CATTLE PRODUCTION, COMMERCIALIZATION AND MARKETING IN SMALLHOLDER FARMING SYSTEMS OF SOUTH AFRICA: IMPACTS AND IMPLICATIONS OF LIVESTOCK EXTENSION AND MARKET TRANSACTION COSTS

By

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Doctor of Philosophy in Agricultural Extension and Rural Resource Management

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   1. Dr Maxwell Mudhara (Supervisor)

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   2. Professor Michael Chimonyo (Co-supervisor)

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DECLARATION 2 – PUBLICATIONS

The following publications (published and under review) form part of the research presented in this thesis.

Publication 1 – Chapter 3 of the thesis:

Ndoro, J.T., Mudhara, M. & Chimonyo, M. (2014). Livestock extension programmes participation and impact on smallholder cattle production in KwaZulu-Natal: A propensity score matching approach. *South African Journal of Agricultural Extension 42*(2):62-80.

Publication 2 – Chapter 4 of the thesis:

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ABSTRACT

The lagging performance of agriculture in sub-Saharan Africa over the past four decades has been attributed to the underlying agro-ecological and market access conditions. Regions with high agricultural potential are often found in remote and rural areas lacking the basic infrastructure to integrate into the market economy. Such challenges are more pronounced in South Africa. The country's livestock sector, for example, accounts for 69% of agricultural land and remains a key livelihood strategy for over three million smallholder farmers. Yet cattle markets are still characterized by low participation rates among smallholder farmers, which could be attributed to weak institutional support and high transaction costs. However, empirical evidence remains scanty. This study evaluated the impact of extension programme on cattle production and investigated the effects of extension information, market transaction costs and famers' motivations on cattle commercialization and marketing in rural KwaZulu-Natal (KZN). The empirical analyses were based on data from a household survey of 230 cattle farmers in 13 communities of the Okhahlamba Local Municipality.

Based on a propensity score matching (PSM) approach, the probit estimation results showed that the probability of participating in extension programmes decreases with education and Nguni breed farming and increases with herd size, group membership and distance from the extension office. The results of the Nearest Neighbour PSM algorithm showed that cows belonging to contact farmers and participants in farmers-to-farmer extension programmes produce more calves than their control counterparts. The results showed higher rates of use of veterinary services among participants in farmer-to-farmer extension sessions than among their control counterparts. However, these findings were not robust across different PSM algorithms. The findings, therefore, suggested that the training and visit (T&V) extension approach in the rural KZN remains largely supply-driven and achieves limited success.

Based on Double-Hurdle estimation technique, the results of probit and truncated models of cattle commercialization and supply volume decisions showed that farmers with larger herd sizes are more likely to participate in cattle markets and, given positive decisions, they supply larger volumes of cattle to the market. They also showed that the likelihood of participating in cattle markets increases with membership in saving groups, Nguni farming, and cattle tagging, and decreases with proximity to water sources and unearned incomes. The results further showed that the quantity supplied increases with participation in farmer-to-farmer extension and decreases with expected price. These findings suggested that cattle commercialization in rural KZN is encouraged by farmer-to-farmer extension and discouraged by transaction costs and store-of-wealth motives.

The estimation results of a multinomial logit model of marketing channel selection showed that selling during December (a festive month) increases the probability of choosing the auction marketing channel versus farm gate, suggesting a scope of market uncertainty during off-peak seasons. The results also showed that knowledge of the buyer and distance to auctions increase the probability of selling to speculators, suggesting that farmers selling to speculators face considerable challenges related to low bargaining power, while participants in dip tank sales face higher opportunity cost of time and efforts to transport the cattle. The results showed a positive effect of volume sold and age on selling at the auction, indicating that farmers spread auction-specific transaction costs over the number of units sold, and they gain the ability to co-ordinate market transaction, at much lower cost, through experience.

The findings have several implications for livestock extension policies in South Africa. To be more demand-driven, extension strategists should: (i) explore advisory and facilitation models; (ii) ensure accountability of extension workers at local levels; and (iii) tap into market-led extension models. To facilitate cattle commercialization, extension workers should support farmer groups and promote non-livestock investment opportunities. Video auctioneering could alleviate the market uncertainty and high negotiation cost. Facilitating trust-based relational exchanges could help to eschew the scope of opportunism among itinerant speculators.

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To my late father, beloved mother, brothers and sister.

ACKNOWLEDGEMENTS

LIST OF ACRONYMS AND ABBREVIATIONS

ATT	:	Average treatment effect on the treated
DAFF	:	Department of Agriculture, Forestry and Fisheries
DUA	:	Dip-tank Users' Association
FFS	:	Farmer field school
HTEM	:	Heckman treatment effect model
IMR	:	Inverse Mills Ratio
KZN	:	KwaZulu-Natal
LR	:	Log-Likelihood ratio
MNL	:	Multinomial Logit
NALEP	:	National Agriculture and Livestock Extension Programme
NGO	:	Non-governmental organization
NIE	:	New Institutional Economics
OLC	:	Okhahlamba Livestock Co-operative
OLM	:	Okhahlamba Local Municipality
OLS	:	Ordinary least squares
PRA	:	Participatory rural appraisal
PSM	:	Propensity score matching
SLF	:	Sustainable Livelihoods Framework
SSA	:	Sub-Saharan Africa
T&V	:	Extension training and visit
TCA	:	Transaction cost approach
TCE	:	Transaction cost economics
TOT	:	Transfer of technology model
UKZN	:	University of KwaZulu-Natal

CHAPTER 1 : INTRODUCTION

1.1. Background

1.1.1. The performance of agriculture in the sub-Saharan African region

The world development report on agriculture suggests that developing countries have led the world's agricultural performance over the last four decades, with an impressive 79% of overall agricultural growth (2.6% per year, against 0.9% per year in industrialized countries) (World Bank, 2007; Wik *et al.*, 2008). The report shows that where the agricultural sector has performed well, better technologies (in the form of widespread irrigation schemes, improved crop varieties and fertilizers) and better policies (including investment in research and development, and rural infrastructure) have been the major sources of growth. Incidentally, as Figure 1.1 shows, sub-Saharan African (SSA) is the only region in the developing world where per-capita agricultural output has been declining (by nearly -0.5% growth rate over the period between 1961 and 2004). Yet this region is home to the majority of agriculture-based economies, where the agriculture sector remains the engine of overall growth, poverty alleviation and food security. The difference in performance reflects the underlying agro-ecological and market access conditions, with about half of the regions with high agricultural potential being found in remote areas lacking the basic infrastructure to integrate into the market economy (World Bank, 2007).

In the SSA region, the integration of smallholder farming into the market economy has received considerable attention among development policy-makers and researchers. Access to agricultural markets contributes substantially to rural development. This includes: (i) the welfare effect of trade according to the comparative advantage school of thought; (ii) the welfare gains of market participation accruing from larger-scale production opportunities in the face of fixed production costs; (iii) technological change effects of regular market-based exchanges; and (iv) the associated total factor productivity growth (Barrett, 2008).
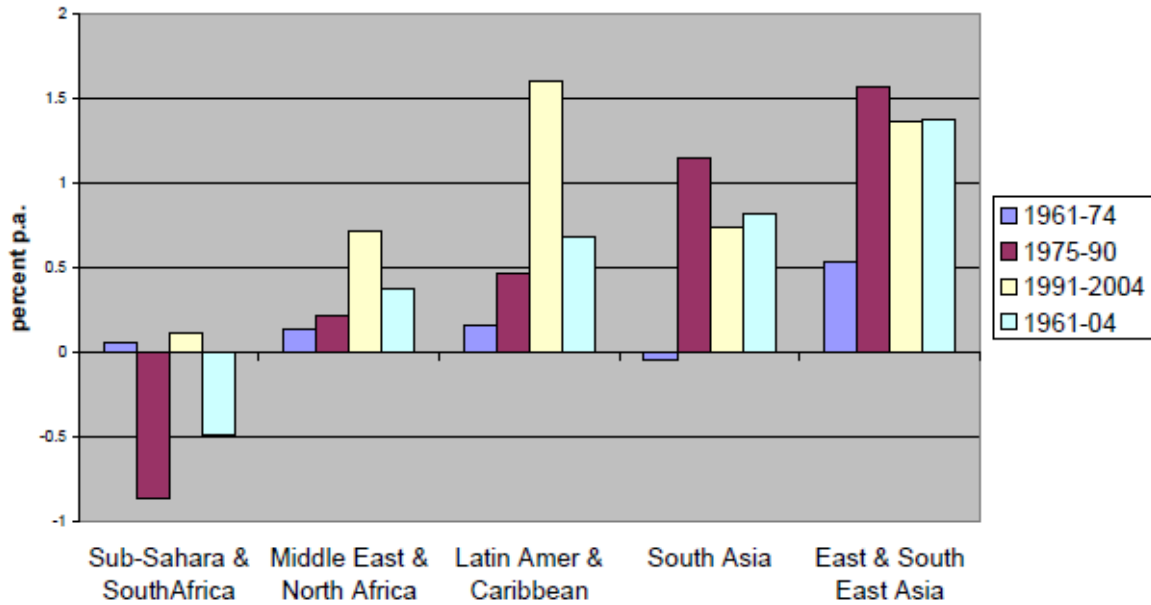
Figure 1.1. Growth rate in total agricultural production per capita in developing regions
Source: Wik *et al*. (2008)

To produce marketable surpluses and sustain food security, smallholder farmers need access not only to agricultural technologies, but also to private assets (e.g. land and equipment) and public goods (Barrett, 2008). Among public goods, there is evidence that agricultural extension information has an important impact on farm productivity (Birkhaeuser *et al*., 1991). Indeed, empirical evidence in developing countries suggests that the impact of access to agricultural extension on poverty reduction is greater than the impact of access to infrastructure (Dercon *et al*., 2009). Moreover, investment in agricultural extension ensures increased returns in both developing and developed countries (Birkhaeuser *et al*., 1991; Evenson, 2001).

1.1.2. The challenge of smallholder market participation in southern Africa

Agricultural markets in SSA are characterized by multiple equilibria, with a high-level equilibrium associated with technological advances and access to private and public goods, co-existing with a low-level equilibrium pertaining to smallholder farmers facing prohibitive fixed and sunk costs, high market transaction costs, co-ordination problems related to public goods provision and liquidity constraints (Barrett, 2008). The challenges

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to pro-smallholder market development are more pronounced in South Africa. South Africa's dual agricultural economy (i.e. largely subsistence, rain-fed farming systems, co-existing with commercial, largely irrigated agricultural systems) has persisted, despite policies pledging to promote the integration of smallholder farmers in high-value market chains (van Schalkwyk *et al.*, 2012). The limited success of rural development policies is owed to supply-side challenges such as weak institutional support, high transaction costs, high risk associated with new products, poor infrastructure, high price variability and weak bargaining power of smallholder producers (Delgado, 1999; Ortmann and King, 2010; Obi *et al.*, 2012).

1.1.3. Importance of smallholder cattle farming in South Africa

The challenges to commercialization of smallholder farming systems are more pronounced in the livestock sub-sector than in the crop or fishery sub-sectors. As Figure 1.2 shows, livestock production is an important agricultural land use in South Africa from its spatial coverage. Livestock production is mainly found in marginal and remote areas (Africa Research Institute, 2013). Such regions are often characterized by degraded lands and meagre economic opportunities. Livestock commercialization, therefore, has profound implications for rural development in South Africa.

A 2011 report on the beef value chain profile published by the Department of Agriculture, Forestry and Fisheries (DAFF) of South Africa shows that 69% of the country's agricultural land is under extensive grazing by commercial, emerging and smallholder beef cattle farmers (Republic of South Africa, 2011). By 2008, it was estimated that cattle production alone contributed to the national agricultural GDP to levels between 25 and 30% per annum (Musemwa *et al.*, 2008). Approximately 8.2 million cattle are owned by 50 000 commercial farmers, while the remainder (5.6 million) are owned by 240 000 smallholder farmers and three million subsistence farmers (Republic of South Africa, 2011).
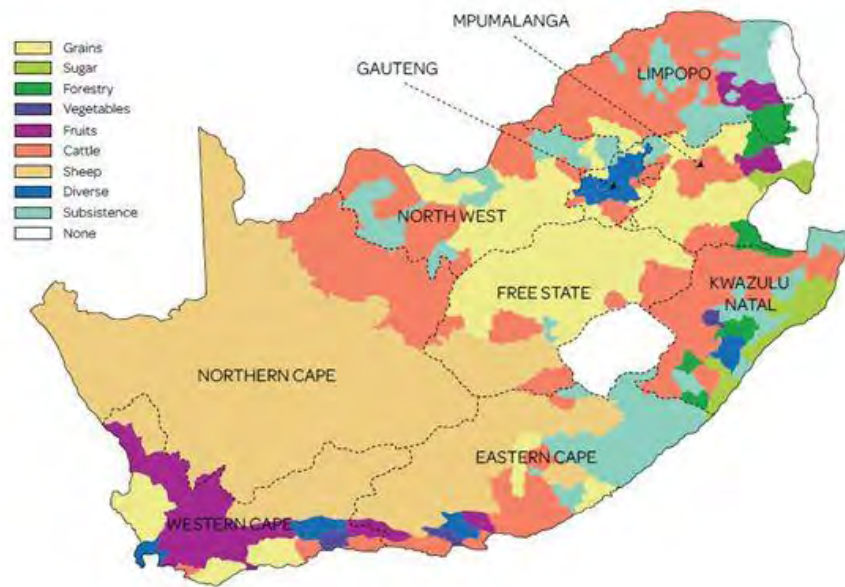
Figure 1.2. Agricultural regions of South Africa
Source: Africa Research Institute (2013)

For these smallholder farmers, cattle farming has multiple functions, both commercial and non-commercial (Swanepoel *et al*., 2010). Non-commercial motives include economic functions (e.g. wealth storage), agro-economic functions (e.g. provision of draught power), agro-ecological functions (e.g. provision of manure), nutritional (e.g. provision of milk for infants) and socio-cultural functions (e.g. dowry) (Musemwa *et al*., 2010; Stroebel *et al*., 2011; Groenewald and Jooste, 2012).

1.1.4. Livestock commercialization policies in South Africa

Farm household commercialization is defined as an allocation of a portion of household resources to marketable agricultural commodities, achieved when a farmer's choice of agricultural products and input use decisions are made based on the principles of profit maximization (Jaleta *et al*., 2009). The appeal of livestock farm households' commercialization for fast-tracking rural development has attracted the attention of policy-makers, leading to the development and implementation of strategies aimed at transforming the rural livestock sector towards a fully fledged commercial industry.

The livestock development strategy pledges to support smallholder and emerging farmers for global competitiveness and profitability, through the creation of an enabling environment, investment in rural commercial and co-operative infrastructures, market development, training and research, equitable access and participation and integration into a sustainable rural development (Republic of South Africa, 2006). For the livestock sector, the agricultural marketing strategy sets out to develop commodity groups/associations (for ease of information communication) and agricultural marketing infrastructure (Republic of South Africa, 2010).

Despite these incentive structures and processes, the livestock market in South Africa remains characterized by low participation rates among smallholder cattle farmers. Musemwa *et al.* (2010) reported off-take rates of between 5 and 10% among communal farmers compared to 25% among commercial farmers. Other sources cited in the livestock development policy document give much lower figures, ranging from 3 to 8% off-take rates among smallholder farmers (Republic of South Africa, 2006). The lower commercialization rates have been attributed to lower productivity among smallholder farmers. Indeed, cattle supply is directly proportional to the holding, with rates of 33% among herders of 10 or fewer cattle, 52% for 11-20 cattle herders and 85% for 20 or more cattle herders (Lehloenya *et al.*, 2007; Musemwa *et al.*, 2007; Groenewald and Jooste, 2012). Other studies show that cattle commercialization is constrained by high transaction costs (Montshwe, 2006; Bahta and Bauer, 2007; Uchezuba *et al.*, 2009). The low off-take rate is a major constraint to investment in fixed costs (Mahabile *et al.*, 2002).

