = under 30, 31-40, over 40); H_k is the other income available ($k = 1\text{-}3$); D_l is the previous dairy experience ($l = 1\text{-}4$); E_m is the educational qualification ($m = 1\text{-}3$) and e_{ijklmn} is the residual error term.

The effects of region, age category, other income, previous dairy experience and educational qualifications were tested for significance using the residual mean square as the error term. For binary variables, chi square analysis was performed using Proc FREQ (SAS, 2006).

2.4. GIS mapping

Each application provided ordinance survey maps and land ownership or land lease documentation which included the folio numbers and Land Parcel Identification Scheme (LPIS) numbers. The geographical distribution of the new entrant farms was conducted using ArcGIS v 9.3 (ESRI, Redlands, CA, USA). New dairy farm co-ordinates were mapped against the existing national distribution of specialist dairy farms within Ireland. A point density method was used to geographically map the farms. The Average Nearest Neighbour Distance tool was used to locate areas of farm clustering or if several new entrant farms are located in the one area.

3. Results

3.1. New entrant profile

The year of application (2009, 2010 or 2011) had no effect on the expectations of the new entrant farmers. The average new entrant applicant is 36 years of age (ranging from 21 to 62 years), while 97% are male. There was a large variation in knowledge and experience of dairy farming evident from the dataset. As the 180hour Agricultural Cert is a minimum prerequisite for Irish dairy farmers to establish land ownership and join the scheme, all applicants have obtained this minimal formal agricultural education. In addition to the minimum requirements, a further 72%

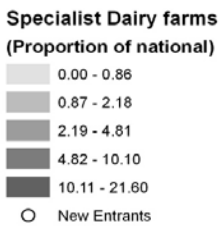
of applicants have completed a 2 year Advanced Agricultural Certificate in agriculture, while a further 21% have achieved a Bachelors degree level qualification. Fifty-eight percent of new dairy entrants are originating from previously beef enterprises, with 22% of all new entrants planning to become exclusively dairy farmers within 5 years. In terms of dairy experience, 44% of new entrants have a close relative in dairying (such as a parent, sibling or uncle) while a further 20% had no experience in dairy farming at the time of applying for milk quota under the New Entrants scheme, with the remainder having either worked as dairy farm labourers or as work experience students on a dairy farm at some point during their agricultural education.

The average new entrant has a substantial land block of 58.1ha (ranging from 20-199 hectares) and of which 60% is owned. The potential land base available to the new dairy farmers is extensive with an expected average stocking rate of 1.73 LU/ha, withstanding 71 cows. The predicted production expected by the new entrant businesses is 654kg MS/ha (fat plus protein kg) and an average milk yield of 4,954kg per cow. Almost 40% of new entrants have existing loan commitments while seventy-nine percent are hoping to secure loan finance as they develop their dairy farm, within a projected full set-up investment cost of €190,114 or €2,677/cow. The average new entrant farmer expects to produce an average of 352,360 litres of milk at an average production cost of 25 c/l and an average gross output of 30 c/l (including a 27 c/l milk price and a further 3c/l from sales of dairy stock). The expected profitability of a new entrant dairy farms is 5 c/l, equivalent to €428/ha and €248/cow.

3.2. GIS mapping and regional distribution

The majority of new dairy farms (80%) are located in the south of Ireland (Figure 1). Figure 1 demonstrates the density distribution of new entrant dairy businesses in comparison to the density of specialist dairy farms in Ireland by their respective county and region.

While region has no effect on the expected total level of capital investment required, the level of borrowings required to finance expansion was lowest in SW (€62,831) and highest in SE (€106,092) while BMW was intermediate (€91,854). Region had no significant effect on production (planned herd size, stocking rate or the level of milk production per cow) and financial (net profit per litre and per hectare) expectations.



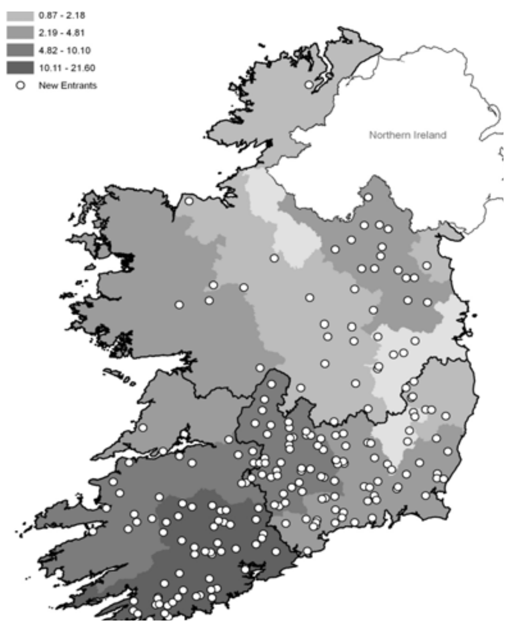


Figure 1. Regional distribution (South East, South West and Border Midlands and West) of new entrant farmers in contrast to the national proportion of specialist dairy farms in Ireland

3.3. The effect of age

The effect of new entrant age on existing resources and planned milk production characteristics and expectations are outlined in Table 1. The proportion of new entrants below 30 years of age (U-30), from 30-40 years of age (30-40) and greater than 40 years of age (O-40) was 26%, 45%, and 29%, respectively. While the total land area planned for dairying was unaffected by age, the area of owned land increased with increasing age (21, 35, and 47 ha for U-30, 30-40, and O-40 respectively). Age has a significant impact on the level of available equity for investment in dairy set-up. Only 63% of the U-30 group had an SFP income in comparison to 89% and 97% for 30-40 and O-40, respectively. Consequently, older new entrants have a significantly larger SFP (€18,874 and €24,925 for 30-40 and O-40, respectively) in comparison to U-30 (€10,246). New entrant age had no effect on either the level of required borrowing or the total level of capital investment planned. There was also no significant age effect on the planned herd size during the first 5 years, however stocking rate and milk solids output expectations were lower ($P < 0.01$) for older applicants (30-40 and O-40). Age had no effect on the expected profitability from milk production in terms of either profit per litre or profit per hectare.

Table 1. The effect of applicant age on the characteristics and expectations of new entrants to the Irish dairy industry

	Under-30	30-40	Over-40	s.e	P-value
Proportion of new entrants (%)	25.8	45.4	28.8		***
Total land (ha)	51	60	61	3.3	
Land owned (ha)	21 [a]	35 [b]	47 [c]	3.1	***
Available equity (€'s)					
Single farm payment	10,246 [a]	18,874 [b]	24,925 [c]	1,920.6	***
Other grants	2,935 [a]	4,471 [b]	5,717 [b]	547.7	**
Production					
Herd size (No. cows)	71	70	70	2.8	
Stocking rate (livestock units/ha)	1.95 [a]	1.68 [b]	1.64 [b]	0.068	**
Milk yield (kg/cow)	4,943	4,920	5,015	55.8	
Milk fat plus protein yield (kg/ha)	756 [a]	645 [b]	587 [b]	30.3	**
Profitability					
Net profit per litre (c/l)	0.08	0.04	0.05	0.013	
Net profit per hectare (€/ha)	565	369	383	90.1	

a,b,c means with different superscripts are significantly different ($P < 0.05$)

3.4. The effect of other income and knowledge and experience

Sixty-six percent of new entrants have an other income source originating from either the continuation of alternative agricultural enterprises or an off-farm job, a further 12.2% have a working spouse, while only 21.8% of the new entrants intend to be full-time specialist dairy farmers with no other additional income. Farms planning to be specialist dairy production units expect to have higher ($P < 0.05$) stocking rates (1.94 LU/ha) and milk output (5,094 kg milk/cow and 747kg MS/

ha) compared to either those with other income sources (4,932 kg milk/cow and 630 kg MS/ha) or a working spouse (4,838 kg milk/cow and 657 kg MS/ha). Full-time specialist dairy farmers also expect to achieve higher profits per litre (9 c/l) and per hectare (€733/ha) compared to either those with a working spouse (3 c/l and €231/ha, respectively) or those with an alternative income stream (5 c/l and €358/ha, respectively).

The majority of new entrants to dairying have gained dairy experience on their home family dairy farms (38%) or as dairy farm labourers (42%) while 20% have no previous experience of dairying. New entrant farm system productivity expectations were unaffected by educational qualifications or the level of previous dairy experience. Similarly, both the planned level of capital investment and the profitability expectations per litre and per hectare are similar for all new entrants irrespective of their level of dairy experience or educational qualification.

4. Discussion

The development of a farm business plan is an essential process to help farmers to focus on the necessary factors for business success, by defining realistic goals to create a viable future enterprise (Johnson and Morehart, 2006). While the analysis of actual farm financial results of new entrants provide the ultimate measure of business success, an analysis of business plans of over 230 successful new entrant dairy farmers highlight the available resources, knowledge and experience and expectations of those entering the Irish dairy industry. The importance of personal attributes (knowledge and experience, education) and expectations in motivating farmers to make significant changes to their farming activities has been widely recognised (Lockheed et al., 1980; Sumner and Leiby, 1987; Kumbhakar et al., 1991; Gloy et al., 2002). The current evaluation of new entrants to the Irish dairy industry provides a unique opportunity to identify the characteristics and expectations of new dairy farmers in addition to the potential evolution of the industry post EU milk quota removal in 2015.

The BMW region of Ireland, while representing 47% of the national land mass, currently accounts for just 25% of national dairy production (CSO, 2010). Shalloo (2004) estimated that the profitability of milk production in the BMW region is reduced by 38 to 58% of that possible on drier southern soils based on a comparative analysis of milk production results. Consistent with these findings, O'Donnell et al. (2010) concluded, based on an attitudinal survey of existing milk suppliers, that future expansion in milk production would mostly occur in the south of Ireland. Similarly, the results of this study indicate that despite having a lower spatial density of specialist dairy farms, only a small minority (19%) of new dairy farms are to be located within the BMW region. As Figure 1 demonstrates, these results provide a further indication that quota abolition is likely to result in an increased intensity of milk production within the already heavily concentrated traditional milk production areas in the south and east of Ireland.

Previous studies indicate that farmer expectations are intrinsically linked to prevailing industry and wider economic conditions in addition to market sentiment (Kelly et al., 2012) however, there was no year of application effect on biological or financial expectations of new entrants in this study despite relatively large variation in actual milk prices during the study period (23.3 c/l in 2009, 30.8 c/l in 2010 and 35.5 c/l in 2011; CSO, 2011). The overall levels of farm performance expectations of new entrants (4,954 kg of milk per cow with an average production cost of 25 c/l) are consistent with existing dairy industry performance norms (5,075 kg milk per cow and with production costs of 23c/l; (Hennessy et al., 2011)) while an average expected milk price of 28 c/l is consistent with overall industry expectations (Binfield, 2008). The analysis of new entrant farmer credentials indicates that a young and highly educated group of new farmers are using the New Entrant Scheme to enter the Irish dairy industry. With an average age of 36 years, this group of new dairy farmers are very young compared to either the existing demographic of dairy farmers (49 years) or the overall population of beef and mixed enterprise farmers (54 years) from which these new entrants originate (Hennessy et al., 2011). In contrast to the findings of Mishra et al. (2009) who reported lower levels of available equity and higher debt-to asset ratios amongst newly establishing farm business set-ups in the United States, the results of this study indicate that newly establishing dairy farmers in Ireland have considerable owned resources and equity from which to establish these new dairy units (with average decoupled EU payments of €22,992 in comparison to €19,488 for the average existing dairy farmer; (Hennessy et al., 2011)).

The impact of farmer age and experience on the expectations and likely performance of these new farm businesses is inconsistently reported in the literature. Although having less equity (savings, sales from previous enterprises, EU farm payments) and other assets (particularly owned land) and therefore requiring additional borrowings, younger new entrants (under-30 group) had significantly higher expectations for the productive capacity of their potential farm businesses. Mishra et al. (2009) similarly observed that younger farmers in the United States starting a new enterprise have fewer assets and concluded that, as younger farmers also have less experience at resource allocation, the financial performance of businesses run by younger farmers would be reduced. Summer and Leiby (1987) also found that older people tend to have fewer borrowings, and concluded that lower costs of borrowing result in larger farms and faster business growth. In contrast with these general findings, other studies have observed superior rates of technical development and adoption amongst younger farmers (Solano et al., 2003, Connolly and Woods, 2010) which may compensate for their inferior financial position. The results of the current study indicate that by initially setting-up with fewer financial assets, the overall profitability expectations of younger entrants are similar to older entrants due to superior farm productivity expectations.

In comparison with the average specialist dairy farmer who currently milks 57 cows on 50 hectares (Hennessy et al., 2011), the average new entrant is planning to milk 71 cows on 58 hectares. The positive expectations of highly educated new entrants are consistent with the findings of Lockheed et al. (1980) who observed that a farms productivity increases for every extra year spent in formal agricultural education. Similarly, other authors have observed that educational qualifications have a positive effect on the financial performance of the dairy farm (Mishra et al., 2009) resulting in increased technology adoption and improved on-farm technical efficiency (Kumbhakar et al., 1991). The increased incidence of other income among new dairy farm businesses (78%) within this study is indicative of the elevated educational status of this group (Mishra et al., 2009) while the reduced productivity and profitability expectations of farm businesses with a lesser reliance on dairy farm income is also consistent with previous findings (Foster, Rausser, 1991).

5. Conclusions

The analysed business plans and applications of over 230 successful new entrant dairy farmers highlight the existing resources, education, experience and expectations of those entering the Irish dairy industry in the lead up to EU milk quota abolition. The results show that a youthful and highly educated group of new farmers are using the New Entrant Scheme to enter the Irish dairy industry. Ninety-three percent of new dairy entrants have at least two years of formal 3rd level agricultural education and intend to develop larger scale and more efficient dairy farms post-EU milk quotas. Applicant age and other income has a significant impact on available equity and expectations of entrants as younger and specialised dairy entrants have less owned resources and significantly greater expectations for the productive capacity of their potential farm businesses when compared to older entrants or those with alternative income sources. The results also indicate that, with 81% of new entrants to dairying located in the south of Ireland, quota abolition is likely to result in an increased regional polarisation of milk production within Ireland with increased concentration of production in traditional milk production areas in the south and east of Ireland.

6. References

Boyle G.E., 2002. The Competitiveness of Irish Agriculture. *Report for the Department of Agriculture and Food.* Dublin: Irish Farmers Journal and the AIB group.

Brereton A.J., 1995. Regional and year to year variation in production. *In:* D.W. Jeffery, M. B. J.,J.H Mcadam (ed.) *Irish Grasslands: Their Biology and Management.* Royal Irish Academy, Dublin, Ireland.

Connolly R., Woods V., 2010. An examination of technology adoption & usage by farmers in Ireland. Dublin City University & Department of Agriculture, Fisheries and Food.

CSO, 2010. Principal Statistics in relation to Agriculture.: Central Statistics Office, Skehard Rd., Cork, Ireland.

CSO, 2011. Principal Statistics in relation to Agriculture. Central Statistics Office, Skehard Rd., Cork, Ireland.

DAFM, 2010. Food Harvest 2020. Dublin, Ireland: Department of Agriculture, Fisheries, and Food.

DAFM, Accessed October 2010. *http://www.agriculture.gov.ie/farmingsectors/dairy/newentrants-scheme/* [Online]. Dublin, Ireland.

Dillon P., Crosse S., Stakelum G., Flynn F. 1995. The effect of calving date and stocking rate on the performance of spring-calving dairy cows. *Grass and Forage Science,* 50, (3) pp.286-299.

Dillon P., Roche J.R., Shalloo L., Horan B., 2005. Optimising financial return from grazing in temperate pastures. . *In:* MURPHY, J. J. (ed.) *Utilisation of Grazed Grass in Temporal Animal Systems. Wageningen Academic Publications.* Wageningen, The Netherlands.

Dillon P., Hennessy T., Shalloo L., Thorne F., Horan B., 2006. Future outlook for the Irish dairy industry: a study of international competitiveness, influence of international trade reform and requirement for change. *International Journal of Dairy Technology,* 61, (1) pp.16-29.

Foster W.E., Rausser G.C., 1991. Farmer behavior under risk of failure. *American Journal of Agricultural Economics,* 73, (2) pp.276-288.

Gloy B.A., Hyde J., Ladue E.L., 2002. Dairy Farm Management and Long-Term Farm Financial Performance. *Agriculture and Resource Economics,* 31, (2) pp.233-247.

Hennessy T., Moran B., Kinsella A., Quinlan G., 2011. National Farm Survey 2010 Teagasc Agricultural Economics & Farm Surveys Department.

IPTS, 2009. Economic Impact of the Abolition of Milk quota Regime - Regional analysis of the milk production in the EU -. EuroCARE, GmbH, Bonn.

Johnson J., Morehart M., 2006. Farm Business Management. *Agricultural Resources and Environmental indicators.* 2006/EIB 16.

Kelly E., Shalloo L., Geary U., Kinsella A., Thorne F., Wallace M., 2012. The associations of management and demographic factors with technical, allocative and economic efficiency of Irish dairy farms. *Journal of Agricultural Science,* 150, (6) pp.738-754.

Kumbhakar S.C., Ghosh S., Mcguckin J.T., 1991. A Generalized Production Frontier Approach for Estimating Determinants of Inefficiency in U.S. Dairy Farms. *Journal of Business & Economic Statistics,* 9, (3) pp.279-286.

Lips M., Rieder P., 2005. Abolition of Raw Milk Quota in the European Union: A CGE Analysis at the Member Country Level. *Journal of Agricultural Economics,* 56, (1) pp.1-17.

Lockheed M.E., Jamison D.T., Lau L.J., 1980. Farmer Education and Farm Efficiency: A Survey. *Economic Development & Cultural Change,* 29, (1) pp.37-76.

McCarthy B., Delaby L., Pierce K.M., Journot F., Horan B., 2011. Meta-analysis of the impact of stocking rate on the productivity of pasture-based milk production systems. *Animal,* 5, (5) pp.784-794.

Mishra A., Wilson C., Williams R., 2009. Factors Affecting Financial Performance of New and Beginning Farmers. *Agricultural Finance Review,* 69**,** pp.160-179.

O'Donnell S., Shalloo L., Horan B., 2010. A survey of the factors affecting the future intentions of Irish dairy farmers. *Journal of Agricultural Science,* 5**,** pp.647-654.

SAS, 1999. User's Guide: Statistics, Version 8 Edition *SAS Institute, Inc.,*. Carey, NC.

Shalloo L., Dillon P., O'loughlin J., Rath M., Wallace M., 2004. Comparison of a pasture-based system of milk production on a high rainfall, heavy-clay soil with that on a lower rainfall, free-draining soil. *Grass & Forage Science,* 59, (c) pp.157-168.

Solano C., León H., Pérez E., Herrero M., 2003. The role of personal information sources on the decision-making process of Costa Rican dairy farmers. *Agricultural Systems,* 76, (1) pp.3-18.