1.1.5. Smallholder cattle marketing in rural South Africa

The beef industry has evolved from a centrally-planned, highly regulated industry to one that is fully governed by market forces. The pre-deregulation era was marked by the distinction between controlled and uncontrolled areas, compulsory auctioneering of carcasses, the use of agency in controlled areas and the floor price system and quotas/permits. The deregulation process was concluded in 1997, with the enactment of the new Marketing of Agricultural Products Act and the abolishment of the Meat Board of South Africa (Groenewald and Jooste, 2012).

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Following the deregulation, the beef industry has been increasingly vertically integrated, driven by high population growth, income growth, urbanization, globalization and their associated changes in lifestyles and consumer preferences (Coetzee *et al.*, 2006; Groenewald and Jooste, 2012). This integration has been mainly marked with increasingly large feedlot companies owning their own abattoirs, abattoirs integrating towards the wholesale level, and wholesalers sourcing their cattle directly from farmers or feedlots on a bid and offer basis (Republic of South Africa, 2011).

Five major channels for livestock marketing are currently available to smallholder farmers. These are auctions, speculators, butcheries, abattoirs, and private buyers (Musemwa *et al.*, 2010). The auction, also known as a dip tank sale, is scheduled by the livestock extension offices. It is the most advanced institutional form of cattle marketing for smallholders in South Africa. Cattle in the auction pens often fetch better prices than those sold elsewhere. Although the speculators are the "principal" buyers at the auctions, they also source their animals directly from farmers.

Farmers do not incur any cost for dealing with speculators, as the transactions often take place at their homesteads. The speculators buy animals with the intention of re-selling them to feedlots, abattoirs and butcheries, with some profit margin. Butcheries also buy their cattle directly from the farmers or at the auctions. Perhaps the most important form of cattle marketing is private sales (Nkosi and Kirsten, 1993; Musemwa *et al.*, 2010). It takes place among neighbours and between neighbouring communities, mainly in the form of barter or cash sales.

1.2. Problem statement

In spite of the low participation rates among smallholder farmers characterising livestock markets in rural South Africa, most studies on agricultural extension and marketing have focused on non-livestock extension and transaction cost factors. There are three research gaps in the understanding of livestock extension models and the working of cattle markets for smallholder farming systems in rural South Africa.

First, empirical literature on the demand for extension information and the effects of such information on livestock production remains scarce. Second, quantitative studies on the effect of marketing transaction costs on smallholder livestock commercialization often do not pay explicit attention to the motivational aspect of livestock farming. Third, empirical measurements of the transaction cost effects on livestock marketing channel selection remain descriptive and do not empirically test the validity of the transaction cost hypothesis.

1.2.1. Participation in livestock extension programmes and impacts

The sustainability of cattle production systems has been constantly threatened by the limited availability of land and water. Despite the decrease in total grazing area due to the expansion of human settlements, mining, cropping, forestry and conservation, the cattle population has increased by a million from 1994 to 2004 (Republic of South Africa, 2011). Generally, such an increase is due to the recent development in breeding, nutrition and animal health that has contributed to increased production, efficiency and genetic gains (Thornton, 2010). The development has induced major changes in commercial beef production systems in the country and has highlighted the importance of transfer of advanced knowledge to the smallholder farmers whose cattle productivity has remained lower.

With such consideration, the central government, as well as provincial governments, continue to invest in agricultural extension. KwaZulu-Natal (KZN), a province contributing about 11% to South Africa's total beef production (Republic of South Africa, 2011), has the country's highest agricultural extension expenditure at provincial level (Worth, 2012). The KwaZulu-Natal Provincial Treasury (2014) reports that the expenditure on agricultural extension and advisory has increased from ZAR626 million in 2010/2011 to ZAR1.012 billion in 2012/2013. In total, the budget line of agriculture development services programme supported 11 526 agricultural demonstrations, 308 farmers' days and 10 functional commodity groups during the 2012/2013 fiscal year.

As in other parts of South Africa, the design of appropriate agricultural extension service delivery models remains a major challenge. For the purpose of effectiveness, there has been increasing effort to shift from a largely supply-driven technology transfer model, towards a demand-driven, farmer-centred approach (Worth, 2006; Williams *et al*., 2008). The situation underscores the importance of empirical research on smallholder farmers' demand for agricultural extension services and their effectiveness in uplifting their productivity.

Empirical studies investigating the drivers of participation in livestock extension programmes and the impact of these programmes on farm productivity, technology adoption and knowledge remains scant. Studies evaluating the impacts of agricultural extension on livestock productivity remain few in number (Taye, 2013). No empirical studies have attempted to estimate the determinants of participation in agricultural extension programmes or to evaluate the impact of livestock extension on smallholder cattle production in South Africa (Evenson, 2001; Taye, 2013).

Moreover, the empirical evidence on the impacts of agricultural extension of farm productivity has been mixed (Taye, 2013). For example, whilst Deschamps-Laporte (2013) reports that participation in the extension programmes in Kenya had no significant impact on maize yield, Davis *et al*. (2012) reported that East African farmers participating in extension programmes have higher farm productivity. The mixed evidence on the impacts of agricultural extension across different studies in different regions indicates the need for investigating the impact case-by-case.

1.2.2. Transaction cost in cattle commercialization

The post-deregulation era in South Africa has been marked by an increasing demand for livestock products. In the beef industry, there was a 54% increase in beef consumption in 2009/10 compared to 2000/1 (Republic of South Africa, 2011). Estimates suggest that the country does not produce enough beef to meet its domestic demand (Republic of South Africa, 2011). Paradoxically, this commercial appeal co-exists with the low market off-take rates among smallholders.

Empirical literature on factors influencing cattle marketing among South African smallholder farmers is limited. A handful of studies has mainly approached the empirical investigation from the perspective of the transaction cost hypothesis (Goetz, 1992; Key *et al*., 2000). For example, Montshwe (2006) and Uchezuba *et al*. (2009) reported that farm households with experienced and trained members have higher chances of engaging in the livestock markets. Their studies also reported that shorter distances to market and good market infrastructure enhance participation. Bahta and Bauer (2007) and Uchezuba *et al*. (2009) stressed the importance of access to market information and extension services for livestock commercialization.

A common weakness in the literature pertains to controlling for motivational aspects (such as the wealth storage or consumption smoothing) for the determination of the livestock market participation outcome (Kazianga and Udry, 2006; Dorward *et al*., 2009; Kinyua *et al*., 2011; Siegmund-Schultze *et al*., 2011). The motivation for keeping cattle in South Africa could be diverse. The lack of understanding of the potential effect of the motivation to keep livestock on their commercialization can overestimate or underestimate the transaction cost effect, leading to bias in agricultural policy recommendations and actions.

1.2.3. Selection of cattle marketing channels

Smallholder cattle farmers consider some aspects of transaction cost when choosing between marketing channels. For example, in the Lebowa region of the Limpopo province, Nkosi and Kirsten (1993) reported that farmers are generally dissatisfied with low prices at the auctions and speculators' disrepute (opportunism, dishonesty and disrespect). The study mentioned that farmer preference for private sales is due to their participation in price determination and low marketing costs. In the Eastern Cape province, Musemwa *et al*. (2007) pointed out that the majority of cattle farmers selling at auctions are mainly attracted by accessibility and reliability.

The costs associated with such friction in market exchanges can have profound implications for poverty alleviation in rural areas. As Woldie (2010) explains, frictionless access to a wider range of market outlets allows farmers to allocate their produce in ways that optimize earnings under different risk scenarios. The information provided by the aforementioned studies, however, is largely descriptive and lack any predictive power. Measuring and testing the validity of hypotheses of transaction costs economics (TCE) for the understanding of livestock marketing channel selection among smallholder farmers in rural areas remains largely ignored. Thus, currently, there is little information at the disposal of livestock marketing policy-makers about the factors determining the costs of transacting in South Africa's rural livestock marketing and the appropriate strategies to alleviate them.

1.3. Research hypotheses

Based on the microeconomics literature, the present study hypothesizes the following relationships:

- The demand for extension information is influenced by the cost of making extension contact, as well as household-specific factors such as skills, risk aversion and resource endowment (Bagi and Bagi, 1989).
- Participants in agricultural extension information produce more cattle and have greater rates of use of production technologies than non-participants (Birkhaeuser *et al*., 1991).
- Cattle commercialization and supply volume decisions are respectively determined by the extents of fixed and proportional transaction costs faced by a farmer, and his/her non-commercial motives (Doran *et al*., 1979; Goetz, 1992; Key *et al*., 2000).
- A producer's choice of the cattle marketing channel is influenced by the degree of information, negotiation and monitoring costs he/she is facing in the channel, as well as his/her socio-economic characteristics (Hobbs, 1997).

1.4. Research objectives

The success of livestock extension and marketing policies in South Africa largely depends on the effectiveness of existing extension models, as well as the inclusiveness of livestock markets for smallholder farmers. It is, therefore, important to understand the demand for extension information in rural areas and its impact on farm production. Moreover, an understanding of the institutional environment surrounding cattle marketing in rural areas is essential. The purpose of the present study is to determine the impacts of livestock extension and marketing transaction costs on cattle production and marketing behaviour among smallholder farmers in rural South Africa. The specific objectives are four-fold:

i. To investigate the determinants of participation in livestock extension among smallholder cattle farmers in rural South Africa;

ii. To assess the impact of participation in the current livestock extension models on cattle production in rural South Africa;

iii. To examine the effects of transaction costs, agricultural extension and motivation on cattle market participation and supply volume decisions; and

iv. To measure the effects of transaction costs on the selection of cattle marketing channel.

1.5. Thesis structure

The thesis is organized into six chapters. A literature review is presented in Chapter 2. The review chapter is followed by three empirical chapters in which the objectives of the study are addressed, based on household survey data collected in the study area. The first and second objectives of the study are addressed in Chapter 3. In this chapter, the determinants of participation in livestock extension programmes and the impact of extension information on cattle production are investigated, using the propensity score matching method. The third objective is addressed in Chapter 4. The Double-Hurdle model is used to analyse the drivers of cattle market participation and supply volume decisions. To address the fourth objective of the study, the transaction costs affecting the choice of cattle marketing channel are estimated in Chapter 5. The conclusions and recommendations for policy and further research are drawn in Chapter 6.

CHAPTER 2 : AGRICULTURAL EXTENSION, COMMERCIALIZATION AND MARKETING IN SMALLHOLDER FARMING SYSTEMS: A LITERATURE REVIEW

2.1. Introduction

The review chapter is subdivided into two sections. In section 2.2, the conceptual literature underpinning of the study is reviewed. The review starts by defining and explaining various models and approaches to agricultural extension, followed by sections elucidating the economics of agricultural extension and transaction cost. Section 2.2 is concluded with a conceptual synthesis. Based on the conceptual synthesis, the empirical evidence from developing countries, with particular focus on South Africa, is presented in section 2.3. The section contains the existing empirical evidence on the demand for agricultural extension and its impacts. Section 2.3 also includes the existing empirical evidence on the effects of transaction costs and farmers' motives on livestock commercialization and marketing in developing countries.

2.2. Conceptual literature review and synthesis

Before discussing the economic theory of the demand for and the welfare effect of agricultural extension through commercialization of production, it is important to define what agricultural extension is, and present an overview of the diverse approaches and models used in the literature.

2.2.1. Definition of agricultural extension

Early scholars confined the definition of agricultural extension to the training of people about new farming ideas in their own context (Bembridge, 1991). However, the concept of agricultural extension has been very dynamic, making a single definition unacceptable (Zwane, 2012). Recent scholarly attempts to define agricultural extension can be classified into one of two categories: substantive or functional. The substantive or essentialist definition broadly views agricultural extension as a generic term describing the delivery of information from scientific researchers and other knowledgeable sources to farm practitioners (Anderson and Feder, 2007). Based on such a definition, Evenson

(2001) states that the first objective of agricultural extension is to provide technical educational services to farmers and the second is an interactive one comprising the provision of feedback to technology suppliers and farmers, to assist the evaluation of the usefulness of technologies and enhance their adoption rates.

The functional definition of agricultural extension is broader than the substantive one (Zwane, 2012). It encompasses three dimensions of agricultural extension: agricultural, rural and community development. In terms of agricultural performance, extension is viewed as a channel through which farm productivity and profitability can be enhanced. In rural development, extension plays a major role in the betterment of the quality of life by proactively participating in food security projects, information dissemination, in the form of farmer education, problem-solving sustainability projects (such as human capital and capacity building) and empowerment of farmer groups. The non-formal educational function consists of agriculture-related continuing education targeting various sections of rural communities such as the youth, adults and spouses.

2.2.2. Models and approaches to agricultural extension

Agricultural extension is a hallmark of social innovation and an important thrust in agricultural change that has evolved over about 4 000 years (Swanson *et al*., 1997). The recent developments in agricultural extension have been marked by a variety of approaches and models adopted by extension policy strategists seeking to improve the outreach and relevance of extension services, and to adapt to changing circumstances (Anandajayasekeram *et al*., 2008).

2.2.2.1. Approaches to agricultural extension

Different stakeholders in agricultural extension emphasise five major approaches to agricultural extension. The "general agricultural extension approach" is a top-down, centrally planned approach that assumes underutilization of locally available knowledge and technology by farmers, and it consists of a "one-way" information flow from government extension workers to farmers seeking advice (Anandajayasekeram *et al*., 2008). The "commodity specialized approach" is another centrally planned approach

often adopted by commodity organizations with the aim of improving the production of a particular commodity (with a narrow range of technological concerns and access to inputs and finance), in which farmers' interests are of lower priority (Butt, 2011). The "training and visits (T&V) approach" has a two-way information flow consisting of extension workers trained by regional scientists "extending" the message to a small group of "contact farmers". The role of contact farmers is to disseminate the information to members of their communities and to pass on farmers' opinions back to the extension workers and, therefore, research station scientists (Anandajayasekeram *et al*., 2008; Birkhaeuser *et al*., 1991).

The "farming systems development approach" is a typical bottom-up approach that assumes that the appropriate technology and knowledge that fits the farmers' needs are lacking and can only be developed "locally" through an interactive process directly involving farmers, extension workers and research personnel (Anandajayasekeram *et al*., 2008). The "participatory agricultural extension approach" is a decentralized system that assumes that farmers have the necessary know-how about agricultural production, but their livelihoods could be improved with access to additional knowledge. Extension workers facilitate group formation and discussions to understand expressed needs and actively involve them in programme planning and evaluation (Anandajayasekeram *et al*., 2008).

The "problem-solving approach" has both top-down and bottom-up features (Akpalu, 2013). The approach consists of giving farmers and agricultural advisors different roles in extension service delivery. Under this approach, advisors offers their specialist knowledge, whilst "competent" farmers decide on the type of expertise they require and provide a basis for the consultants' advice (Akpalu, 2013).

Other general approaches to extension not specifically designed for farmers are noteworthy. The "learning and adult education approach", for example, focuses mainly on helping adult villagers to better understand their situation, using techniques of learning cycles and styles (Akpalu, 2013). The "human development approach" is similar to the

learning and adult education approach. The human development approach, however, uses participatory approaches to expand the goals of extension work, from simply helping people to understand their situation, to defining their problems, solutions and opportunities (Akpalu, 2013).

2.2.2.2. Extension models used in Africa

Anandajayasekeram *et al*. (2008) list five main extension models used in Africa, namely transfer of technology (TOT), public extension, commodity extension, T&V, and farmer field school (FFS) models. The TOT models are top-down, innovation diffusion methods in which new technology and knowledge generated by research station scientists are vertically transferred to "innovative" farmers (generally those with enough land and infrastructure to adopt) through extension agents. This rigid hierarchy often discourages feed-back. The public extension models leverage on the government institutions' (usually the Ministry of Agriculture) relatively deeper penetration in rural areas to reach out to smallholder farmers with the general aspects of their farming (crop production, animal husbandry, natural resources management). The commodity extension models are run by government, parastatals, or private firms parallel to the government extension models, providing specialised extension services focused on the productivity and profitability of specific commodities.

The T&V models (i.e. models based on the T&V approach), rather than reaching out to all farmers directly, concentrates on a small group of contact farmers to facilitate regular field visits, supervision, communication and, hence, achievement of objectives. The T&V model also fosters collaboration between research scientists and extension workers. The FFS models are group extension models based on the premise that participating farmers become researchers in their own fields and under their own circumstances through field experimentation of various technologies. The extension agents in such models are simply facilitators.

2.2.3. New institutional economics of extension information supply

Economic sustainability of various extension models has been the major criterion used in the discourse about their appropriateness (Anandajayasekeram *et al*., 2008). Generally, the underlying question evolving out of such discourse is whether extension service is mainly a public or private good. The new institutional economics (NIE) provides key insights into the understanding of the nature of extension information. Based on the criteria of excludability and rivalry, the NIE school of thought reasons that extension information is a mixed public and private good. The extension information includes general, non-excludable information that is public in nature (e.g. market information), but also specialized information (e.g. specialized management and marketing operations) that are highly excludable, even though their rivalry is relatively low (i.e. the value of information by one farmer is not reduced by its use by another farmer) (Anderson and Feder, 2007). Therefore, the sustainability of extension models depends on the nature of the information flowing through the models. Rivera and Qamar (2003) state that all approaches and models could be effective and efficient, depending on the expected results.

2.2.4. Demand for extension information

The economic science posits that, with limited information availability, lack of awareness of new technologies as well as inaccurate perceptions of their costs and benefits, make decisions on resource allocation and technology choices deviate from the social optimum (Birkhaeuser *et al*., 1991). Like any other input in the classical production function, the demand for extension information is derived from the underlying demand for farm output, based on profit maximization behaviour. The demand for extension information is thus inversely related to the cost of making extension contact, other input prices remaining constant (Bagi and Bagi, 1989).

2.2.5. The welfare impact of agricultural extension

The welfare effect of agricultural extension information is largely defined by the impact of the technology adoption on rural income generation. Minten and Barrett (2008) differentiate the impacts of agricultural technology adoption according to three categories

of farm households: (i) resource-rich farmers endowed with enough land and livestock, generating income from marketable surplus; (ii) resource-poor, net food buyer farmers; and (iii) farm-work dependent households. In a partial equilibrium analytical framework, the welfare impact of agricultural technology and productivity operates through three discrete pathways. When aggregate demand is downward sloping, the effect of technical change (via output) on price is negative and, therefore, the price-mediated welfare effect of technology adoption accrues to consumers, benefitting the net buyers. As long as the elasticity of output with respect to technical change is greater than the elasticity of price with respect to technical change (i.e. output increases at faster rates than price decreases), the net suppliers enjoy increased income from technical change. As long as the increase in marginal physical product of labour, induced by Hicks-neutral technical change, is greater than the elasticity of price, with respect to technical change, farm labour demand will be increasing, benefitting the last category of farmers (Minten and Barrett, 2008).

For all three categories of farmers, agricultural markets are at the centre of the debate concerning the economic impact of agricultural extension via technical change and marketable surplus. Analytically, Barrett (2008) explains that a market is equivalent to a production technology, implying that market and technology adoption choices can be similarly studied. Practically, as Rios *et al*. (2009) contend, agricultural productivity and access to agricultural markets could have bi-directional synergies, i.e. local market conditions affect the incentive to enhance productivity, and increased productivity is a pre-condition for market participation.

Barrett (2008) states that adoption of a technology is fundamental to agricultural marketing behaviour through surplus and, therefore, improving access to agricultural technology and knowledge can be a precursor to aggregate supply response. The returns to technology adoption, however, could depend on the degree of integration in the local market (Barrett, 2008; Rios *et al*., 2009). The lack of access to agricultural markets reduces the incentives to adopt agricultural technologies, as household-specific shadow prices fall quickly after the household consumption needs are satisfied, whilst the demand elasticity under the circumstances of market integration causes a less rapid decrease in

the returns to technology adoption (due to shadow price effect). Therefore, living standards of poor farming communities can be uplifted by increases in both farm productivity and improvement in access to markets (Rios *et al*., 2009).

2.2.6. Agricultural commercialization and transaction costs

Returns to technology adoption depend more on a market integration into broader (national/regional) trade (i.e. aggregate demand elasticity) (Barrett, 2008). Rios *et al*. (2009) emphasized that the challenge to market integration is compounded by poor infrastructure and weak institutions that create friction in market exchanges, manifesting themselves as transaction costs. Such friction is the source of failing or missing agricultural markets.

Starting from the concept of non-separability between consumption and production decisions in smallholder farming systems, Goetz (1992) and Key *et al*. (2000) modelled household marketing behaviour in the context of market failure. The basic idea was to determine the market participation outcome by comparing the utilities obtained from buying, remaining autarkic or selling. Key *et al*. (2000) show how farm households delay their decisions to sell until the expected decision price is sufficiently high to compensate for fixed transaction costs (pertaining to imperfect information such as the cost of search for customers with good terms and conditions, negotiations, bargaining, screening, enforcement and supervision), leading to higher production threshold levels. This situation occurs within the context of an upward shift in supply schedule, caused by increases in proportional transaction costs such as transportation and marketing costs.

Although the extent of transaction costs faced by farm households in marketing their products are unobservable, shadow prices are endogenous to farm households themselves. The extent of these costs largely depends on a household's capability, as defined by its endowment (e.g. education, physical infrastructure and social networks) and access to public goods such as agricultural extension information and roads (Barrett, 2008).

2.2.7. Peculiar determinants of livestock commercialization

There is a school of thought that underscores the importance of diverse motivational aspects (such as wealth storage or consumption smoothing) as determinants of the livestock market participation (Siegmund-Schultze *et al*., 2011). The focus is due to the indirect relationship between farmers and markets through broader motivations behind livestock farming and market off-take. When the main purpose of livestock farming is not beef or milk production, valuation of livestock is based on the economic functions using investment criteria such as security, profitability, liquidity and tax reduction, or cultural functions such as prestige and status (Siegmund-Schultze *et al*., 2011).

Two major strands of analyses exist. On the one hand, the consumption smoothing hypothesis focuses on livestock as a consumption risk-mitigation strategy based on its relatively high liquidity. The thrust is meant to spur the understanding of how households adjust the livestock holding through markets, to compensate for fluctuations in incomes caused by socio-economic and environmental hardships (Kazianga and Udry, 2006; Lee and Sawada, 2010; Kinyua *et al*., 2011).

On the other hand, there is a scholarship contending that, in smallholder farming systems, livestock are often kept for a wealth storage motive, rather than just an income generation function. The starting point of this strand is the understanding that livestock functions include the cash value (through market participation) and other benefits such as prestige and status (Jarvis, 1980). Doran *et al*. (1979) stated that when cattle production is a wealth accumulation strategy (due to functions such as status and prestige), high productivity outweighs marketing incentives (i.e. income generation). In this case, Bellemare and Barrett (2006) describe two important theoretical predictions. First, livestock will be sold only to allow the farmer to meet his/her pressing cash needs, inducing a negative price response, as the farmer will liquidate only as many animals as required, given the prevailing market price. Second, this will lead to a negative relationship between other sources of incomes and livestock sales.

2.2.8. Towards a conceptual synthesis

Analytically, the transaction cost and motivational hypotheses are not mutually exclusive, since the effects of the motivations do not introduce market distortions (Jarvis, 1980). Livestock producers choose one benefit over the other, based on their objectives, and without welfare loss. Therefore, the theoretical predictions of agricultural extension and market participation can be analytically synthesised, using Figure 2.1.

Figure 2.1 draws upon the sustainable livelihoods framework (SLF) (Chambers and Conway, 1992) to conceptualize the impacts of agricultural extension, transaction costs, and farmers' motivations (livestock's multifunctionality) on livestock commercialization. The demand for livestock research and extension derives from the neoclassical production function that combines access to land, machinery, skills and financial resources, to produce livestock. The impact of extension information on livestock marketing is two-fold. Indirectly, access to extension information facilitates technology adoption to ensure marketable surplus. In a direct way, agricultural marketing extension co-ordinates market exchange (e.g. dip tank sales) and provides information on which breed to produce; and where and how to sell their animals (Adesoji, 2009; Shepherd, 2010).

The latter impact is directly related to transaction cost effect, as market information affects the cost of information. For other factors that accentuate the effect of transaction costs, the framework shows how transaction costs affect household specific shadow prices, depending on their access to private (such as farm machinery and skills) and public assets (roads and physical market facilities). Formal and informal regulations and laws can also create extra costs of marketing (e.g. the Stock Movement Permit).

The consumption smoothing and/or store-of-wealth hypothesis depends on farmers' vulnerability context, alternative sources of income and ultimate motivations. Livestock commercialization, therefore, serves as a consumption smoother in the face of environmental and socio-economic stresses and shocks.

Livelihood assets

Human capital: education, skills, abilities, health, etc.

Physical capital: producer goods and infrastructure.

Social capital: social networks, trust, etc.

Financial capital: credit and savings.

Natural capital: water sources, grazing lands, etc.

Transforming structures and processes

Agricultural research and extension policy

Formal and informal laws and regulations (e.g. the Stock Movement Permit)

Endogenous transaction cost

Livelihood strategies

Technology adoption

Livestock intensification

Market participation

Other income sources

Livelihood outcomes (motivations)

Sustainable use of NR

Price / Income

Wealth /asset accumulation

Demand

Impact

Impact

Manageability

Profitability
Liquidity

Security
Prestige/status

Consumption smoothing

Climate change, land degradation, liquidity constraint, cattle rustling

Vulnerability context

Overgrazing

Figure 2.1. A framework for analysing livestock commercialization in smallholder farming systems

Source: Based on Chambers and Conway's (1992) sustainable livelihoods framework

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When livestock is kept as a store of wealth or source of prestige, it will be sold only when there are no other sources of income available (with implications on overgrazing) and/or when the size of the stock becomes unmanageable or cannot be kept without compromising the sustainability of natural resources (Bellemare and Barrett, 2006).

2.3. Empirical evidence of the impacts of extension and transaction costs

Agricultural extension and commercialization has been the topic of various empirical studies in developing countries. Empirical studies have attempted to investigate the determinants of demand for agricultural extension information and impacts of farm productivity. On the other hand, the analysis of transaction cost effect in smallholder farming systems' commercialization has attracted the majority of empirical studies, although the motivational effect is increasingly viewed as a peculiar aspect of livestock commercialization in various parts of the developing world.

2.3.1. Demand for, and effects of, agricultural extension services

There are three groups of methods for agricultural extension impact evaluation. Farm-level, cross-sectional studies presume that agricultural research services are constant (i.e. do not vary) across the observed cases and, therefore, the variation of participation in extension services across observations offers a perfect setting for a "with/without" experimental design for economic impact assessment. Other impact assessment studies are based on aggregated, regional farm production data and presume that both agricultural research and extension vary. One uses separate extension and research variables, whilst the other constructs a variable that combines both extension and research services (Evenson, 2001).

In cross-sectional impact evaluation, a considerable number of studies have attempted to evaluate empirically the impact of agricultural extension programmes on farm performance. Calibrating the agricultural extension impact on farm productivity programmes has been fraught with various empirical difficulties. Two major econometric difficulties associated with the non-randomness of agricultural extension programmes have been highlighted: the (fixed effect) endogenous programme placement bias (related

to government extension targeting of high agricultural potential regions) and the selection bias (resulting from better skilled farmers seeking out extension services or *vice versa*) (Evenson, 2001; Owens *et al*., 2003; Elias *et al*., 2013).

Studies ignoring such potential biases have often led to ambiguous results. For example, based on an input-output model, the results of an ordinary least squares (OLS) estimation by Haq (2012) reported that rice farmers in the Gazipur District of Bangladesh who made more contact with the local extension personnel had higher rice field productivity. Haq (2012) reported that the impact is more pronounced among villages that are closer to the sub-districts' (commonly known as *upazila*) headquarters, particularly those with higher proportions of farming households. The number of rice farmers' contacts with extension workers increased with education, household size, number of income earners, access to irrigation and proximity to the *upazila* headquarters (Haq, 2012). The correlation between two independent variables in the productivity model, namely the effect of proximity to the *upazila* headquarters on both extension contacts and rice field productivity, could signify the scope of endogenous programme placement and/or selection bias.

To address these challenges, using panel data regression model, Owens *et al*. (2003) used two ordinary least squares (OLS) regression models. One model controlled for regional fixed effects and another for household's ability, to evaluate the impact of agricultural extension on the productivity of farms in three agro-ecologically contrasting resettlement regions of Zimbabwe. After controlling for the region fixed effects and farm ability, they found that one or two visits of extension workers to the farm raised maize and non-maize crop production per hectare by 14.4%, an impact that would have been otherwise underestimated for maize and overestimated for other crops. The effect of agricultural extension on farm income was positive only during non-drought years and was negative during periods of drought.

Other studies have resorted to the more robust statistical techniques such as the Heckman treatment effect model (HTEM) and the semi-parametric propensity score matching (PSM). Based on the HTEM, Elias *et al*. (2013) reported that the propensity to participate

in agricultural extension among smallholder farmers in the Amhara Regional State in Ethiopia was influenced by age, education, livestock ownership and use, adult equivalent, group membership and involvement in the ward's administration. Elias *et al.* (2013) reported that agricultural extension increased farm productivity by 20%, which was 12% more than the effect estimated by OLS. The discrepancy was explained by the presence of selection bias indicated by the negative and significant inverse mills ratio. There were two important limitations of this econometric technique, namely the imposition of a linear form of the productivity equation and the extrapolation over regions of no common support, distributional and functional restrictions prone to result bias.

Given this potential bias, Elias *et al.* (2013) resorted to the PSM approach. Their findings about the drivers of participation in extension programmes were similar to those of the HTEM. All the different matching algorithms used suggested a positive effect of agricultural extension on farm productivity.

Based on its empirical appeal, other empirical studies have adopted the PSM approach. In an assessment of the impact of the National Agriculture and Livestock Extension Programme (NALEP) in the Lugari District of Kenya, Deschamps-Laporte (2013) reported that educated and experienced farmers had a higher probability of participating in the NALEP than their uneducated counterparts. Controlling for such differential ability, there was no significant impact of NALEP on maize yield. Farmers participating in NALEP, however, used more commercial fertilizers, and were less likely to store maize compared to their non-participating counterparts. The study explained that the limited impact of extension on maize productivity, in spite of increased fertilizer use, could be attributable to environmental factors such the corn lethal necrosis.

Although the effect of agricultural extension on crop productivity has been widely documented, the impact of extension on livestock production has attracted little attention. One impact evaluation study was conducted by Davis *et al.* (2012) in Uganda, Kenya and Tanzania. Based on the PSM, as well as covariate matching approaches, the propensity to participate in farmer field schools (FFS) generally decreased with age, off-farm income

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and proximity to markets, and with female and educated household heads in Uganda, and increased with illiteracy in Kenya. The study gave further evidence that FFS increased livestock production by nearly 23%, particularly for female farmers and farmers with medium-sized farms and larger land areas.

The mixed evidence on the impact of agricultural extension across different studies in different regions suggests the need for investigating the impact, case by case. There is no empirical study that has evaluated the impact of agricultural extension within the context of South Africa. This gap in the empirical literature is even more apparent in the sub-Saharan region (Taye, 2013). Agricultural extension research in South Africa has rather focused on the design of agricultural extension models (Worth, 2006; Terblanché, 2008; Zwane, 2012; Niekerk *et al.*, 2013). These studies, however, lack important insights into the economic effectiveness of the models in South Africa to gauge their appropriateness.