Sumner D.A., Leiby J.D., 1987. An Econometric Analysis of the Effects of Human Capital on Size and Growth among Dairy Farms. *American Journal of Agricultural Economics,* 69, (2) pp.465-470.

Whetstone L., 1999. The Perversity of Agricultural subsidies. . *In:* MORRIS. J., R., B.R. (ed.) *Fearing Food, Risk, Health and Environment.* London, UK: Butterworth Heinemann.

THE IMPACT OF FARM SIZE ON SUSTAINABILITY OF DUTCH DAIRY FARMS

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Abstract

Sustainable milk production systems require economically viable, environmentally sound and socially acceptable practices. This study compared the economic, environmental and societal impact of large-scale farms with other dairy farms in the Dutch Farm Accountancy Data Network (FADN). Moreover the integrated sustainable performance of large-scale dairy farms was explored. To quantify the impact of farm size on economic performance, we used net farm income (NFI), labour productivity and solvency. We quantified environmental performance using indicators on non-renewable energy use, greenhouse gas (ghg) emissions, phosphorus surplus and pesticides use. To quantify societal performance indicators on milk quality, cow persistency and grazing were used. Large-scale dairy farms had a higher labour productivity and NFI than other dairy farms, without compromising on nitrogen use, energy use or ghg emission. Higher profits were accompanied by a lower solvency ratio on large-scale farms. Pesticides use, however, was higher on large-scale dairy farms due to a lower share of grassland. Large-scale farms had a shorter cow lifetime and applied less grazing compared to other dairy farms. For societal performance, current FADN does not have the potential to assess animal welfare using preferred animal-based indicators.

Keywords: FADN, sustainability, effects of scale, dairy farming

1. Introduction

Since the introduction of milk quota by EU-regulation in 1984, the number of Dutch dairy farms decreased, maintaining an equal level of milk production on sector level, i.e. increased farm size. Increasing farm size is a continuing process in Dutch agricultural and horticultural sector (Van der Meulen et al., 2011). To reduce fixed costs per kilogram of milk, further increase in farm size is necessary (Anonymous, 2009a). The abolishment of milk quota in the EU-27 by 2015, will further strengthen an increase in farm size and lead to a growth of Dutch milk production from 11.5 billion kg currently, up to 14 billion kg in 2020 (Anonymous, 2009a).

Sustainable milk production systems require economically viable, environmentally sound and socially acceptable practices (Thomassen et al., 2009). Over the last decades, sustainable milk production became increasingly important (Anonymous, 2009b). The Dutch Dairy Association and the Dutch Organisation for Agriculture and Horticulture, therefore, joined forces in the Sustainable Dairy Chain initiative. Via the Sustainable Dairy Chain initiative, the processing industry and farmers aim to strengthen future support within the market and society (Reijs et al., 2013).

In the Netherlands, perceptions on large-scale agriculture are diverse and trigger public discussion. Moreover, sustainable development of the production chain is included in policy making increasingly (Boone and Dolman, 2010). Therefore, there is need for a clear view on the relation between farm size and sustainability impact. Several studies explored combined economic, environmental, and societal performance of animal production systems (Van Calker *et al.*, 2006;

Meul et al., 2008; Dolman et al., 2012a). To our knowledge, however, no scientific publication exists that explored the impact of increasing farm size on integrated economic, environmental, and societal performance. The objective of this study, therefore, is to compare the economic, environmental and societal impact of large-scale farms with other dairy farms and explore the integrated sustainable performance of large-scale dairy farms.

2. Material and methods

We quantified economic, environmental and societal performance of specialized dairy farms in the Dutch Farm Accountancy Data Network (FADN) for 2011. The Agricultural Economics Research Institute continuously collects technical and economic data from a large sample of Dutch farms recorded in FADN, providing a wide range of economic, environmental and societal performance indicators. In 2011, FADN provided data from 298 dairy farms. To exclude effects of non-dairy activities, we selected dairy farms when at least 75% of the farm size, measured in standard output (SO), originated from dairy activity and data on all economic, environmental and societal performance indicators were available. Hence, we quantified the effect of farm size for 160 specialized dairy farms.

2.1. Performance indicators

Economic performance

To quantify the impact of farm size on economic performance, we quantified net farm income (NFI), labour productivity and solvency. NFI is often used as an indicator for profitability (Van Calker et al., 2008; Blank et al., 2009; Dekker et al., 2011). We defined NFI as the remuneration for management, family labour and capital that is left after all other costs are deducted (EC 2011). To correct for differences in farm size, we expressed NFI per unpaid annual working unit (awu). To give insight in the labour effort to realize the NFI, a measure of labour productivity is required (Dolman et al., 2012a). Labour productivity is a ratio of volume of output per unit of labour input (OECD, 2001). To enable a comparison of labour productivity among farms differing in scale, we expressed labour productivity in the average number of cows per annual working unit.

Solvency deals primarily with the firm's ability to meet total claims (Barry et al., 2000). A farm business is insolvent if sale of all assets fails to generate sufficient cash to pay all liabilities. We defined solvency as the ratio of total owners' equity as a per cent of total farm assets (equity-to-asset ratio) (Barry et al., 2000). The smaller the safety margins of equity, the greater the financial risk.

Environmental performance

We quantified environmental performance using indicators on non-renewable energy use, greenhouse gas (ghg) emissions, phosphorus surplus and pesticides use. Two main environmental objectives within the Sustainable Dairy Chain initiative are decreasing non-renewable energy use and climate change per kg of milk produced and was therefore available within FADN. Dutch FADN recorded non-renewable energy use at farm level, while ghg emissions were derived from a cradle-to-farm-gate life cycle assessment (LCA) (Reijs *et al*., 2013). For policy evaluation purposes, FADN provided phosphorus surplus per hectare as a measure for eutrophication and pesticide use per hectare as a measure for eco-toxicity.

Societal performance

We quantified societal performance using indicators on milk quality, cow persistency and grazing. These societal indicators were included within the Sustainable Dairy Chain initiative and therefore available in FADN. As a measure of milk quality, we used the somatic cell count. High levels of somatic cell count relate to clinical and subclinical mastitis, which is the most important reason for early culling of dairy cows (Reijs *et al*., 2013). We quantified cow persistency using the average cow lifetime (years), from birth until culling. Extended average cow lifetime indicate improvement in animal health. The number of hours grazing is included as an indicator for animal welfare and social perception (Dolman *et al*., 2012b).

Integrated assessment

To explore the impact of farm size on integrated economic, environmental and societal performance we compared 15% (n = 24) largest dairy farms by average number of cows with the rest of the group (n = 136). Several studies described an approach to aggregate values of performance indicators of livestock systems into a total score on sustainability (Van Calker et al., 2006; Meul et al., 2008; Dolman *et al*., 2012a;). We used an approach based on Meul *et al*. (2008) to compute the integrated performance on the ten economic, environmental and societal indicators. The performance was normalized on a scale from 0 through 100, whereby a score of 100 per indicator was assumed to be sustainable. Similar to *Meul et al*. (2008), a 10 and 90% percentile was used as a minimum and maximum value respectively. Using the 10th and 90th percentile tackles the problem of outliers in the linear approach. We visualized differences in integrated economic, environmental and societal performance using a benchmark diagram of the 15% largest dairy farms with the rest of the dairy farms. Differences between groups were tested using an independent sample t-test ($P < 0.05$).

3. Results

3.1. Descriptive

The 15% large-scale dairy farms had a higher total milk production, a larger cultivated area and a higher number of cows ($P < 0.001$) than other farms (Table 1). Moreover, large-scale dairy farms had a higher production per hectare ($P < 0.001$) than other dairy farms, whereas milk production per cow was equal on both group of farms.

Table 1. Comparison between farm characteristics for large-scale farms and other specialized Dutch dairy farms in 2011 (FADN)

Farm characteristic	Large-scale	Other	Significance [a)]
Number of farms	24	136	
Cows (psc)	202	78	***
Total milk production (kg)	1.714.093	635.083	***
Cultivated area (ha)	94	48	***
Grassland (%)	76	83	*
Milk production per cow (kg)	8.500	8.143	ns
Milk production per ha (kg)	18.311	13.343	***
Milk revenues in total turnover (%)	80	77	*

[a)] *$P < 0.05$; **$P < 0.01$; ***$P < 0.001$; ns – not significant in t-test
Source: own study

With 80% of total revenues origination from milk production, large-scale farms were more specialized than the rest of the farms. Furthermore, the percentage of grassland area was lower on large-scale farms (P < 0.05) than other dairy farms.

3.2. Economic, environmental and societal performance

For economic performance, large-scale dairy farms realized a higher labour productivity and NFI per unpaid awu, whereas solvency (57%, P < 0.01) was lower than on other farms (Table 2, Figure 1). For environmental performance, pesticide use (P < 0.01) was higher for large-scale farms. For societal performance, average cow lifetime (P < 0.05) and grazing hours (P < 0.01) were lower for large-scale dairy farms.

Table 2. Economic, environmental and societal performance of large-scale and other specialized Dutch dairy farms in 2011 (FADN)

Specification	Large-scale	Other	Significance[a]
Economic			
Labour productivity (cow/awu)b)	80	49	***
Net farm income (euro/unpaid awu)	72.840	31.368	***
Solvency (%)	57	70	***
Environmental			
Energy use (MJ/kg)	0,6	0,6	ns
Ghg emissions (kg CO_2-eq./kg)[c)]	1,2	1,3	ns
Phosphorus surplus (kg/ha)	5	14	ns
Pesticides use (kg as/ha)[d)]	1,2	0,5	**
Societal			
Somatic cell count (average/year)	210	216	ns
Cow lifetime (years)	4,8	5,4	*
Grazing hours (hours/cow/day)	1	8	***

[a]*P < 0.05; **P < 0.01; ***P < 0.001; ns – not significant in t-test; [b]awu – annual working unit; [c] cradle-to-farm-gate greenhouse gas (ghg) emissions; [d] as – active substance
Source: own study

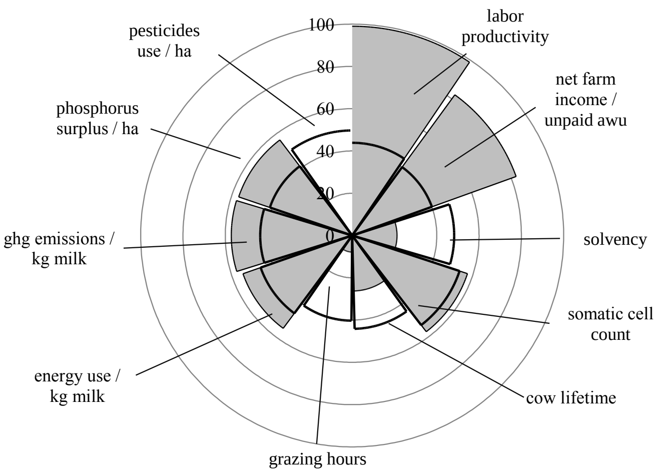

Figure 1. Comparison of indicator scores, 0 (not sustainable) and 100 (sustainable) of large-scale farms (grey wedges) with other specialized Dutch dairy farms (thick black line) in 2011 (FADN)
Source: own study

4. Discussion

4.1. Indicator selection

The basis for the selection of indicators was availability of data in the Dutch FADN and relevance within the Sustainable Dairy Chain initiative. For economic sustainability a large number of indicators are available to measure profitability. We choose NFI and labour productivity because other suggested attributes as liquidity are highly interrelated and linked to NFI (Van Calker et al., 2005).

We quantified environmental performance using indicators on non-renewable energy use, greenhouse gas (ghg) emissions, phosphorus surplus and pesticides use. For ghg we quantified cradle-to-farm-gate performance. Other indicators, however, quantified only impact at farm level and did not take into account the impact occurring in early stages of the milk production chain, such as purchased feed and fertilizers. Including indirect impact for energy use, eutrophication or acidification might differ for large-scale farms compared to other farms. Thomassen et al. (2009) stated, for example, that a high levels of milk production per ha positively effects total environmental impacts.

Van Calker et al. (2005) divided societal sustainability in internal and external societal sustainability. Internal societal sustainability represents the farmers' and employees working conditions, whereas external sustainability includes the societal concern about the impact of agriculture on the well-being of animals and people, such as animal welfare, food quality and spatial quality. FADN did not offer the possibility to quantify indicators for the farmers and employers working conditions. External societal performance of farms could be quantified based on FADN using somatic cell count, cow lifetime and grazing hours. We acknowledge that pasture hours is a simple indicator for welfare. Large dairy farms keep cows in the cowshed frequently. The modernity of cowsheds is higher on large dairy farms (Van der Meulen et al., 2011). In this analyses no indicator was available for the relationship between animal welfare and housing systems. Current FADN does not have the potential to assess animal welfare using preferred animal-based indicators. We didn't report about one relevant societal issue, food safety. The use of antibiotics is a suitable indicator for food safety (Dolman et al., 2012a). The use of antibiotics (daily dosages per animal year) is not reported, due to a lack of observations. Besides animal welfare and food quality, external sustainability includes spatial planning problems to cover the minimal aspects of societal performance. The effect on spatial quality is not quantifiable on farm level, and therefore, not included in the FADN sample (Dolman et al., 2012a).

4.2. Economic, environmental and societal performance

We used most recent available FADN data from one year, i.e. 2011. There were large fluctuations in NFI between years, which may affect the outcome of our analyses. The 2011 was a relatively prosperous year, with a high milk price (Van der Meulen *et al*., 2012). In a year with a low milk price, milk revenue and incomes will decline and significant differences on profitability caused by large-scale would be less.

Better economic results were accompanied by greater financial risks, i.e. lower equity-to-asset ratio. Large-scale farms had a lower solvency than other farms. The increased scale was mainly financed with bank loans. Higher funding makes large-scale farms vulnerable to price fluctuations in the future. The critical issue relating to solvency is the ability of the farm to generate cash to meet all expenses and service the debt with an acceptable margin of safety. Solvency ratios do not indicate an optimal level of leverage for a firm (Barry et al., 2000). Many farm lenders prefer borrowers having at least as much investment in their own farm as their lenders do. Therefore, a standard rule of thumb for the minimum solvency – ratio is 50%. However, the solvency norm varies substantially among farm business and from one type to another. It is commonly accepted that larger farms can carry relatively greater debt loads (Barry et al., 2000).

For environmental performance, we observed only a higher pesticides use on large-scale farms. Large-scale dairy farms had a lower share of grassland than other dairy farms. On large-scale dairy farms, grassland is more frequently rotated with maize resulting in a higher pesticides use compared with other dairy farms.

Large-scale dairy farms had an earlier culling age than other dairy farms. The high number of cows per awu, resulting in less available time to take care of sick cows, might cause this. Another explanation might be that large-scale dairy farms applied a lower grazing frequency than other dairy farms. Grazing becomes more complicated with increasing herd size. Higher levels of grazing decrease leg and claw problems for housing systems with non-optimal housing systems (Van den Pol-van Dasselaar et al., 2008).

5. Conclusions

Large-scale dairy farms had a higher labour productivity and NFI than other dairy farms, without compromising on nitrogen use, energy use or ghg emission. Higher profits were accompanied by a lower solvency ratio on large-scale farms. Pesticides use, however, was higher on large-scale dairy farms due to a lower share of grassland. Large-scale farms had a shorter cow lifetime and applied less grazing compared to other dairy farms.

6. References

Anonymous, 2009a. Anders melken; de toekomst van de Nederlandse melkveehouderij. Rabobank, Utrecht.

Anonymous, 2009b. Nota duurzaam voedsel, naar een duurzame consumptie en productie van ons voedsel. Raad voor het Landelijk Gebied, Advisory Commission of the Ministry of Economic Affairs, Agriculture and Innovation. Hague.

Barry P.J., Ellinger P.N., Hopkin J.A., Baker C.B., 2000. Financial Management in Agriculture, Sixth Edition. Interstate Publishers, Danville, Illinois.

Blank S.C., Erickson K.W., Nehring R., Hallahan C., 2009. Agricultural profits and farm household wealth: a farm-level analysis using repeated cross sections. Journal of Agricultural and Applied Economics 1: 207-225.

Boone J.A., Dolman M.A., 2010. Duurzame Landbouw in Beeld 2010; Resultaten van de Nederlandse land- en tuinbouw op gebied van People, Planet en Profit. Wageningen, Wettelijke Onderzoekstaken Natuur & Milieu, Wot - rapport 105.

Dekker S.E.M., De Boer I.J.M., Vermeij I., Aarnink A.J.A., Groot Koerkamp P.W.G., 2011. Ecological and economic evaluation of Dutch egg production systems. Livestock Science 139: 109-121.

Dolman M.A., Vrolijk H.C.J., De Boer I.J.M., 2012a. Exploiring variation in economic, environmental and societal performance among Dutch fattening pig farms. Livestock Science 149: 2012 143-154.

Dolman M.A., Sonneveld M.P.W., Mollenhorst H., De Boer I.J.M., 2012b. Comparing integral sustainability performance of convential farms with farms focussing on internal recycling of nutrients. 8th International Conference on LCA in Agri-Food Sector, Rennes, France, 2-4 October 2012.

EC, 2011. Community committee for the Farm Accountancy Data Network (FADN). Definitions of variables used in FADN standard results. Brussels, Belgium.

Meul M., Van Passel S., Nevens F., Dessein J., Rogge E., Mullier A., Van Hauwermeieren A., 2008. Motifs: a monitoring tool for integrated farm sustainability. Agron. Sustainable Dev. 28: 321-332.
OECD, 2001. Measuring productivity – OECD Manual: measurement of aggregate and industry-level productivity growth. OECD Statistics Directorate, Division of structural economic statistics.
Reijs J.W., Doornewaard G.J., Beldman A.C.G., 2013. Sectorrapportage Duurzame Zuivelketen. Nulmeting in 2011 ten behoeve van realisatie van de doelen. LEI, LEI Wageningen UR, Hague.
Thomassen M.A., Dolman M.A., Van Calker K.J., De Boer I.J.M., 2009. Relating life cycle assessment indicators to gross value added for Dutch dairy farms. Ecological Economics 68: 2278–2284.
Van Calker K.J., Berentsen P.B.M., Giesen G.W.J., Huirne R.B.M., 2005. Identifying and ranking attributes that determine sustainability in Dutch dairy farming. Agric. Hum. Values 22: 53-63.
Van Calker K.J., Berentsen P.B.M., Giesen G.W.J., Huirne R.B.M., 2006. Development and application of a multi-attribute sustainability function for Dutch dairy farming systems. Ecol. Econ. 57: 640-658.
Van Calker K.J., Berentsen P.B.M., Giesen G.W.J., Huirne R.B.M., 2008. Maximising sustainability of Dutch dairy farming systems for different stakeholders: a modelling approach. Ecol. Econ. 65: 407-419.
Van den Pol-van Dasselaar A., Vellinga T.V., Johansen A., Kennedu E., 2008. To graze or not to fraze, that's the question. Grassland Science in Europe Vol. 13: 706-716.
Van der Meulen H.A.B., De Bont C.J.A.M., Agricola H.J., Van Horne P.L.M., Hoste R., Van der Knijff A., Leenstra F.R., Van der Meer R.W., De Smet A., 2011. Schaalvergroting in de land- en tuinbouw; Effecten bij veehouderij en glastuinbouw. LEI, LEI Wageningen UR, Hague.
Van der Meulen H.A.B., Van Everdingen W.H., Smit A.B., 2012. Actuele ontwikkeling van resultaten en inkomens in de land- en tuinbouw in 2012. LEI, LEI Wageningen UR, Hague.