2.3.2. Transaction cost effect on agricultural commercialization

Various studies have investigated the role of proportional and fixed transaction costs on farmers' market participation and supply volume decisions. For example, Key *et al.* (2000) showed that maize production in Mexico is not only associated with agricultural mechanization, use of high-yield inputs, and price, but also with selling to official sources and membership of agricultural organizations, implying lower proportional transaction costs. The marketable production threshold was significantly associated with pick-up truck ownership, i.e. higher fixed transaction costs (Key *et al.*, 2000). Across different crops, Heltberg and Tarp (2002) showed that the commercialization decisions and levels of various food and cash crops in Mozambique are mainly driven by the differences in the area's characteristics (regional differences in yield and access to urban centres), suggesting transaction cost effects.

In the livestock sector, Bellemare and Barrett (2006) showed that, although animal births have a positive market participation effect among livestock holders in Kenya and Ethiopia, higher fixed costs of marketing (amounting to more than 30% of the sellers' price) could draw farmers from the net seller position to autarky. Variable marketing

costs (adding around 2% of the large stock sellers' price) diminishes the quantity supplied (Bellemare and Barrett, 2006).

In South Africa, empirical studies have shown that endowment with natural resources, particularly herd size, influence market participation rates among smallholder livestock farmers (Makhura, 2001; Montshwe, 2006; Bahta and Bauer, 2007; Uchezuba *et al.*, 2009). Household's endowment in human, physical and financial capital has also been identified as a key participation decision driver. With regards to human capital, however, the evidence is mixed. In the Northern Cape Province, Uchezuba *et al.* (2009) reported that households with few members have high chances of engaging in livestock market, but in the Limpopo, Eastern Cape and Northwest provinces, Montshwe (2006) reported that larger households are more likely to participate in livestock market. However, these two studies agree on the positive effect of experience, skills and training on livestock commercialization. Access to extension information has also been revealed as a significant determinant of participation in livestock markets in the Free State and Northern Cape provinces (Bahta and Bauer, 2007; Uchezuba *et al.*, 2009).

Empirical evidence has suggested that farmers who live within shorter distances to markets have a higher probability of participating in livestock markets (Montshwe, 2006; Bahta and Bauer, 2007; Uchezuba *et al.*, 2009). The significance of the influence of financial assets has been documented. For example, indebtedness was a significant negative factor of market participation among small-scale livestock farmers in the Northern Cape (Uchezuba *et al.*, 2009).

2.3.3. Consumption-smoothing motivation and livestock commercialization in developing countries

The empirical livestock marketing literature has focused on livestock holding and selling as an insurance mechanism in the face of environmental and socio-economic risk. In South Africa, cattle mortality and theft were significant factors explaining positive livestock market participation decisions in Limpopo, the Eastern Cape and Northwest provinces (Montshwe, 2006). Perevolotsky (1986) reported that specialized livestock

farmers in Peru accumulate cattle during good seasons as an insurance against foreseen losses during frequent droughts. Turner and Williams (2002) showed that the livestock markets in the Sahel region facilitate destocking of animals based on the prevailing environmental conditions. Lybbert *et al*. (2004) reported that, with weak livestock market mechanisms in southern Ethiopia, biophysical shocks are the primary determinants of the livestock herd dynamics among the rural population investing all its wealth in the form of livestock. There is also empirical evidence suggesting that livestock sales are a form of insurance against socio-economic shocks. For example, Kinyua *et al*. (2011) showed that, in rural Kenya, even under low prices, livestock is sold spontaneously in the face of insecurity caused by cattle rustling.

In other empirical studies, livestock commercialization has been found to be much less responsive to socio-economic and environmental shocks, despite its relatively high liquidity. Fafchamps *et al*. (1998), Lybbert *et al*. (2004), and Kazianga and Udry (2006) reported that pastoralists tend to sell fewer animals than they would be expected to if livestock was to be used to smooth consumption. Even though Fafchamps *et al*. (1998) feel that such findings could result from measurement error in the livestock marketing transactions, or the availability of alternative, less costly self-insurance mechanisms such as non-farm activities or transfers, evidence has suggested that the problem could be simply that the level of liquidity constraint could be different across farmers. For example, Imai (2003) found that households that keep cattle in Kenya are less severely liquidity-constrained compared to other farm households. Cattle enabled households to allocate more resources to high-risk, high-return enterprises (such as timber farming), because livestock assured a consumption security.

The scale of production and the nature of shock is another reason why cattle commercialization could be irresponsive to livelihood shocks. In studying the poverty dynamics around pastoralists in rural Ethiopia, Mogues (2006) showed that livestock in rural Ethiopia exhibited convergent tendencies, whereby the consumption smoothing hypothesis was observed among large-scale holders, whereas smallholder farmers chose not to sell their cattle for fear of slow or costly reacquisition. McPeak (2004), on the other

hand, showed that the problem could pertain to the specification of the nature of the shock. It was suggested that the use of livestock to buffer consumption would be limited if the exogenous stressor threatens both the incomes and the livestock itself, since selling animals will mean reducing the stream of expected future income. Siegmund-Schultze *et al*. (2011) state, therefore, that the vulnerability of livestock to environmental change calls for insurance products (premiums) for the primary livestock production sector, rather than using the stock as an insurance mechanism.

2.3.4. Store-of-wealth effect on livestock commercialization in developing countries

Empirical evidence to support the store-of-wealth hypothesis is limited in abundance. Matanyaire (1997) showed that livestock in southern Africa is a highly valued production asset that can only be sold in the absence of less-valued assets. In Kenya and Ethiopia, Bellemare and Barrett (2006) reported that the tropical livestock units sold responded negatively to the expected price and non-livestock incomes. In South Africa, Makhura (2001) reported that female-headed households were more likely to participate in the livestock market because they tend to keep small livestock that do not assume a prestige function. Makhura (2001) also reported that the more unearned incomes (e.g. pensions) the household received, the less the probability of its participation in livestock markets. The probability to participate increased with incomes earned from business activities. These findings contrast with those of Montshwe (2006) showing that, in the Limpopo, Eastern Cape and Northwest Provinces, households that received wage incomes had more chance of participating in livestock markets. With such mixed evidence, there is need for an investigation of the importance of the store-of-wealth hypothesis.

2.3.5. Transaction cost effect in livestock marketing

In the empirical literature on marketing channel choice, two approaches have been used: geographical research (mainly focusing on the spatial pattern of region and international co-ordination and integration among firms and their entry mode choices), and marketing literature (McNaughton, 1999). In the marketing literature, although there have been several approaches to the study of channel choice (including the financial,

microeconomic, managerial and behavioural approaches), the transaction cost approach (TCA) has been the most influential (McNaughton, 1999).

The empirical measurement of the transaction costs themselves is based on the seminal work of Coase (1937), positing that transacting within a firm (i.e. vertical integration) is a suitable alternative to hazardous marketing arrangements when the cost of transacting over market outweighs the internal cost of management. Transacting over markets is often costly when market exchange requires a higher level of transaction-specific investments (asset specificity), and/or costs of writing contracts due to external uncertainties (Levy, 1985).

For both market integration and transaction costs, the difficulty in empirical measurement has been a major setback. Although there have been alternative measurements of vertical integration in the literature (e.g. Levy, 1985; Frank and Henderson, 1992), Hobbs (1997) pointed out that most studies rely on data from firms' accounting books or governments' surveys that can hardly measure the intricacies of transaction costs. In spite of these measurement challenges, Rindfleisch and Heide (1997) indicated that the application of TCA to understanding market co-ordination and integration has been biased towards manufacturing firms, with little application to farm firms.

The application of the TCA to vertical co-ordination in cattle marketing research of smallholder farmers is rare. Among the few, Hobbs (1997) reported that the high monitoring costs pertaining to deadweight grade uncertainty and negotiation costs related to relationship with procurement officers prevented farmers in Scotland from selling directly to the packers. The author also reported that higher uncertainty associated with non-sale and the negotiation cost related to time spent at the market prevented auction sales. In China, Gong *et al*. (2006) revealed that transaction monitoring costs related to payment delays, as well as negotiation costs, influenced the selection of processors and auction markets. In Namibia, Shiimi *et al*. (2012) suggested that access to market information and information technology drove the proportion of cattle sold through

various marketing channels. There are few, if any, similar investigations conducted among South African smallholder ranchers.

2.4. Summary

In this review chapter, the conceptual foundation is elucidated, and an overview of the empirical evidence on the impacts of extension information and marketing transaction costs on livestock commercialization is provided. As shown in section 2.2, the supply of extension information is defined by its public or private good nature, whilst the individual demand for such information is derived from the neoclassical production function. In the subsection, three welfare impact pathways of extension information and the increase the expected decision price and shift the supply schedule caused by the transaction costs are explained. With regards to motivational effect, the consumption smoothing hypothesis predicts that households adjust the livestock holding through markets to compensate for fluctuations in income caused by socio-economic and environmental hardships, whilst the store-of-wealth hypothesis suggests that when cattle production is a wealth accumulation strategy (due to functions such as status and prestige), high productivity outweighs marketing incentives (i.e. income generation).

Based on empirical evidence from Bangladesh, Zimbabwe, Ethiopia, Kenya, Tanzania and Uganda, the positive effect of extension information on agricultural productivity is documented in section 2.3. Based on the evidence from developing countries, such as Mexico, Kenya and South Africa, the review also suggests that smallholder market participation is significantly associated with the extent of market transaction costs faced by smallholder farmers. With regards to motivational effect, the evidence from South Africa, Peru, Ethiopia and Kenya supported the consumption smoothing hypothesis (showing that farmers tend to sell their livestock following events of bio-physical and socio-economic shocks), whilst evidence on the store-of-wealth effect on livestock commercialization from eastern and southern Africa has been mixed. Evidence from Scotland, China and Namibia supports the hypothesis that transaction costs influence the choice of cattle marketing.

Based on the empirical research gaps identified throughout section 2.3, the broad objectives of this thesis are to determine the effects of agricultural extension and marketing transaction costs on cattle production, commercialization and marketing. In subsequent chapters, this study aims at: (i) examining the factors influencing the demand for extension information and the effects of such information on cattle production; (ii) estimating the effects of transaction costs, extension information, and farming motivation on cattle commercialization and supply volume decisions; and (iii) measuring the effects of transaction costs on cattle marketing channel selection in the smallholder farming systems of South Africa.

CHAPTER 3 : PARTICIPATION IN LIVESTOCK EXTENSION PROGRAMMES AND IMPACT ON SMALLHOLDER CATTLE PRODUCTION IN KWAZULU-NATAL

3.1. Introduction

The public agricultural extension programmes in South Africa are under pressure to show evidence-based results (Koch and Terblanché, 2013; Worth, 2012). This requires well-designed, results-based monitoring and evaluation systems. In order to secure continued budget supports from the provincial governments, public extension workers must respond to real farmers' needs and do so in a cost-effective manner. The effectiveness of agricultural extension service delivery consists of the quantity and quality of information and the ultimate changes (i.e. improvement) in farming systems' productivity, attributable to such information. Although evaluating the impact of the extension service delivery is methodologically challenging, the results of such exercise are essential for improving the delivery of extension information in rural areas (Evenson, 2001; Owens *et al*., 2003; Elias *et al*., 2013).

In the present chapter, the PSM (Caliendo and Kopeinig, 2008) is proposed as a robust approach to investigate the demand for livestock information among smallholder farmers in South Africa and its effects on cattle production. In the next section, contextual information about extension and livestock production in the study area, the data collection procedures and the analytical and empirical models, are described. The empirical results are presented and discussed in section 3.3.

3.2. Description of the study area

The study was conducted in the KwaZulu-Natal (KZN) province of South Africa. It is estimated that KZN contributes 11% to the total beef production of the country (Republic of South Africa, 2011). One of the major beef production areas in KZN is the Okhahlamba Local Municipality, a 344 000ha municipality in the uThukela District. As documented in the 2012-2017 Integrated Development Plan of Okhahlamba Local

Municipality (2012), the 2007 population census indicates that the municipality is inhabited by 151 414 people (or 28 508 households), mainly traditional households (56%), illiterate (38%), and communal land-dwellers. A the vast majority of these people are deprived of public infrastructure (with only 39, 63 and 44% having access to electricity, water and transportation in their dwellings, respectively). The harsh economic conditions of the municipality are such that 36% of households do not receive any income, whilst 37% earn less than ZAR9 600 (about US$1 100) per annum (Okhahlamba Local Municipality, 2012).

As shown by the land use map (Figure 3.1), commercial and subsistence farming coexist in this region, although geographically separated (a legacy of the segregationist apartheid regime). Smallholder farmers, mainly engaging in maize, vegetable and livestock production, occupy the marginal areas, mainly the foothills of the Drakensberg mountain range, characterized by low fertility lands. Although only 22% of the economically active population engages in crop cultivation (Okhahlamba Local Municipality, 2012), 55% of households living on communal land are reported to engage in livestock farming, mainly cattle, goats and sheep farming (Elleboudt, 2012).

Crop-livestock farming systems are a common feature of agriculture in the foothills of the Drakensberg. A common grazing system is scheduled such that cattle are sent uphill during the cropping season, while all the land becomes grazing land during the off-season in winter (Elleboudt, 2012). This situation creates overstocking tendencies, with the associated environmental consequences, reinforced by the lack of property rights and enforcement mechanisms such as fencing. The area also experiences harsh climatic conditions, characterized by an interchange of prolonged droughts and low winter temperatures, interspaced with snow spells. Palatability of the natural grasslands is seasonal, necessitating the supplementary feeding of animals.
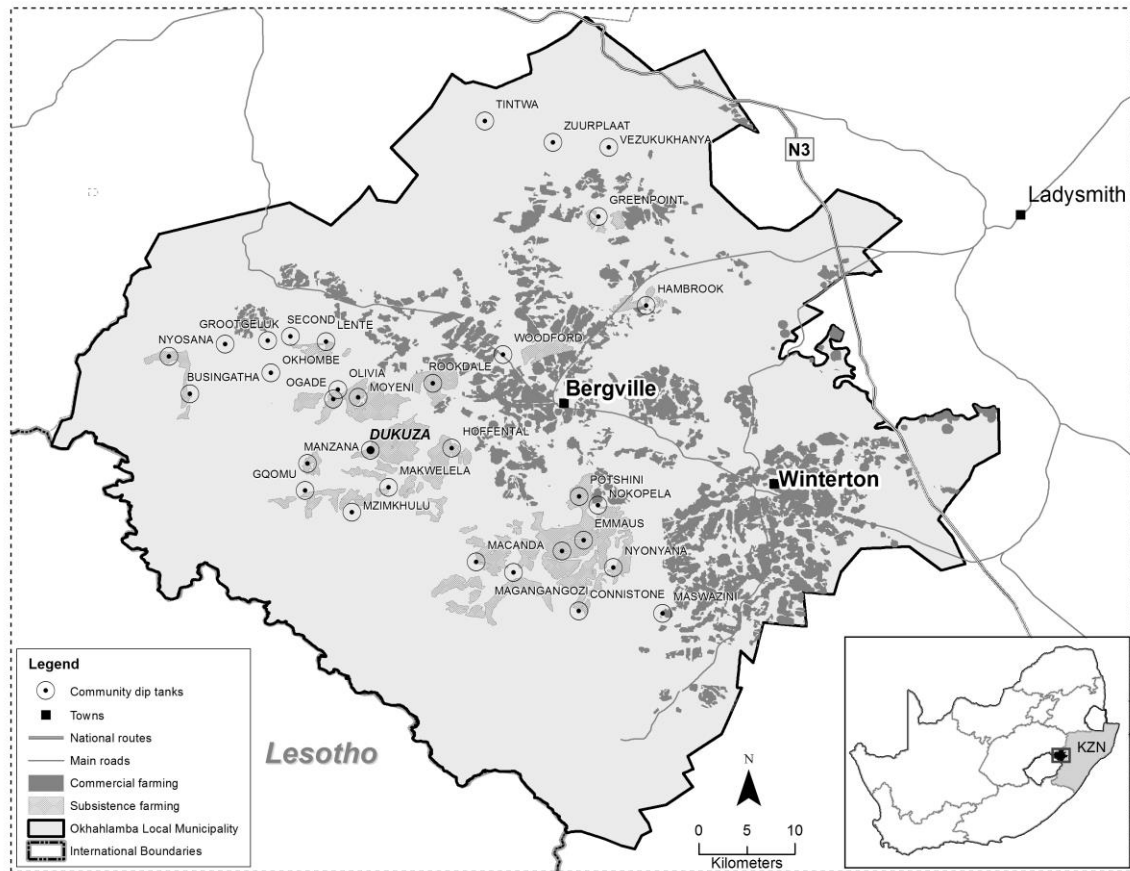
Figure 3.1. Land use map of the Okhahlamba Local Municipality showing dip tanks
Source: Authors - based on land cover dataset provided by Ezemvelo KwaZulu-Natal Wildlife (http://www.bgis.sanbi.org/kzn/landcover.asp).

Livestock extension workers play a major role in the transformation of the livestock sector in the area. Mainly using the T&V extension model, the extension office located in Bergville is responsible for the development of livestock farmers' organizations, pastures, veterinary services, dip-tanks and marketing facilities. Under the auspices of the Municipality's livestock extension office, around 31 dip tanks are operational in the area (see Figure 3.1). All cattle farmers were members of the Dip-tank Users Associations (DUAs). The livestock extension office was also responsible for scheduling cattle auctions at the Dukuza dip tank (see location in Figure 3.1).

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3.3. Material and methods

3.3.1. Data

The data used were collected in two phases. In the first phase, participatory rural appraisals (PRAs) were conducted between June and October 2012. Key informant interviews with the extension personnel were conducted, followed by focus group discussions with knowledgeable members of various DUAs, through their mother co-operative, the Okhahlamba Livestock Co-operative (OLC). This phase was meant to pinpoint the salient livelihood systems, the institutional environment and the challenges and barriers around cattle marketing, as perceived by OLC members.

The information gathered during the PRA phase was used to devise a structured household survey questionnaire (Appendix B). The structure of the questionnaire was based on the SLF. The instrument recorded information on livelihood assets (including human, social, financial, physical and natural capitals, livelihood strategies (viz. cattle production and commercialization and income portfolios) and vulnerability context. Trained field enumerators pilot-tested and then administered the questionnaire during the second phase, spanning from November 2012 to February 2013. Farm households were selected based on a two-stage random sampling technique. In the first stage, 13 out of 31 DUAs were randomly selected using the simple random selection technique. In the second stage, members of each pre-selected DUA were randomly sampled, with probability proportional to size. In total, 230 heads of households owning cattle were interviewed.

3.3.2. Analytical framework

Following previous agricultural extension impact assessment studies (e.g. Davis *et al*., 2012; Deschamps-Laporte, 2013; Elias *et al*., 2013; Wordofa and Sassi, 2014), the current study adopted the semi-parametric PSM approach (Rosenbaum and Rubin, 1983) to investigate decisions to participate in agricultural extension programmes and assess the effect on cattle production and inputs use. This technique aims at minimizing the potential bias resulting from the selection problem of using non-experimental data. The problem arises when the pre-treatment characteristics of the farmers participating in

agricultural extension programmes do not match those of non-participating (control group), to ascertain that any difference in these groups is attributable to extension programmes.

Therefore, for a farmer i, (where $i=1\ldots I$, and I denotes the population of farmers), the major task of impact evaluation studies is to separate the impact of extension programmes participation ($D_i=1$) on a certain outcome $Y_i(D_i)$ from what would have happened anyway to the farmer without participating in the extension programmes ($D_i=0$), the so-called counterfactual scenario. As shown in Equation (3.1), this discernment is done by differentiating the observed outcome for a participating farmer i and the counterfactual potential outcome without/before participating.

$$\Pi_i = Y_i(1) - Y_i(0) \tag{3.1}$$

The impact Π_i cannot be observed, since in an *ex post* setting, a farmer is either a participant or non-participant, but not both. This situation shifts researchers' attention to the average population effect. This consists of estimating the average treatment effect on the treated (ATT) defined as follows:

$$\Pi_{ATT} = E[\Pi|D=1] = E[Y(1)|D=1] - E[Y(0)|D=1] \tag{3.2}$$

Since $E[Y(0)|D=1]$ is unobservable, the technique consists of subtracting the unobserved effect of the participating group ($E[Y(0)|D=0]$), had they not participated in extension programmes.

$$E[Y(1)|D=1] - E[Y(0)|D=0] = \Pi_{ATT} + E[Y(0)|D=1] - E[Y(0)|D=0] \tag{3.3}$$

The RHS of the equation represent the impact under investigation, while the two last terms on the LHS stand for the selection bias. Hence the identification of the true impact Π_{ATT} can only be done if:

$$E[Y(0)|D=1] - E[Y(0)|D=0] = 0 \qquad (3.4)$$

To solve the selection bias, the identification problem assumes that farmers with identical characteristics (X), that are not affected by extension, will observe similar outcomes without participating in extension programmes. Such an assumption is commonly referred to as a conditional independence assumption (CIA) (Rosenbaum and Rubin, 1983). Within the two groups, few participating farmers could be comparable to non-participating farmers, but selecting this subset is technically difficult because it is based on a high-dimensional set of pre-treatment characteristics to be considered (Dehejia and Wahba, 2002). The PSM method allows this matching problem to be reduced to a single dimension: the propensity score $\Pr(X) = \Pr(D=1|X)$.

Rosenbaum and Rubin (1983) identify three assumptions that underlie the PSM method and these are presented below. First, the balancing assumption in equation (3.5) ensures that farmers with similar propensity score will share similar unobservable characteristics, irrespective of their extension participation outcome.

$$D \perp X | \Pr(X) \qquad (3.5)$$

Second, assuming that participation in agricultural extension is not confounded, the conditional independence assumption (CIA) in equation (3.6) implies that after controlling for farmers' characteristics (X), participation in extension is random.

$$Y(0), Y(1) \perp D | X, \qquad \forall X \qquad (3.6)$$

Third, the common support assumption in equation (3.7) ensures that the probability of participating in extension services for each value of vector X is strictly within the unit interval, so that there is sufficient overlap in the characteristics of participating and non-participating farmers to find adequate matches.

$$0 < \left[\Pr(X) = \Pr(D = 1|X)\right] < 1 \tag{3.7}$$

With the CIA assumption, the resulting PSM estimator for ATT can be generalized as follows:

$$\Pi_{ATT}^{PSM} = E_{\Pr(X)|D=1}\left\{E\left[Y(1)|D=1, \Pr(X)\right] - E\left[Y(0)|D=0, \Pr(X)\right]\right\} \tag{3.8}$$

3.3.3. Empirical models

3.3.3.1. Probit model of farmer's decision to participate in livestock extension programmes

To analyse the socio-economic factors influencing a cattle farmer's decision to participate in livestock extension programmes and estimate the propensity score $\Pr(X) = \Pr(D = 1|X)$ for assessing the impact, the study adopted a probit model (Wooldridge, 2002). This model estimates the probability that a farmer i with particular characteristics X_i will fall under a participants group as follows:

$$P(D_i = 1|X_i) = \Phi(X_i'\beta) \tag{3.9}$$

Where Φ denotes the cumulative distribution function of the standard normal distribution.

Despite the negative relationship between the derived demand for extension information and the cost of making extension contacts, briefly discussed in sub-section 2.2.4 and herein represented by distance to Bergville, there are other relevant factors that affect the demand for extension services. The stage in a farmer's life cycle (represented by age and age squared) influences negatively the decision to participate in extension services, as

younger farmers are less risk averse (Pålsson, 1996), more flexible and willing to participate in innovative activities, compared to older farmers.

Household structure can a have positive effect on the participation in extension programmes. Larger households facilitate livelihood diversification. This serves to reduce income risk associated with new technologies (Rosenzweig and Wolpin, 1985). Gender of the head of the household can be linked to factors that indirectly influence the demand for extension services. Extension workers might prefer to visit farmers with more land or with better access to labour to implement new technologies, which could be negatively correlated to female-headedness (Doss and Morris, 2000). Moreover, the attitudes towards new technologies are more salient among men, i.e. they are more focused on the technology, whereas subjective norms and perceived behavioural controls are more salient for females (Venkatesh *et al*., 2000).

Education and farming experience enhance farmers' ability to understand the costs and benefits of a technology, and interpret and modify extension information (Bagi and Bagi, 1989; Elias *et al*., 2013). The numeracy, modernity and agricultural knowledge pertaining to education might influence the likelihood of adoption of new agricultural technologies (Jamison and Moock, 1984). Education has higher payoff in a modernizing/cosmopolitan environment than a static traditional one (Lockheed *et al*., 1980).

Group membership affects the demand for agricultural extension by way of economies of size/scale (Anandajayasekeram *et al*., 2008; Davis, 2008). It also affects extension service supply, particularly in the classical training and visits (T&V) model, as extension workers often target group members as their contact farmers (Anandajayasekeram *et al*., 2008; Davis, 2008). Non-cattle household wealth (in this study represented by vehicle ownership) can positively influence the demand for extension services. Wealthier farmers are more capable of bearing the risk of new technologies and are more likely to participate in technology transfer programmes (Langyintuo and Mungoma, 2008). Lastly, the demand for extension information may increase with farm size, due to economies of size in obtaining and using information services, increasing demand for management

services as farm size increases, and agricultural research may be primarily focused on specific problems faced by large-scale farmers (Bagi and Bagi, 1989).

3.3.3.2. PSM algorithms for assessing the extension impact on cattle production

Different algorithms can be used to match individual propensity score for the purpose of assessing the effect of the treatment. These include the Nearest Neighbour, Caliper and Radius, Stratification and Interval, Kernel and Local Linear, and Weighting (Caliendo and Kopeinig, 2008). In this study, two algorithms, using different matching approaches are used to match participants and non-participants based on the propensity scores. Nearest Neighbour Matching is selected from the category of algorithms that use only a few observations from the comparison group to construct the counterfactual outcome of a treated individual, and the Kernel Matching from the non-parametric matching estimators that use weighted averages of all individuals in the control group to construct the counterfactual outcome (Caliendo and Kopeinig, 2008).

For a participating farmer i and non-participating farmer j, the Nearest Neighbour matching algorithm calculates the absolute difference between propensity scores as follows:

$$\left| \text{Pr}_i - \text{Pr}_j \right| = \min_{k \in I=0} \left\{ \text{Pr}_i - \text{Pr}_k \right\}$$ (3.10)

The Kernel Matching, a non-parametric method, compares each participating farmer to a weighted average of the outcomes of all non-participants, placing higher weights on non-participants with propensity scores closer to that of the participant. Under this technique, for a participating farmer i, the associated matching outcome is given by Deschamps-Laporte (2013):

$$\hat{Y}_i = \frac{\sum_{j \in I=0} K\left(\dfrac{\text{Pr}_i - \text{Pr}_j}{h} \right) Y_i}{\sum_{j \in I=0} K\left(\dfrac{\text{Pr}_i - \text{Pr}_j}{h} \right) Y_i}$$ (3.11)

where $K(\cdot)$ is a kernel function, and h is a bandwidth parameter.

3.4. Results and discussion

3.4.1. Socio-economic characteristics of the interviewed farmers

The descriptive statistics of selected covariates for the probit model, as well as the results of the t-test of differences in means across the participating and non-participating groups, are given in Table 3.1. The average age of interviewed farmers was 57 years old. The majority of interviewed farmers had attended primary school (54%) and very few had matriculated (3-6%), indicating low levels of education. Between 73 and 77% of interviewed households were male-headed, with about nine household members. Membership in OLC was significantly different across the two groups, ranging from 85% among participants to 67% among non-participants. Representing the cost of accessing extension information, the average distance to Bergville (extension office) was between 20 and 24 km, and the difference among the groups was significant. Between 34 and 37% of interviewed households owned a vehicle, an indicator of non-cattle household wealth.

The production characteristics in Table 3.1 are the chosen indicators for extension impact evaluation and are also controlled for in the probit model. Mixed and exotic breeds dominated in the sample, with the participating group producing significantly more mixed breed than the non-participating group. The average cattle herd sizes were 10 and 12 in the control and treatment group, respectively. This difference was statistically significant. Interviewed households had about two calves at the time of interview.

More than 91% of interviewed households had purchased salt mineral blocks. The average rate of usage of veterinary services and forage was only 51% and between 32 and 36%, respectively. The average rate of feed supplement use was 26 and 40% among control and treatment groups, respectively, and this difference was statistically significant.

Table 3.1. Description of covariates in the probit model and t-test for equality of means between treatment groups

Variable	Measurement	Description	Mean		T-test for quality of means	
			Non-participant (control) (n= 83)	Participants (treatment) (n= 147)	t statistic	Pr(|T| > |t|)
Farmer characteristics						
Age	Years	Age of the household head	57.666	57.445	0.131	0.895
Age squared	Years	Age of the household head squared	3465.198	3451.144	0.073	0.941
Education						
Primary	Dummy	1= Attended primary school, 0 = otherwise	0.542	0.544	-0.029	0.976
Secondary	Dummy	1= Attended secondary school, 0= otherwise	0.277	0.244	0.535	0.593
Matriculated	Dummy	1=Matriculated, 0= otherwise	0.060	0.034	0.934	0.351
Gender	Dummy	1= male headedness, 0= female headedness	0.734	0.775	-0.690	0.490
Membership in OLC	Dummy	1= Member of OLC, 0= otherwise	0.674	0.857	-3.334	0.001
Distance to Bergville	Km	Kilometres from the nearest dip tank to the livestock extension office in Bergville	22.886	24.811	-1.874	0.062
Vehicle ownership	Dummy	1 = Own a vehicle, 0= otherwise	0.373	0.346	0.402	0.687
Production characteristics						
Cattle breed	Categorical	1 = Nguni, 2 = Mixed, 3 = Exotic	2.313	2.530	-1.799	0.073
Herd size	Count	Number of cattle heads	10.084	12.693	-2.126	0.034
Calves (births)	Count	Number of calves in the herd	2.180	2.517	-1.047	0.296
Use of salt	Dummy	1= Paid for salt mineral blocks, 0= otherwise	0.914	0.911	0.078	0.937
Use of veterinary services	Dummy	1= Paid for veterinary services, 0= otherwise	0.512	0.513	-0.024	0.980
Use of forage	Dummy	1= Used purchased forage (grass, silage, legume etc) to feed cattle, 0= otherwise	0.320	0.367	-0.699	0.484
Use of feed supplements	Dummy	1= Used purchased feed supplements (grains, soy, etc), 0= otherwise	0.268	0.401	-2.028	0.043

3.4.2. Cattle production and participation of surveyed communities in extension programmes

As shown in Table 3.2, the majority of interviewed cattle farmers kept mixed breeds. Higher proportions of mixed breeds were found in the Rookdale, Potchini and Olivia communities. The Nguni breed was more prevalent among sampled households in Mafhefheteni and Nokopela.

Table 3.2. Household-level cattle breed production among surveyed households

Community/dip tank	Number of interviewed households	Nguni (%)	Exotic (%)	Mixed (%)
Hambrook	19	15.79	5.26	78.95
Potchini	11	18.18	0.00	81.82
Woodford	15	33.33	13.33	53.33
Mafhefheteni	12	41.67	0.00	58.33
Rookdale	6	16.67	0.00	83.33
Nokopela	16	37.50	0.00	62.50
Gqomu	18	22.22	5.56	72.22
Gqomu-B	3	33.33	0.00	66.67
uMzimukulu	20	30.00	0.00	70.00
Intumbane	22	27.27	0.00	72.73
Olivia	33	18.18	0.00	81.82
Ogade	27	25.93	0.00	74.07
Moyeni	28	32.14	0.00	67.86
Total	230	26.52	1.74	71.74

Table 3.3 gives the herd composition among surveyed communities. In total, interviewed households owned 2703 cattle. As expected, cows dominated the composition of the herd, whereas bulls made up the lowest proportion.