EXPERIENCE, LEARNING, AND INNOVATIVNESS IN BEEF PRODUCTION: RESULTS FROM A CLUSTER ANALYSIS

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Abstract

Research in agriculture and other industries has shown that innovativeness is a key driver of improved performance measures of small and medium-sized enterprises. The willingness to change current practice may be a function of the level of experience of the manager as well as the manager's commitment to learning. Firms with more experience may suffer from confirmation bias and therefore may not see the performance benefits that stem from innovative activities. Using data from a survey of beef producers, this study employs cluster analysis to segment firms along experience and learning variables. Using a non-hierarchical clustering procedure, three clusters emerge which represent younger firms with high and low levels of learning and older firms with moderate learning scores. The study employs one-way ANOVA tests to examine differences in innovativeness and performance across clusters. Results indicate firms with a commitment to learning have a greater willingness to accept innovations and are more satisfied with overall performance. The paper concludes with some implications for managers and policy makers.

Keywords: Cluster Analysis, experience, learning orientation, innovativeness, performance

1. Introduction

Many would consider prior experience to be an important resource for managers in any industry. One benefit of experience is that seasoned managers may be able to sense market changes more quickly or may be more adept at assessing the value of information (Martin, Staines 1994). Conversely, greater levels of experience may also lead to increased rigidity in accessing and applying new information (Kim, Oh, Swaminathan 2006). The USDA reports that the average age of a farmer has increased by one year in each agricultural census and younger operators tend to operate larger farms and earn greater returns (USDA -- National Agricultural Statistics Service 2007). It may be that as farmers' age, their aspirations change as well leading to different management decisions. This paper examines organizational learning within the context of primary agriculture to advance the understanding of the relationship between learning and experience.

Experience is often found to be an important resource that managers can draw upon (Wilson, Hadley, Asby 2001; Nuthall 2009). However, there may be instances where experience impedes innovation (and possibly performance) through structural rigidity (Boeker 1997; Koberg, Chesley, Heppard 2000). At the extreme, experience can inhibit learning if the manager makes incorrect inferences from the experience (Levinthal, March 1993). For example, as the tenure of the manager (and firm age) increases, confirmation bias may impede the search for additional perspectives on the competitive landscape (Klayman 1995). As lenders and policy makers often view experience as a value-enhancing resource, further analysis into the relationship between experience and learning may shed light on the issue within the context of production agriculture. One method that may help researchers and policy makers to increase their understanding of the issue is cluster analysis.

Cluster analysis is a statistical method that uses data of heterogeneous firms to create several homogeneous subgroups that are then analysed further. Previous studies have used cluster analysis to group according to their use of meetings and extension (Rosenberg, Turvey 1991), their view of themselves as entrepreneurs (Vesala, Vesala 2010), extensiveness of livestock systems (Usai et al. 2006) and animal husbandry practices (Kiernan, Heinrichs 1994). Researchers in the management and marketing literatures have clustered firms by market orientation strategies (Greenley 1995; Gellynck et al. 2012), innovativeness (Hollenstein 2003) and knowledge management practices (Zack, McKeen, Singh 2009).

The goal of this study is to examine the relationship between a managerial experience and the commitment to learning using a cluster analysis. Specifically, this paper will use cluster analysis to examine if homogeneous subgroups based on managerial experience and the manager's commitment to learning exist. Secondly, this research will examine how these groups differ in terms of innovativeness and their satisfaction with performance.

2. Previous research on farm performance

Performance of agricultural firms is affected by both industry and firm-level factors. Studies have shown that innovative firms are able to achieve greater performance levels (Verhees, Meulenberg 2004; Capitanio, Coppola, Pascucci 2009). As the industry evolves and firms compete for inputs, employees, and land, how firms innovate and how they deploy strategic resources will become of greater interest to researchers and policy makers.

2.1. Experience and performance

Previous literature on decision making has shown that older managers tend to seek more information when making a decision and were more accurate in assessing the value of information (Taylor 1975). Martin and Staines (1994) find that many managers believe competence is a function of industry experience. The basis of these studies is that experience may improve decision-making and therefore may lead to greater managerial competence. However, as Argote and Miron-Spektor (2011) point out, there are cases where experience limits creative thinking through the continued use of heuristics that were successful in the past.

Within the agricultural context, Nuthall (2009) suggests there is a dearth of literature on the relationship between managerial experience and performance. Of the literature that does exist, most studies examine the relationship between experience and efficiency. For example, Wilson et al. (2001) find that managers with more experience, who actively seek information, and who manage large farms are able to achieve higher levels of technical efficiency. More recently, Hansson (2008) finds that managerial experience is significantly related to both short-term and long-term measures of efficiency.

2.2. Learning and performance

Within competitive environments, performance may depend on the learning ability of the firm. As the nature of competition changes, successful firms will be those that are quickly able to become aware of the changes and that can acquire the resources and capabilities needed to compete. To this end, Slater and Narver (1995) suggest that the learning orientation of the firm may be the only driver of sustained competitive advantage. In an agricultural context, Bone et al. (2003) found that managerial attitudes and continuing training were important factors in farm performance in a sample of Australian farmers. Furthermore, Napier and Nell (2007) find that successful farmers are using new technologies and innovation to remain successful in an increasingly competitive environment. This is not possible without continuous learning on new technologies and markets. Finally, researchers have begun to use the balanced scorecard approach, which focuses on continuous learning, as a means to assess performance within agricultural systems (Lourenzani, Meirelles, Filho 2005; Shadbolt 2005)

3. Materials and methods

This research utilizes non-hierarchical cluster analysis using the two-stage clustering method within SPSS (version 20.0). Cluster analysis is a statistical tool that attempts to minimize the variation within groups while maximizing the variation between groups. This research then uses one-way ANOVA tests following the cluster analysis to assess if differences in scores of innovativeness and performance across groups are significant.

Data for this paper come from a questionnaire on managerial culture on beef farms in Illinois. The sampling frame (n = 1569) was based on a mailing list of members of the Illinois Beef Association in 2007. In total, respondents operating cow-calf herds and feeding out steers and heifers returned 347 usable questionnaires. This is study uses responses from 285 cow-calf producers in Illinois. Respondents in this sample are on slightly older than the average farmer is (68 years of age) and have managed their operations for an average of 32 years. The average farm consists of 942 acres and herd sizes average 69 animals.

The survey asked respondents to rate their level of agreement with questions that related to their level of innovativeness, performance, and the learning orientation of the firm. The survey also asked respondents how long they have been producing beef. The survey included five items from Sinkula, Baker, and Noordewier's (1997) organizational learning scale to measure commitment to learning. This scale examines the view that organizational learning is an investment that the firm can deploy to achieve certain advantages in the market. A scale developed by Hurley and Hult (1998) was included to measure firm innovativeness. The innovativeness scale asked farm managers to rate their level of agreement with different items that examined the penchant for managers to utilize innovative strategies to solve problems on the farm. Finally, performance was measured five subjective indicators. We use subjective performance as opposed to objective measures of performance as our sample consisted of small, privately held businesses that are generally unwilling to share confidential financial data, even in an anonymous setting.

Appendix A displays the survey items as well as reliability statistics.

4. Results

Table 1 displays the result of the cluster analysis. Using two-step clustering, three clusters emerge from the data. The distribution of firms across clusters is uniform as the ratio of largest cluster to smallest cluster is only 1.49 (113/76). Cluster 1 consists of firms that have more than 20 years of experience but score on the low end for learning orientation. Cluster 2 consists of firms with over 50 years' experience and a higher learning orientation than firms in Cluster 1. Cluster 3 consists of firms with the least experience (23 years) but the highest scores on the learning orientation scale.

As the input variable used in the clustering procedure was a summated scale, meaningful differences in scores are not apparent. Table 2 displays the individual items that make up the learning orientation scale and the differences across cluster groups. As one might expect, firms in Cluster 3 have the highest score on each item while firms in Cluster 1 have the lowest score.

Scores for firms in Cluster 2 are similar to the overall average score for the items. The largest differences between clusters occur in items assessing the shared vision of the firm and on items measuring the questioning of assumptions.

Following the cluster analysis, comparisons of innovativeness and performance scores were conducted using one-way ANOVA. Table 3 reports the results of this comparison. As one might expect given previous findings, firms that have a higher commitment to learning also have higher scores on organizational

Table 1. Average scores of experience and learning across clusters

	Cluster 1	Cluster 2	Cluster 3
Experience (years)	25.85	51.83	23.01
Learning Orientation	31.17	35.99	40.91
Herd Size	64.17	76.84	70.92
Acres Operated	908.87	1069.03	882.50
Operator Age	69.44	62.97	70.52
Education*	3.97	3.49	4.03
Number of cases	113	76	96

* 1 = some high school, 2 = high school grad, 3 = some college, 4 = vocational/tech degree, 5 = college grad, 6 = graduate degree

Table 2. Differences in learning orientation items across cluster groups

Learning Orientation Items	Cluster 1 E = 25.85 L = 31.17	Cluster 2 E = 51.83 L = 35.99	Cluster 3 E = 23.01 L = 40.91	Average	Difference (High-Low)
The basic values of this farm include learning as a key to improvement.	4.29	4.75	5.33	4.76	1.04
Our take is that learning is an investment, not an expense.	4.31	4.91	5.53	4.88	1.22
Learning on my farm is seen as a key commodity necessary to guarantee survival.	4.33	4.96	5.50	4.89	1.17
We are not afraid to challenge assumptions we have made about our customers.	3.76	4.21	5.01	4.30	1.25
There is total agreement on our organizational vision on our farm.	3.59	4.02	4.69	4.08	1.10
All employees are committed to the goals of this farm.	3.81	4.57	5.11	4.45	1.30
Employees view themselves as partners in charting the direction of the farm.	3.62	4.51	5.02	4.33	1.40
Personnel on this farm realize that the very way they perceive the market must be continually questioned and adapted.	3.46	4.07	4.71	4.04	1.25

Table 3. Innovativeness and performance scores across cluster groups

	Cluster 1 E = 25.85 L = 31.17	Cluster 2 E = 51.83 L = 35.99	Cluster 3 E = 23.01 L = 40.91	F-Statistic
Innovativeness (Summated)	22.07	23.47	25.57	29.779***
Technical innovation accepted	4.15	4.50	4.91	15.741***
Seldom seek innovative ideas#	4.31	4.51	5.10	14.183***
Innovation accepted	4.12	4.59	4.93	22.336***
Penalized for new ideas#	5.01	5.17	5.46	5.240*
Innovation is risky#	4.48	4.70	5.17	10.759**
Performance (Summated)	21.90	23.51	24.64	7.610**
Return on farm assets met expectations#	3.59	3.78	3.84	1.000
Satisfaction with overall performance	3.70	4.13	4.45	11.962**
Return on production investments	3.79	4.18	4.31	6.700*
Cash flow was satisfactory#	3.72	3.74	3.85	0.313
Return on marketing investments	3.80	4.05	4.26	5.361*
We receive higher prices than competitors	3.44	3.74	3.96	5.972*

Note: Items with an # were negatively phrased and were reverse coded, F-statistics: ***,**,* signify significance at the 0.001, 0.01, and 0.05 levels, respectively

innovativeness. Greatest differences between the clusters occur on items that measure the acceptance of innovation and the reverse coded item measuring how often they seek innovative ideas.

Satisfaction with performance did not differ as significantly across clusters. While the summated performance score was significantly different across clusters, differences among individual items were significant in four of the six items. The analysis shows no significant differences in satisfaction with return on farm assets or cash flow. Firms that had a commitment to learning were more satisfied with overall performance and the return on production and marketing investments. Firms with higher learning scores also were more likely to agree that they received higher prices than their competitors.

5. Discussion

The goal of this research was to examine the role of learning in innovativeness and performance. Using two-step cluster analysis, three clusters emerge using years of managerial experience and a summated learning orientation score as inputs. Cluster 1 consisted of firms with over 20 years' experience but lower learning orientation scores. Firms in Cluster 2 had extensive experience and somewhat higher learning orientation scores. Cluster 3 consisted of firms with the least amount of experience in the beef industry but the highest scores on the learning orientation items. Interestingly, a cluster of firms that had high experience and low learning did not emerge from the data. This may be due to survivor bias as firms that do not view learning as a key to survival or do not question assumptions may have already exited the industry.

One-way ANOVA analysis revealed that scores on innovativeness and performance items were significantly different across clusters. Firms that were more likely to agree with the items assessing learning orientation, that is, those with higher scores on learning orientation items also had higher scores for items that measured the level of innovativeness and performance. This result seems to corroborate the findings of Wilson et al. (2001) who find that farms with more experience also exhibit higher levels of technical efficiency. This increase in efficiency may be the result of the willingness these farms display in the adoption of new technologies.

Policy makers interested in helping small farmers succeed may find that programs such as demonstration farms (Pangborn, Woodford, Nuthall 2011) and learning groups such as the Beef Profit Partnerships model that has been successful in Australia and New Zealand (Clark et al. 2007) may increase the adoption of best practices and improve the viability of small and beginning farms. The formation of production alliances in South Africa have shown some promise as they are methods for managers of smaller farms to get together to overcome size inefficiencies and share valuable information (Terblanche, Willemse 2011).

The agricultural industry is continually evolving. Globalization and consolidation are leading to increased competition for inputs and market access. Firms that do not stay abreast of these changes may find themselves unable to compete with firms that have invested time and money in building a learning orientation. Future research could examine how firms with a learning orientation acquire relevant information. Historically, farm consultants have played an important role in the provision of market information and strategic planning to primary agriculture. More technologically adept farmers may find that supplementing that service with information from online social media platforms (i.e. Twitter, Facebook, LinkedIn, and YouTube) is also beneficial. Trough social media, producers can participate in discussions and chats where participants share their views and experiences on production and management issues. Through these online discussions with participants located all over the world, farmers receive an antidote for structural and cognitive rigidity, which may limit the innovativeness and performance of their farm.

This results presented here should be of interest to managers and policy makers. These findings seem to corroborate the results from recent research on factors affecting performance of SMEs outside of agriculture which found that firms that emphasize continual learning are more innovative and have better performance (Rhee, Park, Lee 2010; Real, Roldán, Leal 2012). These results may be especially important to small and beginning firms that may not the benefit of previous experience from which to draw on when issues arise. However, as seen by these results, beginning firms may only become experienced firms if they refrain from becoming too rigid continually question business and production practices and have a willingness to change.

6. References

Argote L., Miron-Spektor E., 2011. Organizational Learning: From Experience to Knowledge. *Organization Science* 22 (5): 1123-1137.

Boeker W., 1997. Strategic Change: The Influence of Managerial Characteristics and Organizational Growth. *The Academy of Management Journal* 40 (1): 152-170.

Bone Z., Henry E., Hunt E., Sefton C., 2003. Attitudes and Family Farm Business Performance. In *14th International Farm Management Congress*.

Capitanio F., Coppola A., Pascucci S., 2009. Indications for Drivers of Innovation in the Food Sector. *British Food Journal* 111 (8): 820-838.

Clark R., Griffith G., Madzivhandila P., Nengovhela B., Parnell P., Timms J., 2007. Achieving Sustained Improvements in Profitability in Beef Enterprises and Regions in South Africa and Australia In *16th International Farm Management Congress*, 379-392.

Gellynck X., Banterle A., Kühne B., Carraresi L., Stranieri S., 2012. Market Orientation and Marketing Management of Traditional Food Producers in the EU. *British Food Journal* 114 (4): 481-499.

Greenley G.E., 1995. Forms of Market Orientation in UK Companies. *Journal of Management Studies* 32 (1): 47-66.

Hansson H., 2008. How Can Farmer Managerial Capacity Contribute to Improved Farm Performance? A Study of Dairy Farms in Sweden. *Food Economics - Acta Agriculturae Scandinavica, Section C* 5 (1): 44-61.

Hollenstein H., 2003. Innovation Modes in the Swiss Service Sector: a Cluster Analysis Based on Firm-level Data. *Research Policy* 32 (5): 845-863.
Kiernan N.E., Heinrichs A.J., 1994. Identification of Farm Manager Types Through Cluster Analysis of Calf and Heifer Management Practices. *Preventive Veterinary Medicine* 18 (3): 225-236.
Kim T-Y, Oh H., Swaminathan A., 2006. Framing Interorganizational Network Change: A Network Intertia Perspective. *The Academy of Management Review* 31 (3): 704-720.
Klayman J., 1995. Varieties of Confirmation Bias. *Psychology of Learning and Motivation* 32: 385-418.
Koberg C., Chesley J.A., Heppard K.A., 2000. Adaptive Latitude: Environment, Organization, and Individual Influences. *Journal of Business Research* 50 (3): 259-272.
Levinthal D. A., March J.G., 1993. The Myopia of Learning. *Strategic Management Journal* 14 (S2): 95-112.
Lourenzani W.L., Quieroz T.R., de Souza Filho H.M., 2005. Strategic Mapping of the Rural Firm: A Balanced Scorecard Approach. In *15th International Farm Management Conference*, 289-296.
Martin G., Staines H., 1994. Managerial Competences in Small Firms. *Journal of Management Development* 13 (7): 23-34.
Napier R., Nell W.T., 2007. How the World's Leading Farmers Are Responding to Global Changes -- A Consultant's Review. In *16th International Farm Management Conference*, 143-151.
Nuthall P., 2009. Modelling the Origins of Managerial Ability in Agricultural Production. *Australian Journal of Agricultural and Resource Economics* 53 (3): 413-436.
Pangborn M.C., Woodford K.B., Nuthall P.L., 2011. Demonstration Farms and Technology Transfer---The Case of the Lincoln University Dairy Farm. *18th International Farm Managment Congress*: 166-171.
Real J.C., Roldán J.L., Leal A., 2012. From Entrepreneurial Orientation and Learning Orientation to Business Performance: Analysing the Mediating Role of Organizational Learning and the Moderating Effects of Organizational Size. *British Journal of Management* Forthcoming.
Rhee J., Park T., Lee D.H., 2010. Drivers of Innovativeness and Performance for Innovative SMEs in South Korea: Mediation of Learning Orientation. *Technovation* 30 (1): 65-75.
Rosenberg A., Turvey C.G.. 1991. Identifying Management Profiles of Ontario Swine Producers Through Cluster Analysis. *Applied Economic Perspectives and Policy* 13 (2): 201-213.
Shadbolt N.M., 2005. Strategic Management of Farm Businesses: The Role of Strategy Tools with Particular Reference to the Balanced Scorecard. In *16th International Farm Management Conference*, 860-870.
Sinkula J.M., Baker W.E., Noordewier T., 1997. A Framework for Market-Based Organizational Learning: Linking Values, Knowledge, and Behavior. *Journal of the Academy of Marketing Science* 25 (4): 305-318.
Slater S.F., Narver J.C., 1995. Market Orientation and the Learning Organization. *Journal of Marketing* 59 (3): 63-74.
Taylor R.N., 1975. Age and Expereince as Determinants of Managerial Information Processing and Decision Making Performance. *The Academy of Management Journal* 18 (1): 74-81.
Terblanche L., Willemse B.J., 2011. Developing a Framework in Order to Assist Producers in Forming an Alliance as Part of Their Competitive Strategy in the Potato Industry. *18th International Farm Managment Congress*: 172-180.
Usai M.G., Casu S., Molle G., Decandia M., Ligios S., Carta A., 2006. Using Cluster Analysis to Characterize the Goat Farming System in Sardinia. *Livestock Science* 104 (1-2): 63-76.
USDA -- National Agricultural Statistics Service, 2007. "2007 Census of Agriculture." http://www.agcensus.usda.gov/.
Verhees F.J.H.M., Meulenberg M.T.G., 2004. Market Orientation, Innovativeness, Product Innovation, and Performance in Small Firms. *Journal of Small Business Management* 42 (2): 134-154.
Vesala H.T., Vesala K.M., 2010. Entrepreneurs and Producers: Identities of Finnish Farmers in 2001 and 2006. *Journal of Rural Studies* 26 (1): 21-30.
Wilson P., Hadley D., Asby C., 2001. The Influence of Management Characteristics on the Technical Efficiency of Wheat Farmers in Eastern England. *Agricultural Economics* 24 (3): 329-338.
Zack M., McKeen J., Singh S., 2009. Knowledge Management and Organizational Performance: An Exploratory Analysis. *Journal of Knowledge Management* 13 (6): 392-409.