With regard to participation in livestock extension programmes, Table 3.4 shows that 36% of interviewed households had not received extension services. Two communities situated relatively closer to Bergville (Woodford and Nokopela), as well as the remote uMzimkhulu community, had the lowest participation rates.

Table 3.3. Herd composition across surveyed communities

Community/dip tank	Total herd size	Calves (%)	Heifers (%)	Cows (%)	Bulls (%)	Steers/Oxen (%)
Hambrook	142	19.01	19.01	38.73	3.52	19.72
Potchini	132	29.55	13.64	31.06	6.82	18.94
Woodford	133	32.33	24.06	37.59	6.02	14.29
Mafhefheteni	178	16.29	11.80	34.27	14.61	23.03
Rookdale	56	19.64	19.64	39.29	3.57	17.86
Nokopela	159	16.98	28.30	32.08	14.47	8.18
Gqomu	325	20.92	20.92	35.08	7.08	16.00
Gqomu-B	65	20.00	20.00	36.92	4.62	18.46
uMzimukulu	264	12.12	20.08	34.85	3.79	29.17
Intumbane	353	20.11	20.40	37.96	8.50	13.03
Olivia	349	23.21	26.93	29.80	8.31	11.75
Ogade	298	19.80	17.45	35.57	7.38	19.80
Moyeni	249	20.48	22.09	34.94	3.61	18.88
Total	2703	20.38	20.75	34.81	7.36	17.39

Table 3.4 indicates the two components of the T&V model: the direct contact with extension officers, in the form of extension training and visits, and indirect participation, through farmer-to-farmer training sessions. The direct contact with extension workers during training and visit sessions dominates extension service delivery in the area. In some communities, such as Hambrook, Mafhefheteni, Nokopela, Gqomu-B and Intumbane, all the interviewed households had had direct contact with the extension workers. Interviewed households had participated in farmer-to-farmer extension services only to a level of 9%. The rate of participation in this type of extension was higher in the Moyeni and Potchini communities. Only 3% of farmers had participated in both direct contact and farmer-to-farmer sessions.

Table 3.4. Surveyed households for each Dip-tank Users' Association (DUA) and extension model

Community/dip tank	Total number of interviewed households	Households that did not receive any extension support (%)	Extension model		
			Direct contacts (%)	Farmer-to-farmer (%)	Combined (%)
Hambrook	19	36.84	63.16	0.00	0.00
Potchini	11	18.18	81.82	18.18	18.18
Woodford	15	53.33	33.33	13.33	13.33
Mafhefheteni	12	33.33	66.67	0.00	0.00
Rookdale	6	33.33	66.67	16.67	16.67
Nokopela	16	50.00	50.00	0.00	0.00
Gqomu	18	33.33	61.11	16.67	11.11
Gqomu-B	3	33.33	66.67	0.00	0.00
uMzimukulu	20	55.00	40.00	5.00	0.00
Intumbane	22	27.27	72.73	0.00	0.00
Olivia	33	33.33	57.58	9.09	0.00
Ogade	27	25.93	70.37	11.11	0.00
Moyeni	28	35.71	39.29	25.00	0.00
Total	230	36.09	57.39	9.57	3.04

3.4.3. Factors influencing participation in livestock extension programmes

3.4.3.1. Probit model diagnostic tests

Following Long and Freese (2005), the probit model specification is tested using the link test. Regressing the three outcomes on their respective prediction and prediction squared reveals no explanatory power, suggesting the model has parsimonious specifications. The Hosmer-Lemeshow test of goodness of fit (Hosmer and Lemeshow, 2000) yields a p-value of 0.47, suggesting that the model fits the data well. To test multicollinearity in the independent variables, the correlation matrix in Appendix A1 indicates that multicollinearity was not a serious issue.

3.4.3.2. Probit estimation results and discussion

The results of the participation model are shown in Table 3.5. Contrary to *a priori* expectation, the results show that, compared to illiterate cattle farmers, cattle farmers that have attended (p-value=0.074) or graduated from high school (p-value=0.039) are not likely to participate in extension programmes as contact farmers. All other factors remaining constant, the propensity of becoming a contact farmer is 19 and 38% lower for farmers that have attended or graduated from high school, respectively. This negative effect is contrary to the findings of some previous studies such as Deschamps-Laporte (2013) and Elias *et al.* (2013). A plausible explanation is that, to the extent that educated farmers have more ability to assess the costs and benefits of participating in programmes, the results would suggest that either the benefits of livestock extension information are lower, or the opportunity costs of accessing that information are too high. Even though the results are consistent with the finding of similar study by Erbaugh *et al.* (2010) in Uganda and Davis *et al.* (2012) in Kenya, this explanation can only be validated by the results of the impact evaluation in the subsequent subsection.

The results further show that membership in OLC increases the farmer's likelihood of participating in extension contact sessions by 30% (p-value=0.001), while decreasing the likelihood of engaging in farmer-to-farmers sessions by 9% (p-value=0.070). Overall, group membership increased the propensity to participate in livestock extension programmes by 24% (p-value=0.001). Consistent with the results of Elias *et al.* (2013) in Ethiopia, and those of Davis *et al.* (2012) in three east African countries, these findings suggest that farmers with membership in commodity groups are more likely to capitalize on scale economies to seek direct contact with extension personnel at a much lower cost. Given the technology-centred nature of agricultural services deliveries in South Africa, the results would also suggest that commodity association increases the ease with which extension workers reach out to a large cross-section of their target beneficiaries and reduce the cost of extension service delivery. The negative effect of group membership suggests that contact and farmer-to-farmer training sessions are substitute sources of information. To a certain extent, these empirical findings suggest that the livestock extension model in KZN could be largely commodity-focused.

Table 3.5. Determinants of participation in extension programmes; results estimated using probit regression model

Variable	Contact with extension workers		Farmer-to-farmer		Combined	
	dD/dx	P>|z|	dD/dx	P>|z|	dD/dx	P>|z|
Farmer characteristics						
Age	-0.013	0.508	-0.0163	0.226	-0.022	0.277
Age squared	0.000	0.529	0.000	0.245	0.001	0.303
Education						
Primary	-0.056	0.546	0.067	0.441	-0.039	0.683
Secondary	-0.192	0.074	0.093	0.324	-0.155	0.167
Matriculated	-0.382	0.039	0.119	0.357	-0.175	0.335
Gender	-0.043	0.557	-0.038	0.471	-0.056	0.459
Household size	0.005	0.397	0.001	0.807	0.005	0.429
Membership in OLC	0.298	0.001	-0.088	0.070	0.242	0.001
Distance to Bergville	0.002	0.601	-0.001	0.893	0.007	0.063
Vehicle ownership	-0.079	0.248	0.024	0.589	-0.053	0.430
Production characteristics (control variables)						
Cattle breed	0.122	0.001	0.044	0.066	0.065	0.069
Herd size	0.010	0.074	0.002	0.560	0.008	0.146
Calves (births)	0.001	0.935	-0.015	0.296	-0.003	0.884
Use of salt	-0.113	0.295	(omitted)		-0.076	0.491
Use of veterinary services	0.010	0.884	-0.084	0.110	-0.125	0.079
Use of forage	.0134	0.064	-0.011	0.823	0.089	0.231
Use of feed supplements	0.036	0.614	0.121	0.012	0.142	0.052

These findings suggest that farmers with membership in commodity groups are more likely to capitalize on scale economies to seek direct contact with extension personnel at a much lower cost. Given the technology-centred nature of agricultural service delivery in South Africa, the results would also suggest that commodity association increase the ease with which extension workers reach out to a large cross-section of their target beneficiaries and reduce the cost of extension service delivery. The negative effect of group membership suggests that contact and farmer-to-farmer training sessions are substitute sources of information. To a certain extent, these empirical findings suggest that livestock extension model in the KZN province could be largely commodity-focused.

Unexpectedly, the distance to the extension office, an indicator of cost of access to extension information in the model, is positive and significant. Contrary to the the empirical evidence from other developing regions (e.g. Haq, 2012), cattle farmers residing farther from the extension office are more likely to participate in extension programmes. This finding contradicts the standard predictions of microeconomics of factor demand (Bagi and Bagi, 1989). Two plausible explanations apply. This could be a consequence of lack of access to alternative (and better) sources of information in remote areas, or a result of rural development policy prioritizing and targeting farmers living in remote communities, in their intervention strategies.

Some production variables also turn out to be significant in the model. The positive marginal effect of cattle breed suggests that shift to mixed and pure exotic breeds influence positively participation in both extension contact and farmer-to-farmer sessions. A plausible explanation is that the indigenous Nguni breed requires lesser managerial capital as it is more fertile, matures earlier and is well adapted to a harsh bio-physical environment and low quality feed compared to other breeds (Bayer *et al*., 2004). From a demand viewpoint, the positive effect of herd size in the contact session model suggests that, by capitalizing on economies of size, cattle farmers are able to spread the cost of accessing extension information over the number of units produced. Contrary to *a priori* expectations, the results show a negative effect of veterinary services usage in the combined participation model. The results also show that the use of forage (e.g. grasses, silage and legumes) in animal feeding is significantly associated with participation in contact sessions. Lastly, the results revealed that the usage of feeding supplements in cattle production is significantly positive in the farmer-to-farmer and combined participation models.

Overall, the regression results suggests that the T&V extension model used in rural South Africa is only attractive to farmers with limited access to alternative sources of information. Therefore, on the basis of the results, the findings suggest that extension service delivery is largely supply-driven.

3.4.4. Impact of livestock extension programmes on smallholder cattle production

The probit models in the preceding subsection are used to generate the propensity scores for the adopted matching algorithms.

3.4.4.1. Model diagnostic tests

With regards to the common support assumption (i.e. the probability of receiving treatment for each possible value of the vector X is strictly within the unit interval), the propensity scores show that, for all farmers, the average probability of participating in contact session, farmer-to-farmer session, or both, is 57, 11 and 63.5%, respectively.

Figure 3.2 shows the overlaps of the propensity scores of the participating and non-participating farmers. In the majority of the propensity score classes, there is a certain number of participating (i.e. treated) and non-participating (i.e. untreated) farmers. However, it can be observed that the contact session and combined participation models show better distribution.

3.4.4.2. Average treatment effect on the treated (ATT) matching estimation results

Tables 3.6 and 3.7 show the ATT estimates for the set of outcome variables using the three scores specified above. The results presented in these tables are based on the Nearest Neighbour and Kernel matching methods, respectively. Given that the survey design oversampled participating farmers, and that the distribution of propensity scores differs considerably between participant and non-participant farmers, the Nearest Neighbour matching is done with replacement.
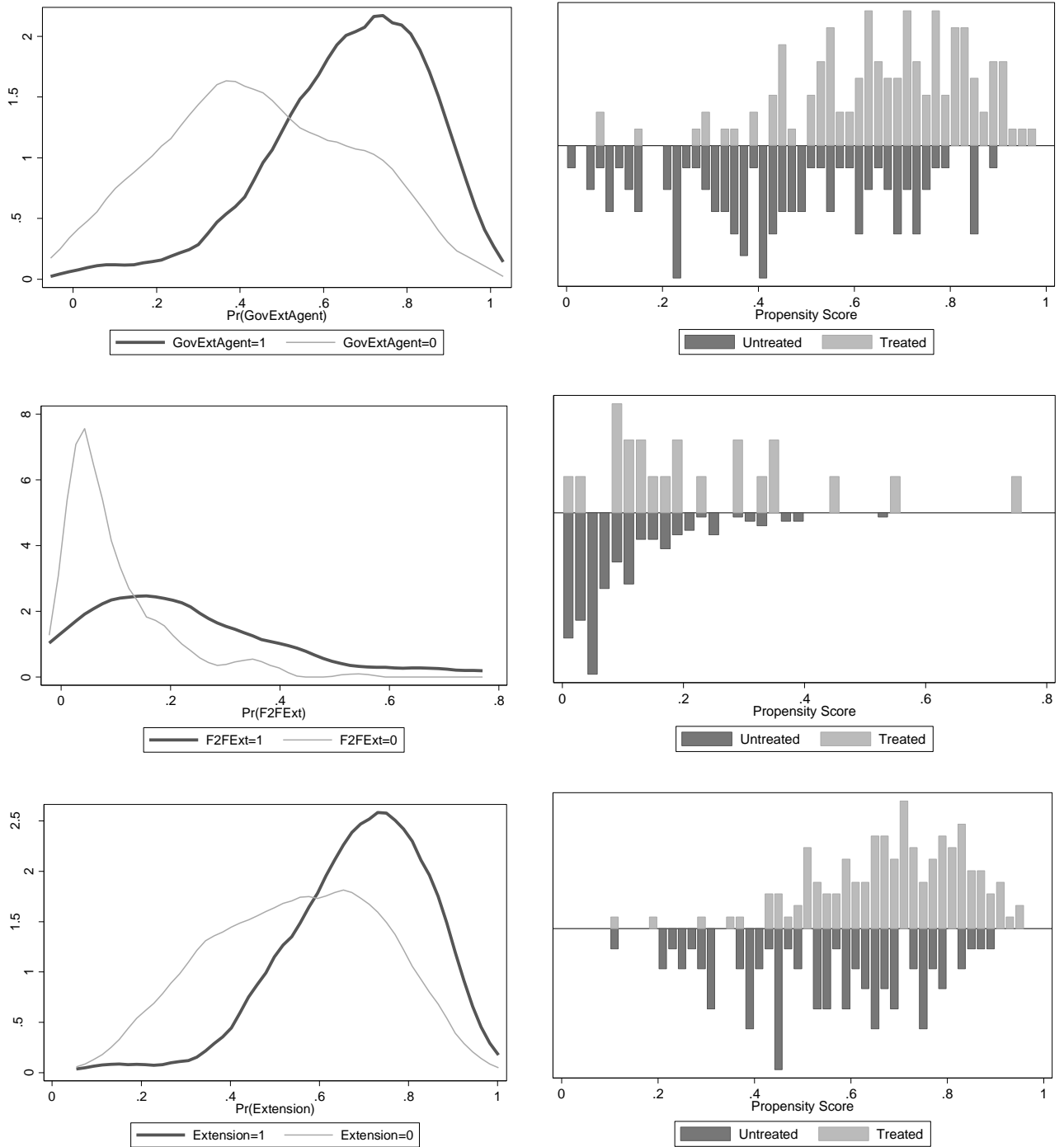
Figure 3.2. Densities of the estimated propensity score over groups

Table 3.6. Average treatment effect on the treated (ATT) matching estimates; results based on the Nearest Neighbour matchning algorithm

	Contact with extension workers			Farmer-to-farmer			Combined		
	ATT	St. Error	T-stat	ATT	St. Error	T-stat	ATT	St. Error	T-stat
Cattle breed	0.032	0.185	0.17	0.227	0.316	0.72	0.050	0.186	0.27
Herd size	1.588	1.946	0.82	1.500	2.53	0.59	0.575	1.555	0.37
Calves (births)	0.451	0.678	0.67	0.363	0.611	0.60	0.676	0.327	2.07
Use of salt	0.032	0.069	0.46				-0.028	0.045	-0.64
Use of veterinary services	-0.056	0.114	-0.49	0.227	0.143	1.67	0.021	0.103	0.21
Use of forage	0.016	0.111	0.14	0.090	0.139	0.65	0.021	0.098	0.22
Use of feed supplements	0.008	0.111	0.07	0.181	0.157	1.16	0.021	0.097	0.22

In the combined model, farmers participating in livestock extension programmes produce more calves than their control counterparts (t-statistic=2.07). In terms of input use, the results of the Nearest Neighbour matching method further show that rate of use of veterinary services is higher among farmers participating in farmer-to-farmer sessions than among their control counterparts (t-statistic=1.67). However, these results are not robust across both matching methods, as similar estimates and standard errors were not obtained using the Kernel matching method. There is no evidence that treated households are likely to use salt, probably because the usage rate among control farmers is already high. However, despite the lower rate of forage and feed supplement usage, the results show no significant impact of extension programmes. Therefore, differing from other developing regions (Davis *et al*., 2012), livestock extension programmes in rural South Africa have no significant impact on cattle production.