APPENDIX A. MEASURMENT ITEMS

Measurement items	Mean	Standard deviation	Item - to - total correlation
Learning Orientation (Alpha = 0.837)			
The basic values of this farm include learning as a key to improvement	4.76	0.891	0.556
Our take is that learning is an investment, not an expense.	4.88	0.968	0.570
Learning on my farm is seen as a key commodity necessary to guarantee survival	4.89	0.960	0.649
We are not afraid to challenge assumptions we have made about our customers	4.30	1.055	0.483
There is total agreement on our organizational vision on our farm	4.08	1.089	0.506
All employees are committed to the goals of this farm.	4.45	1.095	0.676
Employees view themselves as partners in charting the direction of the farm	4.33	1.190	0.581
Personnel on this farm realize that the very way they perceive the market must be continually questioned and adapted	4.04	1.040	0.529
Innovativeness (Alpha = 0.712)			
Technical innovation based on research results is readily accepted	4.50	1.020	0.477
We seldom seek innovative ideas which we can use on our cattle operation[#]	4.63	1.148	0.539
Innovation is readily accepted in our beef operation.	4.52	0.942	0.529
Individuals on our farm are penalized for new ideas that don’t work[#]	5.20	1.020	0.297
Innovation in our farm is perceived as risky and is resisted[#]	4.77	1.118	0.520
Performance (Alpha = 0.819)			
The return on farm assets did not meet expectations last year[#]	3.73	1.328	0.656
We were very satisfied with the overall performance of the farm last year	4.07	1.153	0.710
The return on production investments met expectations last year.	4.07	1.092	0.756
The cash flow situation on the farm was not satisfactory[#]	3.77	1.312	0.559
The return on marketing investments met expectations last year.	4.02	1.041	0.624
The prices we receive for our product is higher than that of our competitors	3.69	1.101	0.249

ECONOMIC ANALYSIS OF ANEROBIC CO-DIGESTION USING DAIRY MANURE AND BYPRODUCT FEEDSTOCKS

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Abstract

There is increasing interest in the United States to expand the use of anaerobic digestion (AD) as a means to generate renewable energy and reduce greenhouse gas emissions from dairy operations. Economic feasibility is the primary constraint facing farmers and investors considering an AD capital investment. The purpose of this paper is to develop an economic optimization model of an AD system using co-digestion of dairy manure and byproduct feedstocks. This model uses a daily time step to specifically model the operating parameters and AD technical design and capacity constraints. The end of system digestate is applied to farm land subject to agronomic application rates and timings. The model is applied to an existing AD system producing electricity in Washington State. The paper reports the technical aspects and operating parameters of the modeled AD system. The economic results conclude a positive economic feasibility but a low rate of return for the modeled system. The conclusions suggest evaluate alternative AD design options and AD evaluation methods to increase the economic feasibility of AD systems for dairies.

Keywords: anaerobic digestion, co-digestion, linear programming, economic feasibility

1. Introduction

Anaerobic digesters (AD) are fixed capital assets that have been constructed to improve the environmental sustainability of dairy farm nutrient management systems, and are now receiving increasing interest for their potential to generate additional revenues. Previous economic analyses of AD, have applied annual capital budgeting to evaluate economic feasibility. Annual budget estimates may oversimplify the AD management on a day to day basis when considering manure inflow rates and delivery of co-digestion feedstocks with respect to the AD design capacities and regulatory constraints. There is a need for a model that evaluates within year AD management strategies that maximizes an anaerobic digester's economic sustainability. The Anaerobic Digester OPTimizer (ADOPT) programming model simulates daily AD management to optimize the annual net economic return of an anaerobic digester utilizing dairy manure with co-digested pre-consumer food-waste feedstocks. The feedstocks have variable value in terms of tipping fees, volumes delivered, nutrient composition and bio-gas electricity producing potential. Anaerobic digestion is receiving increased attention in the United States due to increasing interest in generating renewable energy and reducing greenhouse gas emissions. The USDA has introduced initiatives to promote agriculture based biogas energy development. The USDA signed a memorandum of understand with dairy producers through the Innovation Center for U.S. Dairy to accelerate the adoption of dairy based biogas installations with a goal of 25 percent reduction in greenhouse gas emissions from manure by the year 2020 (USDA News Release, 2011).

Technical feasibility is not the primary hurdle to successful implementation of AD at dairies provided the AD is planned, designed, constructed and operated properly. Anaerobic digestion of dairy manure technology is available for farm applications through a number of commercial vendors. Although AD technology has waste management, environmental and potential economic benefits, it has not been widely adopted in the United States. The number of new farms adopting AD has grown annually since 2000, and there are now over 100 dairy digesters in operation in the U.S., servicing approximately 150,000 cow equivalents Frear and Yorgey (2010). Although the number of ADs is increasing, the present digesters service only small fraction of the potential farms and cows. Barriers to adoption include the intensive capital cost of the existing commercial systems, with typical systems costing as much as $1,500/cow for a 500-2,000 cow operation Frear and Yorgey (2010).

The limited adoption of AD could be due to financial infeasibility or lack of information regarding AD profitability management. Previous economic studies of an AD apply a capital budgeting methodology using AD construction cost estimates and annual projections of AD net revenues to determine the net present value of AD scenarios under consideration. Bishop and Shumway (2009) used a capital budget case study of a Washington AD. Leuer, Hyde and Richard (2008) used a capital budget approach and introduced stochastic parameters on AD revenue factors and life expectancy to analyze AD economics on three different sized dairy farms in Pennsylvania. In each of these and other capital budget AD feasibility studies the capital budget net economic return results are very sensitive to the modeling input parameters associated with the scenario with results ranging from large losses to large net gains. This indicates that AD design and management are critical to AD success.

2. ADOPT model

The ADOPT model was designed to simulate the daily management of an AD. ADOPT is a linear programming model that maximizes the annual net revenue of the AD using a daily time step subject to the AD design capacity and operating constraints. The ADOPT model's objective function is represented in the following equation.

$$Maximize \sum_{t}^{T} \sum_{i}^{n} R_{it}\, P_{it} - \sum_{j}^{m} VC_{jt} - FC$$

The equation is simply the AD profit function that the model maximizes the difference between daily revenues produced minus the daily operating variable costs and the annual fixed costs. Where t represents a day summed over the year T = 365. The variable i represents each revenue source, i = 1 to n, multiplied by the price received for each revenue source, P_{it}. The daily variable cost is VC_{jt} for each variable cost factor j and FC is the annual fixed cost FC. Figure 1 shows the inflows into the AD and the n revenue sources for the ADOPT model. The following sections describe the project site, revenue sources and costs modeled in ADOPT.

2.1. Project site

The base modeling parameters were obtained through a collaborative research project at the Qualco Energy Anaerobic Digester in Monroe, Washington. The project involves an intensive data collection on the AD inflows, bio-gas production, electricity generation, solids, and effluent. The Qualco digester was developed in 2008, and is a public-private partnership between Northwest Chinook Recovery, the Tulalip Tribe, and the Snohomish / Skykomish Agricultural Alliance. Although the digester currently receives manure from only one dairy, the digester was designed with the capacity to receive manure from several nearby dairies through a gravity fed sewer pipe system to the digester that avoids trucking transportation costs. After flowing through the AD the effluent is stored in a lagoon at the AD site. Effluent is pumped back to the dairy farm for agricultural field applications. The dairy is about 1 mile away from the digester, has about 1,100 cows, beds with sand and has a flush manure management system.

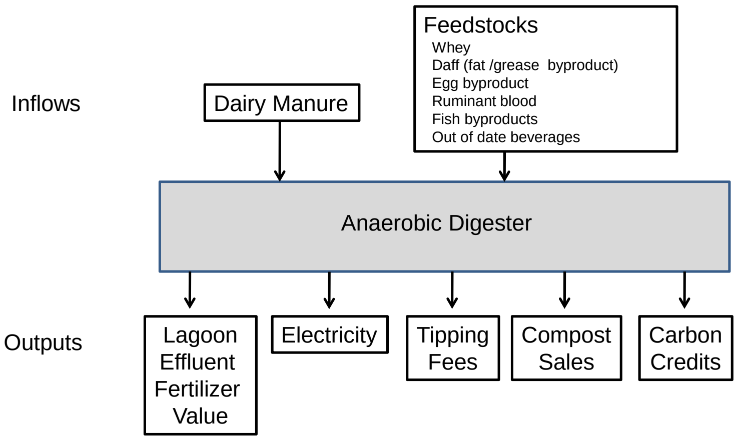

Figure 1. ADOPT Model AD Inflows and Revenue Sources

2.2. Tipping fees

Anaerobic digestion is not limited to manure. Dairy anaerobic digesters can also accept non-manure organic wastes co-digestion feedstocks that can be digested by bacteria to produce methane. Accepting co-digestion feedstocks generates revenue through tipping fees and can also increase the amount of bio-gas produced to increase electricity sales. Bio-gas production from other organic wastes can produce more methane than from manure alone. In dairy digesters, the large feedstock of animal manure helps stabilize the digestion process by providing a high buffering capacity Murto, Bjornsson, and Mattiasson (2004).

ADOPT simulates the daily inflow of manure and co-digestion feestocks using daily data collected at the Qualco project site. Over the time frame modeled the following co-digestion feedstocks were added to the AD: whey, daff which is fat/grease by-product, ruminant blood from a beef packing plant, processed frozen fish byproducts, and out of date beverages which are high in sugar content. Each of these feedstocks were analyzed for nutrient composition and bio-gas production potential. The associated revenue from the feedstocks are called tipping fees to reflect a load of feedstock being tipped into the digester receiving tank. The tipping fee revenue for each feedstock is an individually negotiated contractual rate. The individual contractual tipping fee rates are confidential and are not disclosed in this report. The cumulative tipping fee revenue is reported in the results section.

2.3. Electricity

The Qualco AD is designed to capture the bio-gas and burn the methane to produce electricity. Qualco sells all of the power generated and is not designed as a net metering system. The electricity sales are the megawatt hours generated per day sold to Puget Sound Energy transferred through Snohomish PUD. The electricity revenue is the price per megawatt sold net of the wheeling fee plus Washington's renewable energy credit. The renewable energy credit is $5 per megawatt hour. The net revenue generated is $74 per megawatt hour in the base case analysis. Due to the availability of hydro-electric power in Washington the electricity sale rates are lower in comparison to other regions. The generator is a 450 KW Gauscor system.

2.4. Compost

Most AD use solid separators to reduce the amount of solids stored in their lagoons. The separated solids can be composted and then reused as bedding, sold off site commonly for nursery applications, or applied as a soil amendment. The compost is high in fiber and has some nutrients. The project site AD has a screw press solids separator that is composted using a Daritech Inc. Bedding Master composting system. Presently there are no contracts for continued sales of the compost. Some of the compost is used as bedding and the extra is used as an agriculture field soil amendment. In the base case of the ADOPT model there is no revenue from compost that reflects the current situation that there are no compost sale contracts.

2.5. Carbon Trading Credits

For digester owners, carbon trading is a potential source of revenue because methane emissions are reduced and that can be converted into a carbon credit. However due to the failure to enact federal legislation to establish a carbon cap and trade system, the carbon market has largely collapsed with the exception of regional efforts to establish carbon emission caps. Some dairies have carbon sale contracts that continue to generate revenue. The project site has a small carbon trading contract that generates revenue.

2.6. Other potential revenue co-products

Adding other organic waste feedstocks to dairy digesters can increase biogas production but they can also increase nitrogen and phosphorus nutrients when compared to manure only. Under the dairies nutrient management plan, the increased nutrients for additional feedstocks need to be quantified and incorporated into the nutrient management plan so that the field applications of effluent nutrients are balanced with crop production. There are cases where dairies receiving liquid effluent from digesters have had to obtain additional land and adjust cropping to make use of the increased nutrients. Phosphorus recovery from livestock wastewater in the form of struvite has been demonstrated in other parts of the country. A pilot-scale test at the Qualco Energy digester project site has demonstrated successful struvite recovery from dairy digester effluent, reducing total phosphorus in the effluent by 60-80% (Mena, N. 2011). Another potential revenue source is collect and clean the bio-gas to extract methane. Clean methane can then be sold to natural gas providers. These potential revenues are not included in the base run of the ADOPT model.

Table 1. Digester annual operating and fixed expenses used in the base ADOPT economic analysis

Operating Expenses	
Labor	$ 39,420
Professional Fees	5,500
Shavings	4,000
Supplies	1,000
Repairs	
Composter	35,500
Digester	75,000
Separator	21,000
Site Maintenance	15,000
Interest	15,000
Utilities	70,000
Total Operating	281,420
Fixed Expenses	
Insurance	$ 28,000
Taxes	7,000
Depreciation	170,000
Total Fixed Expenses	205,000
Total Expenses	$ 486,420

2.7. Costs

Table 1 presents the annual digester operating and fixed expenses. The construction cost for the Qualco Energy digester was $3.4 million dollars with a projected economic life of twenty years. The annual straight line economic depreciation cost over this investment is $170,000. The annual interest expense on debt used to construct the digester is $15,000. The annual operating costs are primarily repair expenses, utilities and labor. The total annual operating expenses are $281,420 and fixed costs are $205,000. The total annual expense is $486,420.

3. Adopt analysis and discussion

The ADOPT model is programmed using GAMS mathematical programming software. The Qualco Energy digester serves to calibrate the model parameters and mimics the actual revenue and cost streams of the digester. The AD lagoon effluent is not assigned a revenue value in the modeling results, because the lagoon effluent does not generate revenue. It does have value as fertilizer nutrients in the cropping system, but it does not generate revenue. Figure 2 provides the daily revenue.

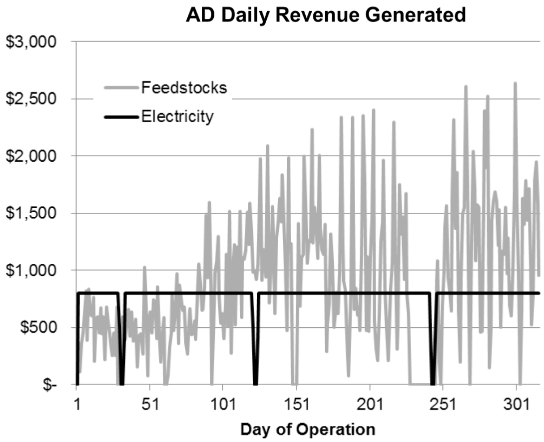

Figure 2. ADOPT model daily revenue

The feedstock revenue is the light grey line in Figure 2 that exhibits high daily variability. The variability is from differences in the volume of co-digestion feedstocks delivered. The contractual tipping fees differ between feedstocks, but the tipping fee of a feedstock remained fixed over the time period modeled. The electricity revenue is the relatively constant black line. The variation in the electricity revenue is when the electrical generator shut down four times for maintenance and electricity revenue went to zero. The electricity generated is fixed to the level constrained by the generator. Presently the more bio-gas is produced than the generator can use and the excess is flared. Additional analysis and data collection on the amount of bio-gas flared is ongoing to determine if a larger generator should be installed, or if adding a second generator to the system would be better economically.

The total annual revenue under the base analysis is presented in Figure 3. The annual electricity revenue is $244,696, for tipping fees the annual revenue is $278,818, and the existing carbon credit contracts provide $22,000. The cumulative annual revenue is $545,514. The annual total costs previously reported in Table 1 are $486,420, which results in an annual positive net return of $59,094. On a capital investment of $3.4 million, the construction cost of the digester, the annual return on investment is only about 2 percent.

The low annual return on investment found in this particular case and reported in other AD economic studies, is an explanatory factor to the low adoption rates of AD across the country. However in this case there is a high potential to increase revenue by improving the digesters electrical generating capacity through capturing the existing bio-gas that is currently being flared off. Also compost sales are a promising potential revenue that currently is receiving no economic value. Work on developing this market potential is ongoing.

The tipping fee revenue cannot be increased by much. Presently in this base case the volume of co-digestion feedstocks in nearly a maximum. The volume currently being received is close to the maximum allowed by state regulations and the dairy farm's nutrient management plan for the application of the AD effluent. The only way to increase tipping fee revenue is to renegotiate the tipping fee contract. That will not be easy as additional AD are constructed and the market becomes increasingly competitive for co-digestion feedstocks. One alternative that is currently being investigated is to evaluate the co-digestion feedstocks for their ability to generate bio-gas and increase electricity revenue. This will provide AD managers information to evaluate tipping fee contractual rates. Co-digestion feedstocks with low electricity potential should require higher tipping fees. Of course this requires that the AD have sufficient electricity generating capacity to effectively convert the bio-gas potential of co-digestion feedstocks to electricity revenue.

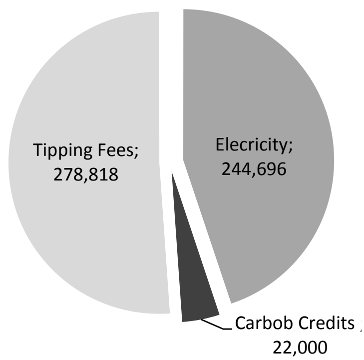

Figure 3. ADOPT model annual revenue from electricity, tipping fees and carbon credits [USD]

Another factor that is often overlooked in the economic analysis of AD is the marginal comparison of a traditional nutrient management system to an AD system. The traditional lagoon – land management system is a sunk cost to the dairy farm that has no potential to generate revenue or a return on investment. The AD return may be low, but as long as it is positive it represents a better capital investment than a traditional system. Even if the AD system has a negative return it still may be a better economic investment than a traditional system when evaluated on a minimum cost basis. Also additional work is needed to evaluate the marginal value difference of the nutrient profile between traditional and AD effluent. The higher nutrient profile of AD effluent is not being captured by current economic models. There are several other potentially positive future developments that may improve AD economics. Increasing electricity costs in the future could have a positive effect on AD economic return. Developing a market for the AD compost should become a primary effort as this is a large volume of product. Also developing analysis on the scale economics of digesters could identify more economically sustainable AD systems.

4. References

Bishop C., Shumway C.R., 2009. The economics of dairy anaerobic digestion with coproduct marketing. Review of Agricultural Economics, 31:394-410.

Frear C., Yorgey G., 2010. Introduction to anaerobic digestion, CSANR Research Report 2010-001, Washington State University, Pullman, WA.

Leuer E.R., Hyde J., Richard T.L., 2008. Investing in methane digesters on Pennsylvania dairy farms: Implications of scale economies and environmental programs, Agricultural and Resource Economics Review, 37:188-203.

Mena N., 2011, Washington dairies and digesters, Washington State Department of Agriculture, AGR PUB 602-343 (N/10/11).

Murto M., Bjornsson L., Mattiasson B., 2004. Impact of food industrial waste on anaerobic codigestion of sewage sludge and pig manure." J. Environmental Management. 70:101–07.

USDA News Release, 2011. Agriculture Secretary Vilsack announces recipients for energy audits, http://www.rurdev.usda.gov/STELPRD4013048_print.html.

FACTORS AFFECTING SMALL LIVESTOCK PREDATION IN THE WESTERN CAPE PROVINCE OF SOUTH AFRICA

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Abstract

Small livestock farmers in South Africa suffer from increasing losses due to predation. Predation losses increased to such an extent that small livestock farming in not viable any more in certain small livestock producing areas. The objective of this study is to determine the predation losses due to predators and identifying the variables that influences the occurrence and level of predation. This can help to develop management systems to reduce predation losses. The black-backed jackal and the caracal are two important medium-sized predators species among the South African wildlife, but they have a negative impact on the livestock industry in South Africa, especially among sheep and goats. The Western Cape Province of South Africa incurred losses in 2010 up to R 104 980 967 ($ 1 165 663). The physical monetary value attached to predation in this study was only the direct cost of predation and do not include indirect cost of controlling damage-causing animals. It was hypothesised that the variables affecting the occurrence of predation and the variables that affected the level of predation was not the same. Therefore, it was necessary to use the Probit and Truncated regression models. The information collected in this study showed that predation is a serious problem for the South African small livestock sector. This study does not answer all questions on predation, but provides valuable information in understanding the magnitude or extent of predation and some of the factors influencing predation on farms.

Keywords: predation, small livestock, South Africa

1. Introduction

Predation on livestock can be a problem for farmers and producers across the world. For example, coyotes kill sheep (Conner, Jaeger, Weller, McCullough, 1998) and goats (Windberg, 1997) in parts of the USA and Canada (Dorance, Roy, 1976). Wolverines kill sheep and domestic reindeer in Norway (Landa, 1999). Farmers have been protecting their stock for hundreds of years, by fencing and kraaling their stock to prevent the risk of predation losses. The black-backed jackal (*Canis mesomelas*) and the caracal (*Caracal caracal*) are important medium size predator species among the South African wildlife, although having a negative impact on the livestock industry in South Africa, especially small stock like sheep and goats (Hall-Martin, Botha, 1980). Although the diet of the black-backed jackal and the caracal normally consists of smaller mammals, they prey on small stock. (Hall-Martin, Botha, 1980; Rowe-Rowe, 1983; Moolman, 1984).

Despite the wide distribution ranges of the black-backed jackal and caracal (Cillie, 1997). Little information is available about their current distribution and their impact on the local small stock industry. However some studies have been done to estimate the problem, the National Wool-growers Organisation (NWGA) estimated a loss of 8% (2.8 million head of small stock, 2007) of stock per year. Losses to predation are not the only economic losses, there are additional costs in preventing predation (Arnold, 2001). The decision of how to manage these predators involves the allocation of scarce resources in the midst of competing needs. Economic analysis is therefore a useful tool to aid such decisions (Moberly, White, Webbon, Baker, Harris, 2003)

The primary objective of this study is to quantify the economic loss due to predation on small stock in the Western Cape Province (WCP) of South Africa. The secondary objectives are to determine the influence of management aspects on predation. These aspects include, different ways to control damage-causing animals and management aspects. Management include time of lambing, flock size, lambing months and breeds.

Opportunity cost is an important factor that must be taken in consideration from an economic point of view. The question basically arise, to what level are farmers able and willing to pay for predator control, and the benefits will be and what will the optimum level be of control. Opportunity costs can be divided into direct and indirect costs. The direct costs focuses on the prevention methods. Which include hunting, traps and fences etc., where a fiscal amount of money can be attached. While indirect costs imply, the time a famer has to spend on implementing certain management aspects. Management aspects consist of certain lambing practices, count of stock or the time it takes to control damage causing animals. Indirect costs are however difficult to calculate and will not be estimated in this paper.

2. Procedures

Economics is often experienced as the discipline that measures things in monetary units, while other disciplines use physical units. This view is to simplistic and even in appropriate, economics is not concerned principally with money but with making rational choices and decisions in the allocation of scarce resources amongst competing alternatives. The conceptual models underlying economic analyses include three major components: people, products and resources (Mclnerney, 1987; Otte, et al., 2001). Economic analysis is therefore a useful tool to aid decision-making (Moberly, et al., 2003). A basic criterion for determining whether predator control is an appropriate management action is whether the benefit of carrying out control exceeds the cost and this should be determined before a control program is instigated in order to prevent unnecessary or uneconomic control actions (Caugheley, Sinclair, 1994; Moberly, 2002).

The profit of a small stock farmer is a function of the number of lambs born and lamb losses between birth and weaning, amongst other factors. Losses are made up of predation losses as well as to other causes. It can be assumed that a farmer aims to minimise lamb losses to predators as far as possible (Moberly, 2002; Skonhoft, 2005). Therefore the cost of livestock mortality should take into account both the loss, or reduction in output, and the expenditure on extra inputs, including control and prevention costs (Mclnerney et al., 1992). There are several ways of valuing the costs of stock mortality. One approach is to use the output loss, the loss as “finished products” or the value of the animal when it is lost (Mclnerney, 1987; Moberly, 2002). The value is difficult to estimate if the animal is not at a point of sale, as to if a “finished product” is lost. Losses is determent according to Otte et al. (2002) and Mclnerney et al. (1992) as the total cost (C), the loss of the animal (L), plus the direct and indirect expenditure cost and control expenditure (E). This estimates the total cost to farmers based on the market price of finished an animal multiplied by the number of losses, as explined in equation (1).

$$C = L + E \tag{1}$$

A farmer has to choose a strategy, what level of pest control or preventive measure to use before the economic impact of the pest is known. If there is uncertainty about what level of pest attack will occur, but the probability of any particular level of attack occurring is known, the expected outcome of alternative strategies can be determined. Preventive or control methods consist of control methods (lethal and non-lethal) and managerial aspects. Lethal methods kill the predator and the non-lethal methods are a mean of reducing predation without killing the predator. These methods include lamping with rifles, shooting by day, hunting with dogs, snares, traps poisoning and the non-lethal methods include kraaling of small stock or indoor housing, sheep herder, bells, guard dogs, King Collers (Arnold, 2001; Moberly, 2002; van Deventer, 2008).

3. Data collection

A questionnaire was developed to obtain relevant information on predation on farms in the WCP of South Africa. This questionnaire was designed for short telephonic interviews with farmers in the WCP. Data collection took place over a period of two years, which included two lambing seasons or farmers who used three lambing seasons in two years. The questionnaire includes questions on farm recourses and flock size, farm location, losses of livestock due to predators, topography, surrounding land uses, predator control (lethal and non-lethal) and managerial aspects for two calendar years (2006 and 2007). Management questions were asked to identify whether certain management practices can lead to a reduction in losses due to predators. The management questions on certain farming practices included; how often does a farmer count his stock, lambing location and identification of small stock.

In April 2008 telephonic interviews was held with farmers in the Western Cape Province (WCP) of South Africa. The WCP host a very diverse agricultural sector, include wine producing areas, field crop production and small stock production in the Karoo. This study is part of an greater study that focus on the five mayor small stock producing provinces of South Africa (Free state, Northern Cape, Eastern Cape, Western Cape and Mpumalanga), in which a total of 1 500 farmers was interviewed in these five provinces. According to the methods used by De Vos et al. (2000) a stratified random sample was selected to draw a sample of farmers. In the WCP 187 farmers was interviewed. The sample of farmers was drawn according to the percentage that each of the different magistrates districts of the WCP contributed to the total small stock numbers (sheep and goat) of the WCP. Nationally the WCP contributed 11% of the commercial small stock numbers of the five major small stock producing provinces in South Africa (DOA, 2006).

4. Methodology

The methodology used consists of quantification of predation losses to set a fiscal economic value to predation losses in the WCP. Furthermore to further investigate factors influencing predation on farms in the WCP.

4.1. Quantification of predation cost in the WCP

The primary objective of this study is to quantify the economic loss due to damage-causing animals in the WCP. Quantification is done by multiplying the market price of an animal by the number of animals lost within a province, however this is difficult when this animal is not at a point of sale. The National Wool Growers' Association valued one unit (animal lost) in earlier estimates at R 600, this was a very low estimate for a unit lost. Stock theft Forum is valuing one small stock (sheep) unit at R1 200, and one small stock (goat) unit at R1 400. By using the value used by stock theft Forum an over estimation is possible. For the purpose of this study a value was used of R600 for one unit (sheep and goat) younger than six months and a value of R1 000 for one unit (sheep and goat) older than six months. However, this only illustrates the direct cost of predation for the WCP and does not reflect the indirect cost of preventing predation on a farm. The cost of prevention includes the cost of a professional hunter, fencing (jackal proof and electrical) and management input, just to name a few. Although some of these methods is a once-off expense, the methods are very expensive and therefore not a viable option to all farmers. Other methods like poison and the use of professional hunters or the farmer hunting himself represent a continuous cost to farmers.

4.2. Model specification

The secondary objective of this study is to determine the influence of management aspects on predation. A hypothesis was made that the variables influencing the occurrence of predation and variables influencing the level of predation is not the same.

In this study the model on factors influencing predation consist of two factors, whether or not predation will occur or not and if predation occurs what level of predation will occur. An important factor that must be taken in consideration is the fact that a small number of farmers incurred no losses on their farms (over 90% of farmers incurred losses). According to Aramyn, Lansink, Verstegen (2007) excluding observation with zero predation can lead to the sample being bias and biased regression parameters. It is however important to include these observations in the regression, because it is possible that no predation occurred during the two year when data was collected or management and control methods (lethal and non-lethal) is of that nature that no predation occurs. Therefore it is important to include these observations when estimating factors influencing predation.

The Tobit regression model is frequently used when dealing with zero observations (Tobin, 1958; Gujarati, 2003; Aramyn et al., 2007). A problem occurs that the Tobit model is very restrictive, according to Aramyn et al., (2007). For example, any variable that increases the probability that predation will occur increases the level of predation on a farm. The Cragg's model is an alternative for the Tobit model and allows one set of parameters to determine the probability that predation will occur and the second set of parameters to determine the level of predation. In the Tobit regression model, a variable that increases the probability of predation will also have a higher influence on the level of predation (Lin & Schmidt, 1984) cited in Katchove and Miranda (2004) and Jordaan and Grové (2010). Thus, the same variables will influence the probability that predation will occur and the level of predation, therefore the Tobit regression model alone would be insufficient in some cases.

According to Katchove and Miranda (2004) the Tobit model arises when the, occurrence of predation (weather or not predation will occur on a farm), is represented by the Probit model in Equation 2.

$$P(\alpha_i = 0) = \Phi\left(-\frac{\beta_\alpha' x_i}{\sigma}\right) \tag{2}$$

The level of predation on a farm, is represented by the Truncated regression model in Equation 3.

$$f(\alpha_i : \alpha_i > 0) = \frac{f(\alpha_i)}{P(\alpha_i > 0)} = \frac{\frac{1}{\sigma}\Phi\left(\frac{\alpha_i - \beta'_\alpha x_i}{\sigma}\right)}{\Phi\left(\frac{\beta'_\alpha x_i}{\sigma}\right)} \tag{3}$$

The variables influencing the probability that predation will occur on a farm is modelled by the Pobit regression model. The dependent variable takes the form of a dummy variable, coded zero for no losses and one if predation incurs on a farm. The variables influencing the level of predation on a farm is modelled by the Truncated regression model. The dependent variable takes the form of a continuous variable, where the reported losses to predators is divided by the total number of ewes/does and lambs/kids on a farm.

According to the hypotheses made, that the variables influencing the probability that predation will occur or not and variables influencing the level of predation is not the same variables.

The Cragg model suggests the assumption that the same variable influences both the probability that predation will occurs as well as the level of predation on a specific farm. In other words the Cragg model is the tool adopted for testing the Tobit model against the alternative two-step model. Cragg's test is based on a comparison between the likelihood ratios (Lin & Schmidt, 1984; Conte & Vivarelli, 2007). The Cragg's model with a log-likelihood function is illustrated in Equation 4 as given by Katchove and Miranda (2004) and furthermore explained by Lin and Schmidt (1984); Zhang *et al.* (2006) and Conte and Vivarelli (2007). The log-likelihood in Cragg's model is a sum of the log-likelihood of the Probit model (the first two terms) and the log-likelihood of the Truncated regression model (the second two terms).

$$\ln L = \sum_{c_i=0} \ln \Phi(-\gamma' z_i) + \sum_{\alpha_i>0} \left\{ \ln \Phi(\gamma' z_i) + \ln\left[\frac{1}{\sigma}\Phi\left(\frac{\alpha_i - \beta'_\alpha x_i}{\sigma}\right)\right] - \ln \Phi\left(\frac{\beta'_\alpha x_i}{\sigma}\right)\right\} \ldots. \tag{4}$$

All the regression models regarding the analyses on data on predation were done by using NLOGIT 4.0 statistical software.

4.3. Hypothesised variables

A summery of hypothesised variables, a short description of variables and the expected signs influencing predation in the WCP is shown in Table 1. The variables in Table 1, can be divided into two groups, management variables and control variables (lethal and non-lethal). It is hypothesised the management will have a negative sign in regression models, it is believed that a higher level of management will reduce predation on a farm (McAdoo, 2000). Management aspects will include time of lambing, flock size, breeds, lambing intervals, counting of small stock, identification of small stock and lambing months.

A positive sign is expected with all control methods including lethal and non-lethal methods. Lethal methods include hunting, poisons and gin traps. Non-lethal methods include electric fences, jackal-proof fencing, bells, King Collars and guarding dogs. According to De Waal (2009) the unnecessary killing of predators will lead to increase in predation in that specific area. Non-lethal methods will only reduce the level of predation and will not stop the occurrence of predation on a farm.

Table 1. Variables influencing predation and direction of influence

Variable	Description	Expected sign
Farming size	Continuous variable, area of farm in hectares	-
Lambing interval	Dummy variables, coded 1 for farms with 8 or 12 month lambing interval, 0 otherwise	-
Lambing months	Dummy variables, coded 1 for farms with lambing seasons in March-April or August-September or March-April and August-September or year round, 0 otherwise	-
Production ewes/does	Continuous variable, number of ewes/does	-
Counting of small stock	Continuous variable, times per months farmers counts small stock	-
Identification of small stock	Dummy variables, coded 1 for identification of small stock, 0 otherwise	-
Combination of two or more non-lethal control methods	Dummy variables, coded 1 for using more than 2 non-lethal control methods, 0 otherwise	+/-
Predator control carried out (including lethal and non-lethal)	Dummy variables, coded 1 for farms where predators were killed by various control measures, 0 otherwise	+
Believed foundation of predation problem	Dummy variables, coded 1 for different sounding practices that contributes to predation on farms (farmers view point), 0 otherwise	+

5. Results

This section will consist of the direct cost to predation in the WCP, was a fiscal amount will be put on predation. in section 5.2 factors influencing predation are shown and discussed.

5.1. The cost of predation in the WCP

Although predation losses are relatively low for the whole province there are some areas within the province that experience very high losses due to predation. These areas mostly include the Central Karoo where small stock farming is the main agricultural activity. A loss of 6.1% was associated with lambs between zero and six months and 0.1% for animals older than six months. The direct cost of predation in the WCP added up to R 104 980 967 as explained in Table 2. Farmers in these areas have high indirect costs in preventing predation on their farms, costs that include professional hunters, electrical fences and management practices.

Table 2. The cost of predation in the WCP

		Number of small stock	Average predation losses (%)	Losses due to predators	Cost per unit (R)	Cost of predation
Sheep	< 6 months	2 564 250	6.1%	156 419	600	93 851 550
	> 6 months	2 564 250	0.1%	2 564	1 000	2 564 250
Goats	< 6 months	227 797	6.1%	13 896	600	8 337 370
	> 6 months	227 797	0.1%	228	1 000	227 797
Total		2 792 047		173 107		104 980 967

5.2. Factors associated with predation losses in the WC province

Different variables that were included into the regression models are shown in Table 3. Variables were kept the same between the two model specifications to test the Cragg's model specifications. The variables were selected at a statistically significant level of 15% significant level. The Cragg's model had a significant P value (P = 0.000; CHISQ = 43.312); according to the Cragg's model it was necessary to use the Probit and Truncated models to analyse data on predation in the WCP.

In the Probit model a number of variables are significant in modelling the occurrence of predation in the WCP. These variables are mostly associated with managerial aspects such as number of ewes on a farm and counting of small stock. A negative coefficient was expected for all managerial aspects, meaning the more intensive the management, the loses the occurrence of predation. In the WCP a higher level of management is associated with larger small stock numbers on a farm (Probit, P = 0.005). Therefore, a higher level of management on a farm will have a tendency to a reduction in predation losses. Regular counting of small stock was not founded to be significant in the Probit model, although having a negative impact on predation. In the WCP agriculture practices are to a great extent diversified, making it difficult for farmers to manage all of there farming enterprises and to do effective predation management.