These results validate the empirical findings of the probit model. Notably, the vanishing benefits of livestock extension programmes (especially the contact session with extension workers) for cattle farmers explains the finding that more educated farmers, i.e. those with ability to understand the costs and benefits of extension information, are less likely to participate in the livestock extension programmes.

Table 3.7. Average treatment effect on the treated (ATT) matching estimates; results based on the Kernel matching algorithm

	Contact with extension workers			Farmer-to-farmer			Combined		
	ATT	St. Error	T-stat	ATT	St. Error	T-stat	ATT	St. Error	T-stat
Cattle breed	0.042	0.190	0.22	0.075	0.251	0.30	0.055	0.163	0.34
Herd size	1.562	1.599	0.98	0.643	2.315	0.28	0.167	1.453	0.12
Calves (births)	0.439	0.471	0.93	0.066	0.550	0.12	0.244	0.428	0.57
Use of salt	0.000	0.055	0.01				-0.002	0.050	-0.04
Use of veterinary services	-0.044	0.102	-0.43	0.013	0.130	0.11	-0.030	0.090	-0.34
Use of forage	0.044	0.095	0.46	-0.009	0.124	-0.07	0.055	0.085	0.65
Use of feed supplements	-0.008	0.095	-0.09	0.021	0.129	0.17	0.002	0.081	0.03

There are two major information problems behind the limited success of government-run extension services. As the NIE explains, extension service delivery is transaction cost-intensive, and the demand-driven extension information is often more discretionary and specific (Birner and Anderson, 2007). Information asymmetry makes extension workers unable to determine what individual farmers actually need, and to delivering "standardized", rather than specific information. Moreover, information asymmetry between field extension workers and their managers creates a principal-agent problem. Agricultural extension workers often cover vast rural agricultural areas. Their performance indicators thus depend on numerous exogenous factors (e.g. climate). The exogenous factors confound the appraisal of their performance.

3.5.   Summary

This empirical chapter investigates the influence of micro-level factors on participation in livestock extension T&V and its impact on cattle production in rural KZN. The results of a probit model indicate that educated farmers and farmers living in proximity to the extension office are not likely to participate in agricultural extension contact and farmer-to-farmer training sessions, respectively. Membership in commodity-groups increases the propensity to participate contact sessions, but decreases the propensity to participate in farmer-to-farmer sessions. The results also show that participation in livestock extension

is governed by cattle breed, herd size and input use. Overall, the findings indicate that the livestock extension model in South Africa remains supply-driven.

This suggestion is validated by the results of the Nearest Neighbour and Kernel matching algorithms. The PSM estimates indicate that farmers who have direct contact with extension workers and participate in farmer-to-farm extension sessions produce more calves than their control counterparts. In terms of input use, the results of the Nearest Neighbour matching method show that the rate of use of veterinary services is higher among farmers participating in farmer-to-farmer sessions than among their control counterparts. However, these results are not robust across both matching methods, as similar estimates and standard errors were not obtained using the Kernel Matching method.

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CHAPTER 4 : DRIVERS OF CATTLE COMMERCIALISATION AND SUPPLY VOLUME DECISIONS IN RURAL SOUTH AFRICA

4.1.   Introduction

Smallholder cattle farming systems in South Africa are caught up in a low-level equilibrium trap (Nelson, 1956). These systems remain in a stable equilibrium of incomes close to the subsistence level and often record no growth to minimal growth. Given the rapid population growth in rural areas, rural farmers will have to exploit their comparative advantages to the fullest in order to secure higher savings and investment rates and escape from the low-level equilibrium trap. Given that market participation has a considerable potential for unlocking the production systems from cycles of poverty, it is very important to understand the constraints to commercialization, identify the existing opportunities and inform the necessary policy interventions.

The Sustainable Livelihoods Framework-based framework of smallholder livestock commercialization outlined in section 2.2.8 offers two unique advantages over any other analytical frameworks for analyzing and addressing the challenges to the commercialization of smallholder farming systems. First, the framework gives an explicit consideration of both aspects of the confounding factors, i.e. endowments (defining transaction cost) and farmers' motivations (defining the market participation outcome) (Department for International Development, 1999). Second, the framework not only offers a conceptual framework, but also an integrative programming framework for poverty alleviation in a sustainable manner (Krantz, 2001). The SLF is, in principle, a responsive and participatory programming framework that builds on the strengths of people when attempting to overcome the challenges and barriers on a multi-level basis, i.e. ensuring that micro-level challenges informs policy development and macro-level environment enables people to build on their strengths (Department for International Development, 1999).

Leveraging on this unique appeal, the present chapter aims to estimate empirically the effects of factors under different SLF components on market participation decisions

among smallholder cattle farmers in rural South Africa. The Double-Hurdle econometric model used for estimation purpose is described in the methodological section. The results are presented and discussed in section 4.3, and the major findings are summarized in section 4.4.

4.2. Material and methods

4.2.1. Study area and data collection

The study area and data collection procedure are described in sections 3.2 and 3.3.1, respectively.

4.2.2. Econometric model specification and estimation

Sample selection models are appropriate to the empirical studies of agricultural market participation behaviours under transaction costs (Key *et al*., 2000; Bellemare and Barrett, 2006; Alene *et al*., 2008). The most popular sample selection models used to correct the presence of zeros in the empirical literature on market participation are the Double-Hurdle (DH), Tobit and Heckman sample selectivity models (Humphreys *et al*., 2009; Wodjao, 2007). Empirical studies have commonly vindicated the superiority of the Double-Hurdle approach over the Tobit and Heckman sample selectivity models (Humphreys *et al*., 2009; Wodjao, 2007). Therefore, to estimate the influence of livelihood factors on the participation and supply outcomes, the study adopted the DH econometric technique proposed by Cragg (1971). Under this empirical strategy, a cattle farmer has to cross two hurdles to become a participant in cattle marketing. First, the farmer becomes a "potential participant" after crossing the first hurdle, i.e. after making a positive decision; and given that he/she is a potential participant, capability factors will determine his actual/observed level of participation (the second hurdle). Therefore, the DH model is a two-equation framework (Matshe and Young, 2004; Moffatt, 2005), as depicted in the equation (4.1).

Let I_i^* denote a binary choice variable. Let Q_i^{s*} be a latent variable reflecting the number of cattle sold (therefore the observed variable, Q_i, being determined as $Q_i = I_i^* \cdot Q_i^{s*}$).

In equation (4.1), Z and α are vectors of factors explaining the decision of participation and their relative influences respectively, whereas X and β are vectors of factors explaining the intensity of participation and their relative influences, respectively. The DH model can be written as follow:

$$I_i^* = Z_i^{'}\alpha + \varepsilon_i \quad \text{first hurdle}$$
$$Q_i^{s*} = X_i^{'}\beta + \mu_i \quad \text{second hurdle} \tag{4.1}$$

where the error terms (ε_i and μ_i) are such that $\begin{pmatrix} \varepsilon_i \\ \mu_i \end{pmatrix} \sim N\left[\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} 1 & 0 \\ 0 & \sigma^2 \end{pmatrix} \right]$, i.e. assumed to be independently distributed.

Following Moffatt (2005), the log-likelihood function for the DH model is:

$$LogL = \sum_0 \ln\left[1 - \Phi(Z_i^{'}\alpha)\Phi\left(\frac{X_i^{'}\beta}{\sigma} \right) \right] + \sum_+ \ln\left[\Phi(Z_i^{'}\alpha)\frac{1}{\sigma}\phi\left(\frac{(Y_i - X_i^{'}\beta)}{\sigma} \right) \right] \tag{4.2}$$

The analysis of marginal effect helps to assess the impact of the exogenous variables on the dependent variable. To do so, the unconditional mean is decomposed into the effect on the probability of participating and the effect on the conditional level of participation and differentiating these components with respect to each explanatory variable. The unconditional mean can be written as:

$$E[Q \mid X_i] = P(Q_i > 0) \cdot E(Q_i \mid Y_i > 0) \tag{4.3}$$

The probability of participation and the expected number of cattle sold conditional on participation are:

$$P(Q_i > 0) = \Phi(Z_i^{'}\alpha)\Phi\left(\frac{X_i^{'}\beta}{\sigma} \right) \tag{4.4}$$

and

$$E(Q_i \mid Q_i > 0) = \Phi\left(\frac{X_i^{'}\beta}{\sigma_i} \right)^{-1} \int_0^\infty \left(\frac{Q_i}{\sigma_i\sqrt{1+\theta^2 Y_i^2}}\phi\left(\frac{T(\theta Q_i) - X_i^{'}\beta}{\sigma_i} \right) \right) dY_i \tag{4.5}$$

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To estimate the effects of livelihood factors on market participation decisions (Equation 4.4), the Double Hurdle estimation technique uses a probit regression model, whilst the intensity of participation, the second stage (Equation 4.5), is estimated using a truncated regression model (Cragg, 1971).

4.2.3. Empirical model

The dependent variables in the empirical models are a dummy variable, capturing participation in cattle markets, as well as a count variable capturing the number of cattle sold over the period of 2009-2011. Following the conceptual synthesis in Figure 2.1, the vulnerability context, represented by cattle loss due to heavy snow and droughts, was included to detect the consumption smoothing effect.

To calibrate the transaction cost effect, various indicators of livelihood assets were included in the models. Farmer's age was used as a human capital indicator. Social capital was measured by membership in the Okhahlamba Livestock Co-operative (OLC). Financial capital was represented by membership in *stokvels*. Physical capital was represented by tractor ownership and distance to the Dukuza market. Access to natural capital was indicated by the walking distance to the nearest source of water. Three variables are used to represent the role of transforming structures and processes. Two agricultural extension model variables, direct contact with extension workers and participation in farmer-to-farmer extension sessions, represent the "direct" impact of agricultural marketing extension, as specified in the conceptual synthesis. To control for the formal rules/regulations, a cattle tagging variable was included in the model.

With regard to livelihood strategies, the herd size (quantity) and cattle breed (quality) are output variables representing the effect of (fixed) transaction costs on decision price (i.e. market surplus threshold level discussed in sub-section 2.2.6) in the model. For the purpose of calibrating the motivational effect, two variables are included in the model: a variable indicates the importance of unearned incomes (e.g. grants) in the household income portfolio, and a fixed-effect variable captures the average price of cattle sold at the farm gate in the community.

4.3.   Results and discussion

4.3.1. Socio-economic characteristics of the surveyed farmers

The sample statistics describing the variables used in the empirical model are presented in Table 4.1. The majority of interviewed household heads were born between 1953 and 1955, and household heads in the market participants group were significantly younger than their counterparts. The majority of interviewed farmers were members of the OLC, although the rate of membership was significantly higher in the market participant group. With regard to financial capital, rates of participation in the savings groups (*stokvels*) ranging from 34% (non-participants) to 42% (participants) were recorded. For physical capital, about 11% of interviewed households owned a tractor (producer goods) and stayed within 21 km of the Dukuza cattle market. Concerning natural capital, the walking distance to the nearest source of water was statistically different between the two groups, with the majority of households in the participants group walking for 20 minutes, while their counterparts walked for 14 minutes.

The majority of interviewed farmers (50 to 65%) had recently made contact with extension staff from the provincial DAFF. Households in the market participants group had relatively and significantly made more contact than farmers in the non-participants group. The rates of participation in farmer-to-farmer extension programmes were lower, ranging from 12% in the participants group to 6% in the non-participants group. The difference in the participation rates between groups was not statistically significant. The majority in both groups had tagged their cattle. The participating group recorded a significantly higher tagging rate. Unearned incomes were more important among interviewed households in the non-participants group.

Table 4.1. Description of covariates in the Double-Hurdle model and t-test for equality of means between market participants and non-participants

Variable category, SLF component and variable name	Measurement	Description	Mean		T-test
			Participants n=111	Non-participants n=119	p-value
Vulnerability context					
SNOWLOSS	Dummy	1= the household experienced cattle deaths attributable to heavy snow over the last three years; 0= otherwise.	0.49	0.41	0.246
DROUGHTLOSS	Dummy	1= the household experienced cattle death attributable to drought conditions over the last three years; 0= otherwise.	0.20	0.26	0.273
Asset pentagon *Human capital*					
BIRTHHH	Continuous	Year of birth of the head of household	1955.94	1953.08	0.076
Social capital					
OLCMEMB	Dummy	1= the head of household is a member of OLC; 0= otherwise.	0.84	0.74	0.071
Financial capital					
SAVGROUP	Dummy	1= The head of household saves money in a *stokvel*; 0= otherwise.	0.42	0.34	0.198
Physical capital					
TRACTOR	Dummy	1=The head of household owns a tractor; 0=otherwise.	0.10	0.11	0.734
DISTDUKUZA	Continuous	Shortest driving distance from the community's dip tank to Dukuza cattle market place (measured in kilometres using GPS navigation software).	21.577	20.265	0.461

Natural capital

DISTWATER	Continuous	Walking distance (in minutes) between the household and the nearest cattle water source – an indicator of access to natural ecosystem services.	21.61	14.74	0.097

Transforming processes and structures

EXTCONTACT	Dummy	1= the farmer received a training or visit from government extension workers over the last three years; 0=otherwise.	0.646	0.504	0.030
F2FEXT	Dummy	1= the farmer has participated in farmer-to-farmer extension training or information sessions over the last three years; 0=otherwise.	0.123	0.068	0.154
CATTLETAG	Dummy	1=Cattle conforms to the required identification tags, 0= otherwise.	0.95	0.85	0.020

Livelihood strategies

HERDSIZE	Count	Total number of cattle owned at the time of interview	14.68	8.92	0.000
CATTLEBREED	Categorical	1= Nguni; 2= Mixed; 3= Exotic breed	1.73	1.77	0.578

Livelihood outcomes

UNEARNEDRANK	Categorical	1 = Unearned incomes are most important sources of income, …, 5= least important	3.44	2.65	0.000
EXPPRICE	Continuous	Expected cattle price at farm gate in the community (i.e. the total value of cattle sold at farm gate in the community divided by the number of cattle sold)	5480.767	5595.009	0.339
Inverse mills ratio (IMR)	Continuous	The standard normal probability distribution function over the standard normal cumulative distribution function of the predicted probabilities			

The average herd sizes ranged between eight for non-participants and 14 for participants, and the difference was statistically significant. The expected cattle price was about ZAR5 500. As the table shows, nearly 48% of interviewed farm households had participated in cattle markets. Vulnerability to climatic conditions was more pronounced among the interviewed households, with staggering proportions of nearly 50 and 25% reporting cattle loss following severe winter and drought spells, respectively. The rates were not statistically different between market participant and non-participant groups.

4.3.2. Patterns of cattle commercialization among the surveyed communities

Based on the survey data, Table 4.2 gives details of cattle commercialization among the surveyed areas. In total, surveyed farmers owned 2703 cattle head and had reportedly sold 13% of the total herd size over the period of 2009-2011. Therefore the community-level annual off-take rate was 4.3%. Some communities located closer to Bergville, such as Woodford and Rookdale, had the highest annual off-take rates (>9%) in the sample, whilst remote areas such as Mafhefheteni and Ogade recorded the lowest off-take rates (<2.1%). The sample was thus deemed representative of the general population of cattle farm households in South Africa.