A great deal of success is associated with control methods in the WCP. Although control methods reduce the level of predation (Truncated), some of these methods will also influence the occurrence of predation on a farm (Probit). This can be attributed to the fact that a specific method or farming action can be highly effective in a specific region at a certain point in time. The use of bells, gin traps and jackal-proof fencing can be seen as an example of very effective control methods, which will have an influence on the occurrence of predation on a farm. Kraaling small stock (Truncated, P = 0.081) at night was founded significant in effecting the level of predation on a farm. A negative coefficient was expected. The reason being that kraaling at night is not significant in the occurrence of predation and the positive coefficient in the Truncated model is due to the fact that damage-causing animals adapt themselves to infiltrate in closed areas and cause major losses, where fences are not up to standard, according to some farmers in the WCP. Hunting by using a professional hunter in the WCP influence on the level of predation, due to the fact that damage-causing animal control is only practised in small parts of the WCP makes it very difficult to control effective predation management.

A high level of success is experienced when non-lethal methods are used in combination or in rotation with one another (Probit, P = 0.050), mainly due to the adaptability of predators.

Table 3. Output of the Probit and Truncated regression models for the WC province

Variables	Probit		Truncated	
	Coefficient	P value	Coefficient	P value
Constant	0.458	0.015	-0.127	0.050
Number of ewes	-0.000	0.005	-0.296	0.807
Counting of small stock	-0.013	0.630	-0.002	0.592
Hunting (by professional hunter)	-0.022	0.957	0.083	0.047
Combination of non-lethal methods	-1.100	0.050	-0.057	0.264
Bells	1.125	0.013	0.06	0.279
Jackal-proof fencing	1.386	0.000	0.052	0.448
Kraaling small stock at night	0.026	0.966	0.117	0.081
Gin traps	0.594	0.069	0.100	0.011

6. Conclusion and recommendations

Predation on small stock by black-backed jackal and caracal is a growing problem in the WCP and in South Africa. Problem-causing animals are responsible for large losses in small stock in the WCP. Direct losses in the WCP added up to R104 980 967 this only included direct cost of predation. Indirect cost of predation is difficult to calculate, control methods differ immensely between production regions. A number of these methods is a once-off payment and usually are tremendously expensive and therefore not accessible to all farmers.

A hypothesis was made that variables that influenced the occurrence of predation and variables that influenced the level of predation was not the same, thus it was necessary to use the Probit and Truncated regression models. An assumption was made the factors influencing the occurrence of predation are usually associated with management aspects and normally will be negatively correlated with predation losses. Variables affecting the level of predation can be seen as factors reducing the level of predation. These factors will usually include non-lethal and lethal methods. Mon-lethal control methods generally do not stop predation, but will reduce the level of predation on a farm. However, where a great deal of success is associated with a curtain prevention method, mostly control methods, this variable will be significant in effecting the occurrence of predation on a farm and at a specific point in time.

The WCP is a very diverse agricultural sector, which include wine producing areas, field crop production and small stock production in the Karoo and southern parts of the province. Due to the fact of the very diverse agricultural sector in the WCP predation losses fluctuate immensely in the province and makes predator control very difficult.

There can be no uncertainty regarding the fact that predation in South Africa is a serious problem for the South African small livestock sector and there is no indication that the problem of predation is subsiding. This study will not answer all questions on predation, but is a step forward in understanding the magnitude of predation and factors influencing predation on farms. The information collected can be used in addition to evaluate smaller areas intensively to deal with predation problems and develop strategies accordingly.

Due to the fact that these two predator species are so abundantly and widely found in South Africa, it makes effective management of problem-causing animals fairly difficult. The results of this study indicated that a higher level of management would lead to a reduction in predation losses. However, a higher level of management is not always financially or physically possible on every farm. These management aspects compete with the same resources on a farm and make it very difficult to implement. Due to the adaptability of these problem-causing animals, mostly black-backed jackal, management aspects must be diversified to have an efficient impact on predator management programs. A farmer has to decide for himself what level of predation is acceptable and what level of control would be sufficient, so that the cost do not exceed the benefit of predator control. As previously said, not all farmers have the ability to effectively control problem-causing animals, mainly due to a lack of resources. On the other hand, this is a major problem for farmers within areas experiencing high losses due to predation. That is why it is necessary for a nation-wide strategy in controlling problem-causing animals.

Government intervention will assist tremendously in implementing a coordinated national strategy in controlling problem-causing animals. The primary responsibility of controlling problem-causing animals will still be in the hands of the farmers. Government intervention can help to make recourses available to farmers in efficiently controlling problem-causing animals.

7. References

Aramyan L.H., Oude Lansink G.J.M., Verstegen A.A.M., 2007. Factors underlying the investment decision in energy-saving systems in Dutch horticulture. Business Economics, Wageningen Univesity, Hollandseweg 1, 6706 KN Wageningen, The Nederlands.

Arnold M.B., 2001. Wildlife integration for livelihood diversification project (working paper 6). Department for international development.

Caughley G., Sinclair A.R.E., 1994. Wildlife Ecology and Management. Blackwell Scientific, Boston, MA.

Cillie B., 1997. Die soogdiergids van Suid Afrika. Briza publikasies.

Conner M.M., Jaeger M.M., Weller T.J., McCullough D.R., 1998. Effect of coyote removal on sheep depredation in northern California. Journal of Wildlife Management, 62, 690-699.

Conte A., Vivarelli M., 2007. R&D and embodied technological change. The role of firm size and sector belonging. Max Planck Institute of Economics, Jena, Germany.

De Vos A.S., Strydom H., Fouche C.B., Delport C.L.S., 2002. Research at Grass Roots: For the Social Sciences and Human Service Professions, (Eds) Second Edition. Van Schalk Publishers.

De Waal H.O., 2009. Recent advances in co-ordinated predator management in South Africa. African Large Predator Research Unit, Department of Animal, Wildlife and Grassland Science (70). University of the Free State, Bloemfontein .

Dorrance M.J., Roy L.D., 1976. Predation losses of domestic sheep in Alaberta. Journal of range Management, 29, 457-460.

Hall-Martin A.J., Botha B.P., 1980. A note on feeding habits, ectopapasites and measurements of the black-backed jackal *Canis Mesomelas* from Addo Elephant National Park. Department of Research and Information, National Parks Board of Trustees.

Jordaan H., Grove B., 2010. Factors affecting forward pricing behaviour: Implecations of alternative regression model specifications. Department of Agricultural Economics, of the Free State, South Africa.

Katchova A.L., Miranda M.J., 2004. Two-step econometric estimation of farm characteristics affecting marketing contract decisions. American Agricultural Economics Association.

Landa A., Fudvangen K., Swenson J.E., Roskaft E., 1999. Factors associated with wolverine Gulo gulo predation on domestic sheep. The Journal of Applied Ecology, Vol 36, No. 6. pp. 963-973.

Lin T., Schmidt P., 1984. A test of the Tobit specification against an alternative suggested by Cragg. The Review of Economis and Statisties, Vol. 66. No. 1. pp. 174-177.

Mclnerney J.P., 1987. An economist's approach to estimating disease losses. Disease in Farm Livestock. Economics and Policy, K. S. & J.P. (Eds.), pp. 35-60.

Mclnerney J.P., Howe K.S., Schepers J.A., 1992. A framework for the economic analysis of disease in farm livestock. Preventive Veterinary Medicine 13, 137-154.

Moberly R.L., 2002. The cost of fox predation to agriculture in Britain. PhD Thesis, Environment Department, University of York.

Moberly R.L., White P.C.L., Webbon C.C., Baker P.J., Harris S., 2003. Modelling the cost of fox predation and preventive measures on sheep farms in Britain. Enviromment Department, University of York, York Y010 5DD, UK.

Moolman L.C., 1984. n Vergelyking van die voedingsgewoontes van die rooikat *Felis caracal* dinne en buite die bergkwagga nasionale park. Departement Dierkunde, Universiteit van Pretoria.

National Department of Agriculture of South Africa, 2006. Abstracts for Agriculture in South Africa. www.nda.agric.za.

Otte M.J., Chilonda P., 2002. Animal health economics. Livestock information, Sector Analysis and Policy Branch, Animal Production and Health Division (AGA), FAO, Rome, Italy.

Rowe-Rowe D.T., 1983. Black- backed jackal diet in relation to food availability in the Natal Drakensberg. Natal Parks, Game and Fish Preservation Board.

Skonhoft A., 2005. The costs and benefits of animal predation: An analysis of Scandinavian wolf re-colonization. Department of Economics, Norwegian University of Science and Technology, N-7491 Trondheim, Norway.

Tobin J., 1958. Estimation of relationships for limited dependent variables. Econometrica, Vol. 26(1), pp. 24.36.

van Deventer J., 2008. Die holistiese benadering tot roofdierbestuur. Resolbing Human-Wildlife Conflict. Prevention is better than cure.

Windberg L.A., Knowlton F.F., Ebbert S.M., Kelly B.T., 1997. Aspects of coyote predation on Angora goats. Journal of Range Management, 50, 226-230.

Zhang, F., Chung, C.L. & Lin, B (2006). Modelling fresh organic produce consumption: A generalized double-hurdle model approach. U.S. Department of Agriculture.

DRIVERS OF AWARENESS AND ADOPTION OF MAIZE AND SORGHUM TECHNOLOGIES IN WESTERN KENYA

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Abstract

Despite extensive promotion of maize and sorghum cultivars adapted to multiple stresses through public, private and research institutions' extension initiatives in Western Kenya, the adoption of such technologies by small scale farmers is low and production of the two crops is not only declining, but also continues to fall behind potential. Production of maize and sorghum are not only below 0.5 t/ha against a potential of 3-4 t/ha, but also declining. The objective of the study was to not only characterize awareness and adoption of maize and sorghum cultivars adapted to moisture stress, striga, low fertility acid soils and aluminum toxicity, but also isolate factors influencing their adoption. Data was collected from five sites in Nyanza and Western provinces using systematic sampling to generate a sample of 100 farmers. Data was analyzed using descriptive statistics and a probit model. Results show that gender, age, farm size, income, and access to extension influence adoption of maize and sorghum technologies. It is recommended that policies should consider household structure, empower them economically and improve access to extension services to enhance adoption of maize and sorghum technologies.

Keywords: drivers, adoption, maize and sorghum, technologies, Western Kenya

1. Introduction

Food and nutrition insecurity is a major problem in western Kenya, which is home to more than 15 million people who derive their livelihoods from agriculture. About 4.5 million people from the region experience serious food and nutrition insecurity, largely due to drought, low soil fertility, soil acidity, pests and diseases (FEWSNET, 2009). In this region, sorghum (*Sorghum bicolour (L.) Moench*) and maize (*Zea mays (L.*) are the two major staple food crops and sources of livelihood. These crops are produced by smallholder farmers (SHF) who use low levels of inputs and have limited access to new technologies. Consequently, sorghum and maize grain yields are low and declining, normally less than 1.0 ton and 1.5 tons /ha, respectively (FAOSTAT, 2006). It is predicted that in the marginal areas of Eastern Africa including the dry land areas of western Kenya, global climate change will cause more food deficit, increasing vulnerability of the local population. If not checked, drought, soil acidity and other environmental stresses prevalent in western Kenya may prevent the country from realizing the vision 2030 and the Millennium Development Goal (MDG) No. 1 which commits countries to halving poverty and hunger by 2015.

Maize and sorghum production and yield per unit area in Kenya is affected by many factors. Among the most important are total planted area and productivity. There is limited scope for expanding cultivated land under maize production since unused land is diminishing or is of marginal quality or just unsuitable for maize production. Producing higher maize yields on existing cultivated land is therefore the surest way of generating the extra maize grain required to feed the nation. However, this is curtailed by multiple stresses such as drought, soil acidity, low available phosphorus, and striga infestation. Even though, locally based research initiatives in Western Kenya have generated and disseminated maize cultivars adapted to these multiple stresses, adoption rates still remain very low and maize production continues to fall way behind potential.

In many parts of Kenya, sorghum remains an important crop for rural food security. Since many sorghum producing areas still experience periodic food deficits, production must be increased in order to ensure food security. The growing of improved sorghum varieties in Kenya has been promoted by not only public agricultural extension service, but also private extension initiatives and outreach arms of research institutions as one of the ways of achieving this. However, the adoption of technologies associated with these varieties by small scale farmers is still low resulting, probably, in the low production of the crop.

In Kenya, Striga infestation is most severe in Nyanza and Western provinces. Despite extensive promotion of both maize and sorghum cultivars tolerant to striga infestation by ministry of agriculture and other research institutions' initiatives in western Kenya levels of adoption are low and the weed continues to wreak havoc on production of the two crops in the region. With the above background several questions can be raised. What is the level of awareness among farmers of maize and sorghum cultivars tolerant to drought, acidic soils, Aluminium toxicity and striga infestation in western Kenya? What is the level of adoption of some of these technologies and what influences the adoption behaviour? In an attempt to address the aforementioned questions, the objectives of the paper are to characterize the level of awareness and adoption of maize and sorghum cultivars adapted to drought, aluminium toxicity, low fertility acid soils and striga infestation and to assess factors affecting their adoption.

2. Methodology

2.1. Study sites

The survey was carried out in five sites, two in Nyanza province and three in Western Province. The sites included; Karungu, Sega (Nyanza), Matayos, Koyonzo, and Angurai (Western). Karungu is located 0° 51' 0" South, 34° 9' 0" East, at an altitude of about 1, 145 m. The area has low (250 - 750 mm), unimodal (March – May) rainfall, with low to medium (≈ 60%) reliability. The area is in the Lower Midland 4 (LM4) agro-ecological zone (AEZ) and is suitable for sorghum, cassava and sunflower. The soils are neutral, verticarenosol/vertisols of medium to low fertility. Sega site is located 0° 15›N & 34°20›E, at an altitude of about 1,200 m and receives the long rains between March–June (Jaetzold and Schmidt, 1983) and the short rains between September and December. The area is in AEZ LM 3 and is suitable for maize, sorghum, cassava and sunflower. Sorghum and maize are the priority cereals, but grain yield is affected by drought and soil acidity (pH < 5). The soils are orthicacrisol that contain toxic levels (33% saturation) of aluminium (Al) and low levels (3.0 mg/Kg soil) of available P (Obura et al., 2008; Kisinyo et al. 2009). Angurai is in Teso District and falls in AEZ LM3, characterized by a long (155 to 174 days) cropping season followed by a short (85 -104 days) second growing period (Jaetzold et al., 2005). Angurai receives 1300 mm of rainfall annually. The soils are acidic, ferralo-orthicacrisols with moderate to low fertility. Farmers in this region grow significant quantities of sorghum, which is mixed with cassava and used as a staple food. Koyonzo is in Matungu division of Butere-Mumias district. Matayos is in Busia District and is in AEZ LM3. The site lies at an altitude of 1,219 m, and receives 1,420 mm of rainfall annually, that comes in during the long and short rainy seasons. The soils are well drained, deep, red to dark red, friable Chromic Acrisols; partly petro ferric.

2.2. Data types and sources

Both primary and secondary sources of data were used. Both qualitative and quantitative data were collected. Types of data used in this study included general demographics of the respondents such as age, gender, education, household size and occupation among others; awareness, access and adoption of maize and sorghum technologies, resource endowments such number of livestock, acreage under key crop enterprises, sources of livelihoods, types and sources of maize and sorghum seed, marketed fraction and market outlet for seed and constraints in the maize and sorghum value chain, maize and sorghum production and yield levels, input usage and past production trends of maize and sorghum. The technologies under consideration were maize and sorghum varieties. These varieties have been bred and tried under multiple stresses under farmers' conditions in a participatory approach for more than 4 years at the 5 sites. The multiple stresses include moisture stress, aluminium toxicity, acidic soils and striga weed. Both local maize and sorghum varieties as well as cultivars generated through a participatory screening process by Moi University research team were at the disposal of farmers. The maize varieties at the disposal of farmers were hybrids (H505, H507, H511, H512, and H614), Duma, and Pwani. The sorghum varieties which were at the disposal of farmers had been screened for different tolerance to the aforementioned stresses. They included Nyadundo1 (drought, striga, aluminium), Nyadundo 2 (drought and aluminium), C26 (drought, Striga), P53B (Striga), T30B (Drought), ED95A (Aluminium and Phosphorous), E97 (Aluminium and Phosphorus), E94 (Aluminium and phosphorus), Seredo (Aluminium and Phosphorus), N57 (Striga), N68 (Striga), E16 (drought), E12 (drought), E15 (drought) and M45 (Striga). Farmers were therefore aware of existence these sorghum varieties. Primary data was obtained through a baseline survey while secondary data was acquired through perusal of government and private research documents, journals and other publications relevant to the study.

2.3. Sampling procedures

The target population was all maize and sorghum farmers in the five sites of Sega, Matayos, Koyonzo, Angurai and Karungu. A sample of 100 small holder maize and sorghum farmers were purposively selected from the five sites. In each site, 20 farmers were systematically selected. However, the first farmer was selected randomly and subsequent farmers selected by skipping every next sorghum/maize farmer.

2.4. Data collection instruments and methods

The main instruments used for data collection were questionnaires, interview schedules, observation, and focused group discussions. A mixture of enumerator administered questionnaires and interview schedules were used to retrieve information from farmers. Questionnaires and interview schedules were structured with both open ended and closed ended questions. Instruments of data collection were pre-tested in Sega site on 10 respondents to ensure reliability and validity and revised before embarking on the actual survey. To supplement information gathered using questionnaires, an interview schedule was used to collect information from key informants such as extension service providers from Ministry of Agriculture and non-governmental organizations and local leaders to facilitate formation of general opinion about behaviour of variables under investigation.

2.5. The probit model

In order to explain the behaviour of a dichotomous dependent variable a suitably selected Cumulative Distribution Function (CDF) was used. The logit model uses the cumulative logistic function. But this is not the only CDF that one can use. In some applications, the normal CDF has been found useful. The estimating model that emerges from the normal CDF is known as the Probit or Normit Model. The Probit model is expressed as (1):

$$probit(\pi(x)) = \phi^{-1}(\pi(x)) = \alpha + \beta x \tag{1}$$

Where is the inverse standard normal cumulative distribution.

The probit model is an alternative to the logit model and does not show the structural problem such as the linear probability model. There are a lot of similarities and minor differences between a logit and probit model. The chief difference between logit and probit is that the logistic model has slightly flatter tails. The normit or probit curve approaches the axes more quickly than the logistic curve. Qualitatively, logit and Probit models give similar results and the estimates of parameters of the two models are directly comparable (Vasisht, 2002). The study employed the Probit model to evaluate the adoption of maize and sorghum cultivars adapted to multiple stress such as drought and striga in Western Kenya. It was assumed that there is a latent, or unobserved, variable Y* which is generated from a familiar looking model:

$$Y^{*} = \beta^{'} X + e \tag{2}$$

Where β is a K-vector of parameters, x is a vector of explanatory variables and e ~ N(0; 1) is a random shock. We observe y = 1 if y* > 0 and y = 0 otherwise.

In this study, the model was specified as follows;

$$Y = \beta X + e \tag{3}$$

Y = a vector of farmer's adoption of stress tolerant maize/ sorghum cultivars

X = a vector of independent variables including:- demographic characteristics**,** farm size, area allocated to maize/ sorghum, household size, Age, education, gender, occupation, income, yield of maize/ sorghum. Since the level of awareness among farmers of existing stress tolerant maize/ sorghum technologies was low models were estimated for adoption of moisture stress tolerant sorghum and striga tolerant maize in western Kenya.

2.6. Data processing and analyses

All questionnaires and interview schedules were sorted and coded before inputting in the appropriate software. Data was then analyzed using Statistical Package for Social sciences (SPSS) version 17.0 and Ms-Excel. Descriptive statistics such as measures of central tendency, bar charts and cross tabulations were used to describe the socio-economic indicators of households and to characterize awareness and adoption of multiple stress tolerant sorghum and maize technologies. Regression analysis was used to determine the cause and effect relationship between variables under study.

3. Results and discussions

3.1. Characterization of awareness and adoption of maize/sorghum technologies

Farmers were asked if they were aware and used locally available multiple stress tolerant sorghum and maize varieties. Table 1 shows awareness among farmers of multiple stress tolerant sorghum and maize technologies. The general level of awareness among farmers of existing multiple stress tolerant sorghum cultivars was very low in the entire sample and replicated across experimental sites. While 17-18% of all respondents were aware of Al tolerant sorghum and maize cultivars, only 41% were aware of moisture stress tolerant sorghum and maize varieties.

Table 1. Awareness in percentage of sorghum and maize technologies across the study area

Location	Stress tolerant		Aluminium tolerant		P-efficient		Striga tolerant	
	Sorghum	Maize	Sorghum	Maize	Sorghum	Maize	Sorghum	Maize
Koyonzo	5	6	4	5	3	4	5	6
Angurai	5	4	2	2	2	3	5	5
Matayos	12	12	4	4	5	6	11	13
Sega	14	14	7	7	10	10	14	15
Karungu	5	5	0	0	0	0	3	3
Total	41	41	17	18	20	23	38	42

Source: Authors' Survey, 2011

While 20-23% of respondents were aware of P-efficient sorghum and maize cultivars, 38-42% of them were aware of striga tolerant sorghum and maize cultivars. That implied that less than half of the farmers were not aware of the multiple stress tolerant maize and technologies calling for more awareness campaigns to enlighten farmers on the existing multiple stress maize and sorghum tolerant technologies. However, Koyonzo, Angurai and Karungu require more awareness campaigns. The relative level of awareness of moisture stress and striga weed was high across all the sites. This could point to the devastating effects of the two challenges in the study area.

Table 2 shows adoption of multiple stress tolerant sorghum and maize cultivars. The general level of adoption of multiple stress tolerant sorghum and maize cultivars by farmers was too low in the entire study area and across the experimental sites. Less than 10% of respondents had adopted any of the four sorghum technologies. The story was the same for maize technologies with exceptions of P-efficient and striga tolerant maize cultivars which were adopted by 23 and

Table 2. Adoption in percentage of sorghum and maize technologies across the study area

Location	Stress tolerant		Aluminium tolerant		P-efficient		Striga tolerant	
	Sorghum	Maize	Sorghum	Maize	Sorghum	Maize	Sorghum	Maize
Koyonzo	1	1	0	0	0	4	0	6
Angurai	2	3	1	1	1	3	2	5
Matayos	1	3	1	1	1	6	1	13
Sega	3	3	1	1	3	10	5	15
Karungu	0	0	0	0	0	0	0	3
Total	7	10	3	3	5	23	8	42

Source: Authors' Survey, 2011

42 % of respondents respectively.Among adopters of striga tolerant maize majority came from Sega and Matayos experimental sites. That implied that enough sensitization may have been undertaken at the two sites calling for more sensitization in the other sites. It could also point to striga weed being a more devastating problem in the study area than the other multiple stresses thus eliciting more adoption.

That could be attributed to the low levels of awareness among farmers of the existing multiple stress tolerant sorghum and maize cultivars in their neighbourhoods since majority of the farmers were known to work with technologies they understood. This calls for awareness campaigns in the entire study area in order to trigger interest in the multiple stress tolerant crop technologies

3.2. Probit regression results

Table 3 shows probit regression results for adoption of stress tolerant sorghum. Results show that age, social capital, sorghum farm, income and extension advice were significant and positively influenced adoption of moisture stress tolerant sorghum. These results are consistent with Okuthe *et al*., (2000) findings that farmers' adoption of improved sorghum varieties and technologies depend on household size, income, farm size, age, education attainment and gender of household head. However, while Okuthe focused on Ndhiwa Division in Nyanza Province, this study covered parts of Nyanza and Western provinces. He also used chi-square to determine the relationship between the independent variables and the dependent variable while this study fitted a probit model to unravel drivers of adoption of sorghum/maize production technologies. It is also consistent with Adesina et al (1995) findings in his study in Burkina Faso and Guinea on farmers' perceptions and adoption of new agricultural technologies. However, the range of variables used in this study while they cut across socio-economic, demographic and institutional factors they do not include farmers' subjective perceptions of the characteristics of new agricultural technologies.

The positive relationship implies that older people are more likely to adopt stress tolerant sorghum than young people which is attributable to the fact that sorghum as a crop is mainly consumed by older generations who have valued the crop through the years as opposed to young

Table 3. Regression results for moisture stress tolerant sorghum

	Coefficients	S.E.	Sig.
Age			
Gender	-3.656*	.057	.017
Education	.520	.665	.544
Group membership	.939**	.067	.003
Occupation	.581	.042	.435
Sorghum acreage	.805*	.155	.016
Income	.034*	.011	.043
Advice	.823*	.114	.050
Farm	-.887*	.078	.024
Constant	-23.520	5757.000	.997

-2 Log likelihood → 26.610; Cox & Snell R Square → 0.500; Nagelkerke R Square → 0.695 Omnibus test for model coefficients – Chi-square → 156.906; Hosmer&Lemeshow test – Model Chi-square → 2.116; Sample Size → n = 100

Source: Author's Survey Data, 2011

people who view sorghum as an inferior cereal. In addition, older people retain ownership of farm assets, including land and welcome ideas that promote enterprises they engage in. Social capital enhances adoption of stress tolerant sorghum technology since members of groups seek information and share it among themselves. Groups also make it economical to get attention of technology innovators rather than the technology innovators targeting individual farmers; which may be expensive on the part of the technology innovators.

On the contrary, gender and sorghum farm even though significant, negatively influenced adoption of moisture stress tolerant sorghum. The results indicated that an increase in the number of male headed households by one unit would bring about a decrease in the log of odds in favour of adoption by 3.656. The converse is also true. This was expected because sorghum farming is usually a preserve of women especially in the Western part of Kenya. In that light therefore, women would be more willing to take up stress tolerant sorghum that would guarantee them better returns even when rain fails or is erratic.

Land size allocated to sorghum was found to influence adoption of stress tolerant sorghum among small holder farmers in Western Kenya. Its coefficient was positive and significant at 5 percent implying that a unit increase in the land size allocated to sorghum leads to an increase in the log of odds in favour of adoption of stress tolerant sorghum by 0.805. This means that small scale sorghum farmers who have allocated a larger portion of their land on sorghum production are more likely to adopt the technology than those who have allocated a small portion. That is reasonable because large scale sorghum producers should find it economical to take up new technology as opposed to small scale producers.

The positive relationship between income and adoption of stress tolerant sorghum implies that economic empowerment of small holder farmers opens opportunities for them to adopt technology. That is justifiable because new technologies come at a cost and only those with adequate financial resources can afford them. That was expected because most smallholder farmers in Western Kenya depended entirely on subsistence agriculture as their major source of livelihood (93%), and only 4% had formal employment while 3% had small scale business enterprises. That implies that farmers have limited scope to earn income; the situation is further aggravated by low prices for their produce and high input prices.

The positive and significant relationship between extension and adoption of stress tolerant sorghum implies that farmers who received extension advice were more likely to adopt the technology than those who did not. That is justifiable because extension agents bring to the attention of farmers existence, benefits and costs of various technologies. About 39% of farmers reported to have received extension advice in the previous year on sorghum production. That could explain why this technology had not been widely taken up by farmers in the study area.

The negative and significant relationship between total land size owned by households and adoption of stress tolerant sorghum implies that as the total land owned increased, there was a tendency for farmers to abandon sorghum farming and move to other crop enterprises like maize, sugarcane, and tobacco as was observed in the sampled sites. That was so because farmers being economically rational would seek to engage in a bigger scale in those farming activities that yield more output and therefore income. Almost all farmers who were engaged in growing sugarcane and tobacco as cash crops never allocated any land to sorghum production. Table 4 shows probit regression results for adoption of striga tolerant maize.

Table 4. Regression results for striga tolerant maize

Variable	Coefficients	S.E.	Sig.
Maizefarm	.869*	.456	.050
Income	.521**	.011	.008
Advice	1.881**	1.051	.004
Occupation	1.862*	.875	.033
Member	2.199*	.912	.016
Education	.445	.567	.433
Gender	.217	.974	.824
Age	.064*	.037	.041
Constant	-10.936**	3.182	.001

2 Log likelihood → 26.539; Cox & Snell R Square → 0.560; Nagelkerke R Square → 0.714 Omnibus test for model coefficients – Chi-square → 179.314; Hosmer&Lemeshow test – Model Chi-square → 2.908; Sample Size → n = 100
Source: Author's Survey Data, 2011

Results show that maize farm, income, extension, occupation, social capital and age positively and significantly influenced adoption of striga tolerant maize variety. The positive relationship between maize farm area and adoption of striga tolerant maize implies that small scale maize farmers who have allocated a larger portion of their land on maize production are more likely to adopt the technology than those who have not. That scenario is attributed to the willingness of large scale producers to adopt new maize technologies due to their economies of scale compared to small holder producers. The positive relationship between income and adoption of striga tolerant maize among smallholder farmers in Western Kenya implies that well endowed small holder farmers would easily take up technology unlike their poor counterparts. This is true because new technologies come at a cost and it is only reasonable that those with enough income afford them. The positive relationship between extension and adoption of striga tolerant maize cultivar implies that farmers who received extension advice were more likely to adopt the technology than those who did not. Extension advice on the existence, benefits and costs of striga tolerant maize is therefore critical for triggering adoption of the aforementioned technology. About 39% of farmers reported to have received extension advice in the previous year on maize production which explains why the technology had not been widely taken up.

The positive and significant relationship between occupation of the household head and adoption of striga tolerant maize implies thatfarmers with other livelihood sources adopted technology easily since this economically empowered them to secure new technologies. Businesses and formal employment expand farmers' scope to earn income and therefore afford technology.

Social capital positively influenced adoption of striga tolerant maize variety by smallholder farmers in Western Kenya. This is consistent with the finding in the previous section that famers who work in groups are well placed to better engage in their farming activities. Group intervention is crucial and cost-effective for such category of farmers.

The positive and significant relationship between gender of household head and adoption of striga tolerant maize implies that an increase in the number of male headed households by one unit would bring about an increase in the log of odds in favour of adoption by 0.64 which was expected because men make most of the decisions affecting households including farming decisions.

The positive and significant relationship between adoption of striga tolerant maize and age of respondents implies that older people were more likely to adopt striga tolerant maize varieties than young people. That was expected because older people were the land owners and owners of other farm assets and therefore could take the initiative to invest in new technologies when they were assured of increased returns from such technologies. Furthermore, the role of older people as household decision makers gives them a head start in making choices that are supposed to benefit the households at large. In addition, older people are often charged with the great responsibility of providing food and fibre to the members of the households and therefore will be willing to take up technologies that guarantee them better yields.

4. Conclusions

It is concluded that the level of awareness and adoption of multiple stress maize and sorghum cultivars were generally low in the study area and across the experimental sites. This calls for awareness campaigns to enlighten majority of the farmers on the existence and availability of multiple stress tolerant maize and sorghum cultivars in their neighbourhoods. The major drivers of adoption of moisture stress tolerant sorghum and striga tolerant maize were indentified. Drivers of moisture stress tolerant sorghum were age, social capital, area allocated to sorghum, income and extension advice. On the other hand, drivers of striga tolerant maize were area allocated to maize, income, extension, occupation, social capital and age. It is recommended that policies that seek to improve adoption of multiple stress tolerant sorghum and maize technologies in Western Kenya should consider the household structure, empower them economically, enhance social capital and improve access to extension services.

5. References

Adesina A.A., Baidu-Forson J., 1995. Farmers' perceptions and adoption of new agricultural technology: evidence from analysis in Burkina Faso and Guinea, West Africa. Agricultural Economics 13 (1995) 1-9.

Bekunda M.A, Bationo A., Ssali H., 1997. Soil fertility management in Africa.A review of selected research trials pp 63-80.In:Buresh RJ, Sanchez PA, Calhoun F (eds). Replenishing soil fertility in Africa. Soil Sci. Soc. of America. SSSA Special Publication (51). Madison Wisconsin.USA.

Buresh R.J, Smithson P.C., Hellums D.T., 1997. Building soil phosphorus capital in Africa.In: Buresh PJ, Sanchez PA, Calhoun F (Eds)Replenishing soil fertility in Africa, 111-149. Soil Science Society of America Special Publication No.51. Madison Wisconsin: USA.

CSA NEWS, 2009. The *Striga* Scourge.Vol 54: 5-8

Dagg M., Woodhead T., Rijks D.A., 1970. Evaporation in East Africa. Bulletin of the International Association of Scientific Hydrology XV: 61-67

Ejeta G., 2007. Breeding for Striga resistance in sorghum: Exploitation of an intricate host-parasite biology Crop Sc 47-S-216-S-227.

Earthtrends, 2003. http//earthtrends.wri.org accessed June 30 2012

ECASARM, 2005. Sorghum and Millet Research for Development in Eastern and Central Africa 2005 – 2010: Regional priorities.

Food and Agriculture Organization of the United Nations, 2006. FAOSTAT– FAO Statistical Databases.

Hove L., Masingaidze N., Twomlow S., Nyathi P., Moyo M., Mupangwa W., Masvaya E., 2008. Micro doses, mega benefits: Promoting fertilizer use in semi-arid Zimbabwe.Manual.International Crops Research Institute for the Semi-Arid Tropics.

Jama B., Swinkels R.A., Buresh R.J., 1997. Agronomic and economic evaluation of organic and inorganic sources of phosphorus in Western Kenya.Agron. J. 89 (4): 597-604.

Kochian L.V., Hoekenga O.A., Pineros M.A., 2004. How do crop plants tolerate acid soils? Mechanisms of aluminium tolerance and Phosphorus efficiency.*Annu. Review of plant Biology* 55:459-493.
Ligeyo D.O., Gudu S., 2005. Further laboratory screening of more Kenyan maize inbred lines for tolerance to Aluminum.In: Third Year Progress Report, (March 2004 – 28 February 2005), McKnight Foundation USA funded Project, (EMBRAPA, Purdue and Cornell University's (USA) and Moi University (Kenya) Phase 1, 2003 – 2005.
Ligeyo D.O., 2007. Genetic analysis of maize (Zea mays L.) tolerance to aluminium toxicity and low phosphorus stress and development of synthetics for use in acid soils of western Kenya. Ph.D. Thesis. Moi University, Eldoret, Kenya
Obura P.A., Okalebo J.R., Othieno C.O., Woomer P.L., 2001. The effect of PREP-PAC product on maize-soybean intercrop in the acid soils of western Kenya.African Crop Science Conference Proceedings, Lagos, Nigeria. 22– 26October 2001, 889-896.
Okuthe I K., Ngesa F.U., Ochola W.W., 2000. "Socio-economic Determinants of Adoption of Improved Sorghum Varieties and Technologies among Smallholder farmers in Western Kenya."Ministry of Agriculture and Egerton University, Kenya.
Pari L., Grassi G., Sénéchal S., Capaccioli S., Cocchi M., 2008. State of the art: harvesting, storage and logistic of the sweet sorghum. 16^{th} European Biomass Conference & Exhibition, 2-6 June 2008. Valencia, Spain.
Soleri D., Cleveland D.A., 2009. Plant breeding for quantitative variables.Part 1: Farmers and Scientists knowledge and practice in variety choice and plant selection. FAO, Rome, 2009.
USAID, 2009. Famine Early Warning Systems Network (FEWSNET). FEWSNET Executive Overview of Food Security.
Wortmann C.S., Mamo M., Abebe G., Mburu C., Kaizzi K.C., Letayo E., Xerinda S., 2006. Sorghum Atlas: Production in Five Countries of Eastern African. University of Nebraska, Lincoln.

INSTITUTIONAL CREDIT POLICIES AND NIGERIA'S AGRICULTURAL TRANSFORMATION: BOON OR BANE?

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Abstract

The agricultural sector in Nigeria has attracted tremendous attention because of its enormous potentials and central role in the nation's economic development. However, sub-optimal performance and stagnation persists despite its enormous potentials. Myriad of institutional credit programmes were initiated to arrest the national food insecurity as well as transform the sector. The expected transformation is yet to be met and contribution to industrial growth is still a mirage. The primary focus of this research is to examine institutional credit policies, budgetary allocations and Nigeria's quest for agricultural transformation. Using the historical and content analysis methods, it explores the developmental issues confronting the financing of agricultural sector and budgetary provisions. It also noted two theoretical foundations on financing agricultural development, the financial accelerator and credit channel theories (Bernanke, B.S 2007). *The paper recommends, among others, that the structural gaps in the sector must be addressed for the emplacement of real agricultural transformation in Nigeria.*

Keywords: credit policies, agricultural transformation, Nigeria

1. Introduction

Nigeria's agricultural sector has undergone tremendous changes in the past few decades to tap its numerous potentials for the nation's economic development. The country is richly endowed with diverse natural resources and total land area of 924,000 square kilometers out of which 304,920 square kilometers are cultivable. Over 70 percent of its population is engaged in the agricultural sector. It can also provide the raw materials requirements for agro-based industrialisation. With a population of well over 167 million people, Nigeria's agriculture must satisfy the country's basic food needs. It's the largest contributor to non-oil sector at ….

However, there is stagnation in the sector leading to poor economic performance and food insecurity, despite employing over 70 per cent of the population and contributing on average, 41.4 percent of the country's GDP. The poor performance of the sector is attributed to challenges such as low productivity, poor technology and cultural practices, low research and development, and under-financing of the agricultural value chain.

Bernanke (2007) posited that though economic growth and prosperity is primarily created by productivity, quantity and quality of the capital stock, availability of land and natural resources, among others, financial factors plays more crucial role. This he referred to as 'financial accelerator' which is amplified by 'credit channel' and both are essentially related. Bernanke submitted that '..healthy financial conditions help a modern economy realize its full potential.' Thus the transformation of the Nigeria to be one largest twenty economies by the year 2020 has been the principal focus of Government in recent times. The country's comparative advantages in the agricultural sector have made it the cynosure of the transformation agenda.

2. Financing of agriculture in Nigeria

Financing of the agricultural sector is paramount because it was considered as the spring board for Nigeria's modern economy. Added to this, is that it is politically expedient because of the large population engaged by the sector, to create jobs and poverty reduction. The sector has always been a major thrust of all budgets since the country became independent in 1960. At various times, the national and sub-national governments through budgetary provisions established institutions, introduced policies, and initiated institutional credit schemes aimed at boosting financing of agricultural production. These include:

- credit ceiling,
- direct control of interest and exchange rates,
- sectoral credit allocations
- Agricultural research institutes
- Operation Feed the Nation (OFN)
- National Accelerated Food Production Programme (NAFPP)
- Directorate for Food, Roads and Rural Infrastructure (DFRRI)
- Green Revolution Programme
- Agricultural Development Projects
- Bank of Agriculture (formerly Nigeria Agricultural Cooperative and Rural Development Bank)
- River Basins Development Authority
- People's Bank
- Community Banks
- Nigerian Agricultural Land Development Authority (NALDA)
- Family Economic Advancement Programme (FEAP)
- Better Life for Rural Women
- Family Support Programme (FSP)
- Rural Infrastructure Development Scheme (RIDS)
- Natural Resource Development and Conservation Scheme (NRDCS)
- Rural Banking Scheme (RBS)
- Commercial bill for financing schemes for regional commodity boards,
- Export financing and rediscounting facility
- Agricultural Credit Guarantee Scheme (ACGS),
- Interest Draw-back Programme (IDP),
- Agricultural Credit Support Scheme
- ₦200 Billion Commercial Agricultural Credit Scheme (CACS)

3. Funding of the agricultural sector with budgetary provisions

Between the years 2003 to 2013, the total budget of the Federal Government of Nigeria was over ₦33.0 trillion, with only a paltry sum of ₦834.0 billion allocated to the agricultural sector. This was 2.53% of the total sum expended within the eleven years. The trend of Government expenditure on agriculture is shown in Table 1.

Generally, the trend of budgetary allocations to the agricultural sector shows a negative relationship with total budget provisions, except in years 2008, 2009, and 2010. Thereafter it was inverse relationship. As the total budget increases, provisions to the sector decrease. Furthermore, it was only in 2010 that the budget of 4% met the requirements stipulated in the National Eco-

Table 1. Provisions to Agriculture as a Component of the Federal Budget 2003-2013

Year	Total Budget (N'000 Millions)	Allocation to Agriculture (N'000 Millions)	% of Allocation to Agriculture of Total budget	% Change
2003	976.25	18.05	1.85	1.25
2004	1,302.52	18.94	1.45	0.45
2005	1,799.94	20.47	1.14	0.14
2006	1,899.99	30.81	1.62	0.62
2007	1,885.92	38.83	2.06	1.06
2008	3,431.30	134.95	3.93	2.93
2009	3,101.81	166.67	5.37	4.37
2010	4,608.62	184.39	4.00	3.00
2011	4,226.19	63.53	1.50	0.50
2012	4,877.21	78.98	1.62	0.62
2013	4,987.22	81.41	1.63	0.63
Total	33,096.98	837.04	2.53	

Source: Compiled from CBN Annual Reports various editions & National Bureau of Statistics (NBS)

nomic Empowerment and Development Strategy (NEEDS) for increased output in the sector. It is noteworthy that it was in 2010 that the ₦200 Billion Commercial Agricultural Credit Scheme (CACS) initiated by the Central Bank of Nigeria in collaboration with the Federal Ministry of Agriculture and Rural Development (FMARD) commenced full operations.

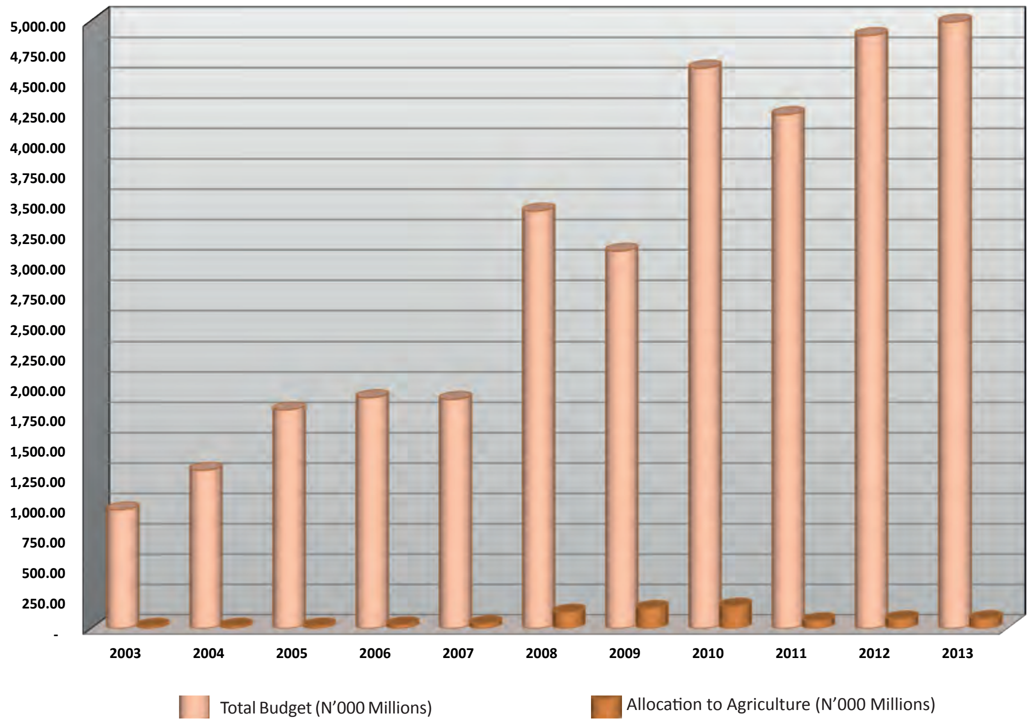

Figure 1. Provisions to Agriculture as a Compnent of the Federal Budget 2003-2013

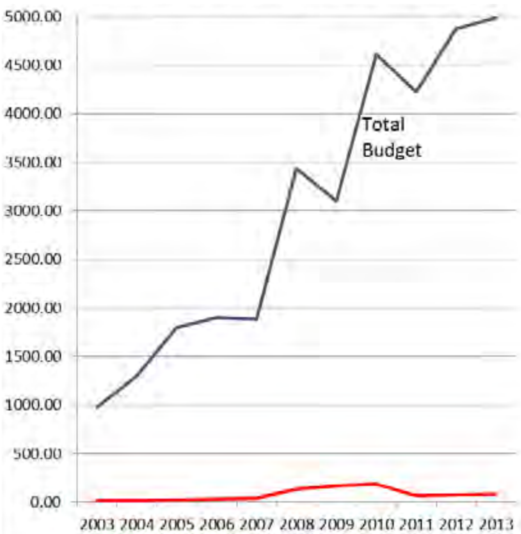

Figure 2. Total Federal Budget and Allocation To Agriculture (2000-2013)

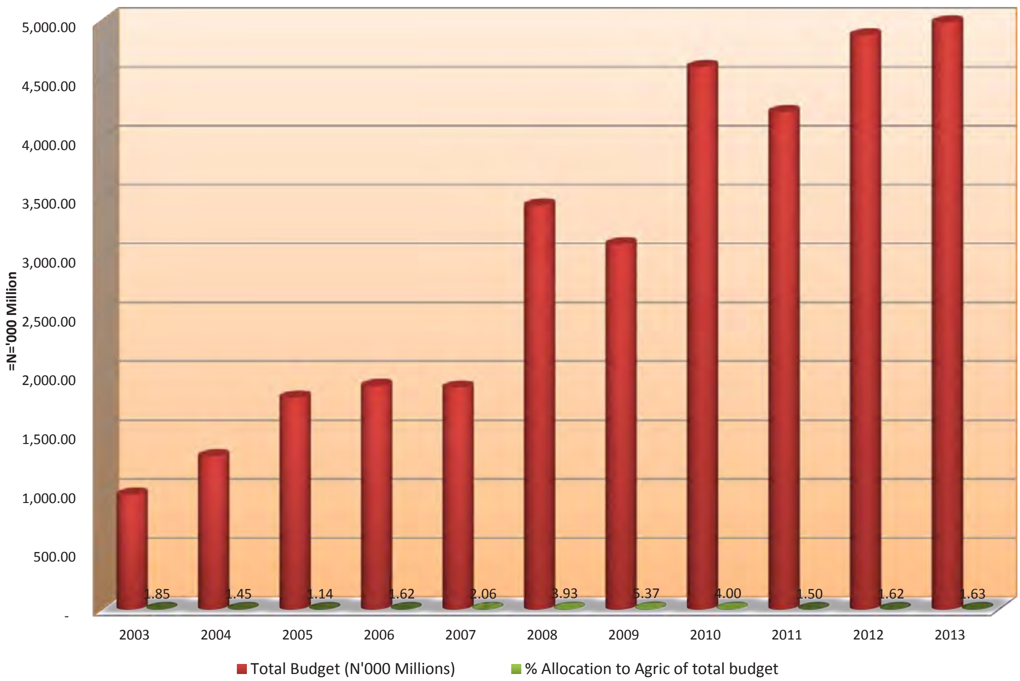

Figure 3. Budgetary Provisions to Agriculture as a % of Total Federal Budget (2000-2013)

The food import bill of the country continues to rise due to increasing population, despite the plethora of funded programmes to transform the sector. According to the Honourable Minister of Agriculture, Nigeria spent about N1trillion (USD 6.33 billion) annually on the importation of wheat and rice, making the country the world's largest importer of wheat from the US at N635 billion (USD 4bllion). The country imported sugar and fish worth N217 billion (USD 1.4 billion) and N97billion (USD61.3 million), respectively in 2011.

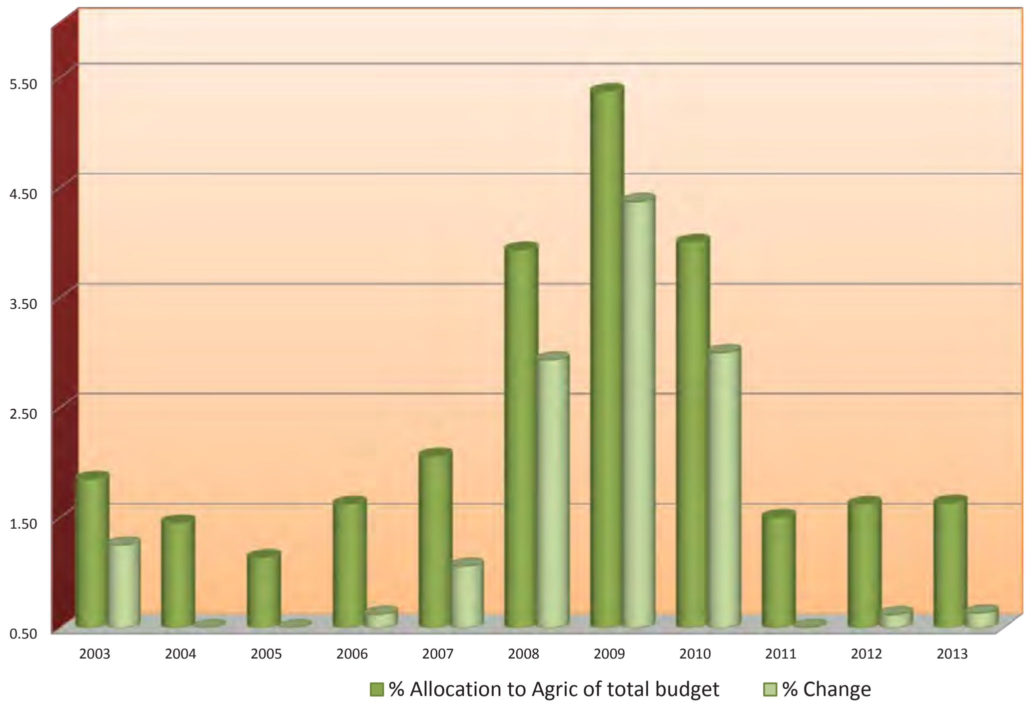

Figure 4. Budgetary Allocation to Agriculture of the Federal Budget and % of change (2003-2013)

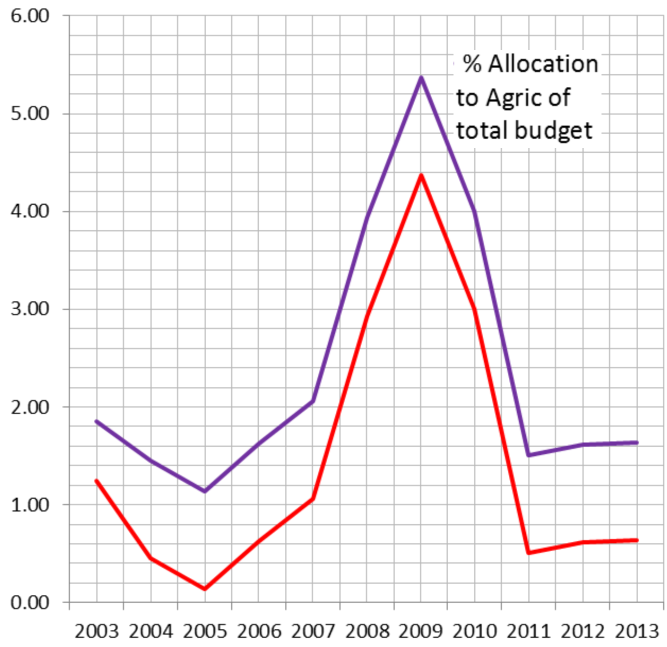

Figure 5. Change in Budget Provisions to Agriculture of Total Federal Budget (2000-2013)

4. Challenges of agriculture transformation in Nigeria

Basic infrastructure like roads, water, electricity, rudimentary technology, poor business model and inadequate funding are impediments to attracting investments in the sectors. This created structural gaps. The provision and management of basic infrastructures have become a daunting challenge in the transformation of agriculture. The World Bank (2010) estimated that poor infrastructure across Africa, Nigeria inclusive reduced economic growth by 2% per annum. The Debt Management Office in Nigeria has estimated that Nigeria will require investing \$8 – \$10bn per year, for the next 10 years to fill the gaps in power and transport sectors and the under-investment in social infrastructures.

Gross underfunding of the agricultural sector is a major challenge (Table 1). The budgetary allocation to the sector is less than 4 per cent of the Federal budget contrary to the 2003 African Union (AU) Maputo Declaration that directed member countries to increase investment in the agricultural sector to at least 10 per cent of the national budget by 2008. Furthermore, private investment in the agricultural value chain is at a low ebb owing to perceived risks, distortions and uncertainties such that Nigerian agriculture is today one of the most underfunded in the world. Currently, lending to agriculture accounts for only about 2.5 per cent of total banks' lending in Nigeria. This performance is below the levels recorded in some other developing countries like Kenya and Brazil with 6 per cent and 18 per cent, respectively (Nigeria Incentive-based Risk Sharing for Agricultural Lending, 2011).

Other challenges include low technology, inadequate processing of primary produce and low value additions, high post-harvest losses, lack of interface of operations of banks with the farming system which was dependent on seasonal dynamics and cash flows of the enterprises and weak linkages with other major growth drivers, e.g. manufacturing sector, research and development (R&D). The sector's numerous challenges demands pragmatic approach to address them for the transformation of agriculture to occur.

5. Strategies to achieve agricultural transformation for economic development

Stiglitz, J (2002) in *Review of Development Economics* posited that development can be regarded as a transformation of society. According to him, it is a movement from traditional ways of thinking and traditional methods of production to more modern ways to improve all aspects of peoples' lives. In *Communication for Development: One World, Multiple Cultures*, J. Servaes (1999) opined that development must be multi-dimensional. It was on this premise that the South African's *Rural Development Framework* (1997) referred to rural development as a means of helping rural people set the priorities in their own communities.

Nigeria has some of the most fertile lands in the world, with over 79m ha. of agricultural land of which 40m ha. is arable. Over 45% of arable land remained uncultivated. The country has potentially irrigable land of up to 3.14m ha. of almost all crops exists. Nigeria is currently the global leader in cassava production. In the 1960s, it was on record that during that decade Nigeria was the leading exporter of key crops such as cocoa, groundnuts, cotton, rubber and palm produce (Federal Ministry of Agriculture & Rural Development, 2008).

Today, the reverse is the case as Nigeria's agricultural imports bill stands at about N1trillion annually. There is still strong justification for Government to support agricultural development in all ramifications to facilitate the on-going process of agricultural transformation along the value chain of financing, production, storage and marketing for the sector's sustainable development.

The Federal Government has stated in the New Agricultural Policy Direction that the provision of facilities and incentives such as rural infrastructure, rural banking, primary health care, cottage industries etc., are paramount to encourage agricultural and rural development and attract youths (including school leavers) to go back to the land. It also stated that deliberate efforts would be made for integrated rural development programmes to raise the quality of life of the rural people. The Federal Government was saddled with the following specific responsibilities in the policy document:

- the provision of a general policy framework, including macroeconomic policies for agricultural and rural development and for the guidance of all stakeholders;
- maintenance of a reasonable flow of resources into agriculture and the rural economy; and
- support for rural infrastructure development in collaboration with state and local governments.

6. Conclusions

Nigeria is a country that is determined to accelerate its pace of development. Agriculture can greatly assist in a sustainable way in the generation of jobs and income, creation of viable enterprises, empowerment of agro businesses and improve the standard of living of the populace. To attain this, we are left with no choice but to re-design and embrace a holistic approach in addressing the gamut of challenges confronting our agricultural sector, particularly rural agriculture. The role of finance in providing windows of opportunities for the strengthening and stabilizing the agricultural transformation we so desired cannot be underestimated. It requires commitment at the highest political level. Youth entrepreneurial farmers must be attracted to replace the old farmers. There is need for capacity building of farmers on modern agri-business so that the can graduate of the current practice of subsistence farming. Nigerian farmers must think and globally, while Government addresses other structural gaps in the agricultural industry. Budgetary allocations to the sector should be scaled up to the 10% stipulated in the 2003 Maputo Declaration, if not above for agricultural transformation in the Nigeria to be a reality.

7. References

Ben S. Bernanke (2007): Presented at the Credit Channel of Monetary Policy in the Twenty-first Century Conference, Federal Reserve Bank of Atlanta, Atlanta, Georgia June 15, 2007.

Central Bank of Nigeria of Nigeria (CBN) Publications.

Federal Ministry of Agriculture and Rural Development (2008): "Invest Opportunities in Nigerian Agricultural Sector" (2010) : "New Agricultural Policy".

Food and Agricultural Organisation (1999): Nigeria Rural Finance Project- Working Papers, 2nd August, 1989.

Olaitan, M.A. (2001) *"Emerging Issues on Micro and Rural Financing in Nigeria"* in Bullion, a publication of the Central Bank of Nigeria, Volume 25 No.1 January/March, pp 64-71.

Olaitan, M.A. (1997): 'Factors Influencing Repayment Patterns Under the Agricultural Credit Guarantee Scheme (ACGS) in Ogun State, Nigeria'. Unpublished Ph.D Dissertation, University of Ibadan, Ibadan, Oyo State, Nigeria.

National Bureau for Statistics (NBS) Publications.