Table 4.2. Description of cattle marketing transaction among surveyed households

Community/dip tank	Number of households	Number of cattle head owned	Percentage of cattle head sold (2009-2011)	Annual off-take rate
Hambrook	19	142	12.88	4.29%
Potchini	11	132	9.59	3.20%
Woodford	15	133	27.72	9.24%
Mafhefheteni	12	178	5.32	1.77%
Rookdale	6	56	27.27	9.09%
Nokopela	16	159	8.62	2.87%
Gqomu	18	325	17.30	5.77%
Gqomu-B	3	65	10.96	3.65%
uMzimukulu	20	264	7.69	2.56%
Intumbane	22	353	16.75	5.58%
Olivia	33	349	10.28	3.43%
Ogade	27	298	6.29	2.10%
Moyeni	28	249	15.88	5.29%
Total	230	2703	13.11	4.37%

4.3.3. Double-Hurdle model diagnostics

The estimation results of the Double Hurdle model are shown in Tables 4.3 and 4.4. Overall, the variables used in the model seem to give a good fit. For both models, the null hypothesis that "the influence of all variables is jointly or simultaneously equal to zero" was rejected at 0% significance level. For the intensity model, self-selection bias was corrected for each participating household by generating an Inverse Mills Ratio (IMR) from predicted probabilities of the probit model and including it as an explanatory variable in the truncated regression (Wooldridge, 2002). The coefficient of the IMR variables turned out to be insignificant in the intensity model, suggesting that self-selectivity bias was not an issue.

Although theory does not point to the need for imposing exclusion restrictions in the Double-Hurdle model, as with the Heckman model, an exclusion restriction was imposed in the model since the IMR variable can be correlated with the vector of explanatory variables in the intensity model, especially if both hurdles have equal vectors of explanatory variables (Wooldridge, 2002). It is recommended that a variable that is likely to affect the selection, but not have partial effect on the intensity model can conveniently be excluded. Potential factors to be excluded in the intensity model, were those that explained, to some extent, the fixed transaction costs, since they influenced only the first participation decision model (Key *et al*., 2000; Alene *et al*., 2008). Using the LR test, distance to market was excluded.

Multicollinearity was tested using a correlation matrix. In econometrics, the extent of pairwise correlations is a fundamental indicator of the severity of multicollinearity in data, based on which the necessity for further tests can be gauged (Wooldridge, 2002). The results presented in Appendix A2 suggest that multicollinearity was not a serious problem in the data. To curb the potential heteroskedasticity in the model, the study used the heteroskedasticity-robust standard errors for parameter estimates.

4.3.4. Determinants of cattle markets participation and supply decisions

With regards to livelihood assets, participation in saving groups turns out to be a major predictor of the decision to participate in cattle as a seller. Other livelihood factors remaining unchanged, opening an account in a local saving group (or a *stokvel*) increases significantly the probability of participating in cattle market as a seller by 13.4% (p-value=0.078). Previous studies have reported the significant effect of agricultural credit on commercialization (Kelly *et al.*, 2003), particularly in the livestock sector (Abedullah *et al.*, 2009). Arguably, smallholder farmers that belong to saving groups have access to credit that enables them to increase the productivity and market value of their herd, thereby increasing the prospect of market participation.

The coefficient of walking distance to the nearest water source also has a significant positive effect in the selection model (p-value=0.002), inferring that OLM cattle farmers staying far from water sources such as rivers and dams have more chance of participating in cattle markets as sellers. This finding signals the potential of distress sales among smallholder farmers, particularly during adverse periods of prolonged drought. This suggests that cattle are sold as a way to limit herds to manageable sizes. Similar behaviour was reported from Kenya and Ethiopia (Bellemare and Barrett, 2006).

Table 4.4 shows that, among structures and processes factors, the coefficient of farmer-to-farmer extension variable is significant for the supply model (p-value=0.029). This finding infers that, given a positive participation decision, potential participants that received extension training and information-sharing sessions through their groups tend to supply more cattle to the market. This result indicates that farmers do capitalize on the information networks when deciding on the number of cattle to be sold. Similar results were reported by previous studies (Gebremedhin and Jaleta, 2010). This finding vindicates the contention that what matters for positive economic outcomes among the poor is not membership in groups, but the quality and quantity of resources (information) flowing within those networks (Kirsten *et al.*, 2009).

Table 4.3. Determinants of farmer's decision to participate in cattle market using the probit regression model

SLF component and variable name	Coefficient	Marginal effects	p>|Z|
Vulnerability context			
SNOWLOSS	-0.127	-0.051	0.527
DROUGHTLOSS	-0.355	-0.140	0.124
Asset pentagon			
Human capital			
BIRTHHH	0.009	0.003	0.247
Social capital			
OLCMEMB	0.177	0.070	0.472
Financial capital			
SAVGROUP	0.338	0.134	0.078
Physical capital			
TRACTOR	-0.277	-0.109	0.367
DISTDUKUZA	0.002	0.001	0.729
Natural capital			
DISTWATER	0.009	0.003	0.002
Transforming processes and structures			
EXTCONTACT	0.277	0.110	0.186
F2FEXT	0.444	0.173	0.165
CATTLETAG	0.565	0.216	0.070
Livelihood strategies			
HERDSIZE	0.046	0.018	0.000
CATTLEBREED	-0.458	-0.182	0.031
Livelihood outcomes			
UNEARNEDRANK	0.189	0.075	0.001
EXPPRICE	-0.000	-0.000	0.280
Constant	-18.088	----	0.241

The empirical results of the participation model yield a positive and significant coefficient for cattle tagging (p-value=0.070). These results indicate that compliance with the Livestock Identification Act is a key factor in cattle marketing and the most important constraint to the cattle market participation in empirical model. *Ceteris paribus*, registering (branding and marking) the cattle herd increases market participation propensity by 21%. Other studies have reported the significant effect of livestock movement legislation on market participation (e.g. Yusuf, 2008). This finding vindicates the assertions of Coetzee *et al.* (2006) and Groenewald and Jooste (2012) that registration

legislation is an important challenge for a pro-poor cattle market development policy in South Africa.

Table 4.4. Determinants of cattle market supply volumes among smallholder farmers in OLM using the truncated regression model

SLF component and variable name	Coefficient	p>|Z|
Dependent variable: TOTSOLD		
Vulnerability context		
SNOWLOSS	2.872	0.728
DROUGHTLOSS	-11.825	0.318
Asset pentagon		
Human capital		
BIRTHHH	-.135	0.619
Social capital		
OLCMEMB	-11.722	0.197
Financial capital		
SAVGROUP	-3.275	0.631
Physical capital		
TRACTOR	7.991	0.287
Natural capital		
DISTWATER	.052	0.648
Transforming processes and structures		
EXTCONTACT	.922	0.915
F2FEXT	21.966	0.029
CATTLETAG	-14.332	0.235
Livelihood strategies		
HERDSIZE	1.340	0.002
CATTLEBREED	7.648	0.481
Livelihood outcome		
UNEARNEDRANK	3.147	0.298
EXPPRICE	-.005	0.092
IMR	14.140	0.349
Constant	148.752	0.774

With regard to livelihood strategies, the regression results in both tables indicate that cattle market participation and supply decisions are significantly and positively governed by the size of cattle herd. Adding one animal to the herd increases significantly the chances of participating in the cattle market as a seller by 1.8%, *ceteris paribus* (p-value=0.000). These findings vindicate the hypothesis that agricultural market participation is associated with its productivity (Lapar *et al*., 2003; Rios *et al*., 2009) and

the empirical evidence that shifting to commercial cattle farming systems in southern Africa requires growth in herd sizes (Behnke, 1987).

The probit model also showed that the cattle breed has a significantly negative effect on market participation decisions. All other factors in the model remaining constant, shifting from an exclusively indigenous Nguni breed herd to mixed/crossbred herds, towards an exotic breed, reduces significantly the farmer's prospect of cattle market participation (p-value=0.031), implying that farmers who keep indigenous breeds are more likely to participate in the market as sellers. This suggests that farmers do take into account the breed when deciding to sell their cattle. This is probably due to the fact that the indigenous breed of the eastern and northern South Africa is more fertile, matures earlier, is well adapted to low-quality feed and is therefore easily replaceable, compared to other breeds (Bayer *et al*., 2004). This finding shows that both the quantity and quality of cattle herd are important for a pro-poor market development strategy.

With regards to livelihood outcomes, Table 4.3 shows that the coefficient of the rank of unearned incomes in the income portfolio is significantly positive (p-value=0.001), suggesting that cattle farmers who regularly secure more unearned incomes such as remittances from their family members and friends and government grants are not likely to participate in the cattle market. This result is in line with the walking bank hypothesis of livestock marketing (Bellemare and Barrett, 2006), suggesting that market participation decisions are driven by the need to cater for immediate household needs when cash is not otherwise available.

The results show that the coefficient of the expected price variable is only significant in the supply model (p-value=0.092). Consistent with the findings of previous studies done in developing countries, such as that of Alene *et al*. (2008), this empirical finding reveals that smallholder farmers do not necessarily consider information on prevailing price incentive when deciding to sell their cattle. Nonetheless, the evidence suggests that, given positive participation decisions, smallholders will consider price signals when deciding upon the number of cattle to be sold on the market. These results possibly suggest that

market participation and volume decisions are not taken simultaneously, i.e. although predisposed to selling their cattle, livestock farmers do not pre-commit the number of cattle to be sold before learning information about the prevailing market conditions, especially the price (Bellemare and Barrett, 2006). However, the negative sign indicates that there is a considerable storage scope of non-commercial motivations. This specifically indicates the store-of-wealth effect whereby cattle are only sold to meet some pressing cash needs (Doran *et al.*, 1979). This finding validates the previous result suggesting that farmers who manage to secure more incomes from alternative sources are less likely to participate in cattle market.

4.4.   Summary

In this empirical chapter, an investigation into the effects of agricultural extension, transaction costs and motivational aspects on cattle commercialisation decisions among livestock farmers in rural KwaZulu-Natal is carried out. Based on the proposed SLF-like analytical synthesis, the review chapter, the Double-Hurdle model estimation results show that access to livelihood assets such as financial capital (savings groups) and natural resources (distance to water source) increase a smallholder farmer's likelihood of participating in the cattle market. Transforming structures and processes such as compliance with cattle registration regulations (i.e. cattle tagging) and participation in farmer-to-farmer training and information sessions, respectively, increases the farmer's likelihood of participation in cattle markets and, given position participation decisions, influences positively the volume supplied. With regards to livelihood strategies, the regression results indicate that cattle market participation and supply decisions are significantly and positively governed by the cattle herd size, whilst shifting from an exclusively indigenous breed (Nguni) herd to mixed/crossbred herds, towards exotic breeds reduces significantly the farmer's prospect of cattle market participation. Lastly, with regard to livelihood outcomes, the results indicate that cattle farmers who regularly secure more unearned incomes are not likely to participate in cattle markest, whilst those who expect better prices tend to sell fewer cattle.

CHAPTER 5 : EFFECTS OF TRANSACTION COSTS ON FARMERS' CHOICE OF CATTLE MARKETING CHANNELS IN RURAL SOUTH AFRICA

5.1.   Introduction

Currently, as the domestic beef markets are experiencing increased demand, there is a tendency to modernize the supply chains. These changes have received considerable attention among the livestock extension strategists, who view this situation as an opportunity to turn rural regions' comparative advantages into real competitive advantages (Coetzee *et al*., 2006). Although the livestock extension policy-makers in South Africa view auctioneering as the most advanced form of cattle marketing and, indeed, cattle in the auction pens generally fetch better prices, private sales remain the most important form of cattle marketing in rural areas. This situation signals the incidence of friction in the exchanges across different marketing outlets.

For example, the increasing vertical co-ordination in South Africa's beef industry (as briefly discussed in section 1.1.) may secure market power to key beef cattle buyers, whilst the complexity of operational and institutional arrangements of modern supply chains could become a challenge to the often-uneducated and uninformed smallholder producers living in remote areas. Such challenges have direct (negative and positive) impacts on the welfare of cattle producers' income and rural poverty, in general. A good understanding of the cattle marketing structures and the role of factors such as access to market information, farmers' bargaining power and monitoring costs is thus crucial. Such information can assist in identifying existing or potential opportunities and devising key policy intervention strategies that can contribute to the realization of South Africa's rural development objectives.

In Chapter 5, therefore, the transaction cost approach is applied to the investigation of smallholder farmers' selection of cattle marketing channels in rural South Africa. A discrete choice model of marketing channel choice, based on which the investigations are carried out, is described in the subsequent section. Based on the survey data (as documented in the previous chapter), an empirical model for estimating the influence of

transaction cost indicators (controlling for farmer's characteristics) on the channel selection outcome is described. The model estimation results are reported and discussed in section 5.3. The major findings are summarized in the last section.

5.2. Material and methods

5.2.1. Study area and data collection
The study area and data collection procedure are described in sections 3.2 and 3.3.1, respectively.

5.2.2. Econometric model specification and estimation
The most widely used econometric technique in the channel choice literature (Jari and Fraser, 2009; Bardhan *et al*., 2012; Martey *et al*., 2012; Panda and Sreekumar, 2012) is the multinomial logit (MNL) model (Hausman and McFadden, 1984). Under this framework (see Anas, 1983), a farmer *i* from a population *i*= 1… *I* of individual decision-making farmers (with homogeneous preferences) is assumed to face a choice set of *m*=1…*M* of discrete alternative market channels. The utility of each alternative market channel for farmer *i* ($\hat{U}_m^i$) is assumed to be a linear function of the utility attribute of a particular market. Hence:

$$\hat{U}_m^i = \alpha_{0m} + \sum_{k=1}^{K} \alpha_k + X_{mk}^i + \varepsilon_m^i \tag{5.1}$$

where $\bar{\alpha} = [\alpha_{o1}\alpha_{o2}...\alpha_{om}\alpha_1\alpha_2...\alpha_k]$ are the utility coefficient common to all farmers in the population; X_{mk}^i is the kth attribute's value for market alternative channel *m* and farmer *i*; and $\bar{\varepsilon} = [\varepsilon_1\varepsilon_2...\varepsilon_m]$ is the vector of stochastic utility distributed over the population. Alternative-specific constants α_{om} measure the unspecified part of the utility for each market alternative.

The probability that farmer *i* selects market channel *c* over the *m* alternative can be written as follows:

$$P_c^i = \text{Pr.}\left[\hat{U}_c^i > \hat{U}_m^i; \forall m \neq c\right] \qquad (5.2)$$

The derivation of the MNL model follows the assumption that ε_c^i is identically and independently distributed (IID) over the population and for each farmer based on the Gumbel distribution with the following cumulative distribution function:

$$\text{Pr.}\left(\varepsilon_c^i \leq \varepsilon\right) = \exp\left(-\exp\left[-\left(\frac{\pi^2}{6\sigma^2}\right)^{1/2}\varepsilon\right]\right) \qquad (5.3)$$

with zero mode and σ^2 variance for each alternative market channel $m=1\ldots M$.

With this consideration, the MNL derives in the following form:

$$P_c^i = \frac{\exp\left\{\beta_{0c} + \sum_{k=1}^{K}\beta_k X_{ck}^i\right\}}{\sum_{m=1}^{M}\exp\left\{\beta_{0m} + \sum_{k=1}^{K}\beta_k X_{mk}^i\right\}} \qquad (5.4)$$

where $\beta_{0c} = \left(\pi^2/6\sigma^2\right)^{1/2}\alpha_{0c}$ and $\beta_k = \left(\pi^2/6\sigma^2\right)^{1/2}\alpha_k$.

This model is estimated by maximizing the likelihood function with respect to the estimable coefficients $\bar{\beta}$. Thus,

$$\underset{\bar{\beta}}{\text{Maximize}} \, \text{Log}\,\hat{\lambda} = \sum_i\sum_m \delta_m^i \log P_m^i(\bar{\beta}) \qquad (5.5)$$

where $\delta_m^i = 1$ if farmer i selects alternative marketing channel m, $\delta_i^m = 0$ if the farmer i does not select alternative marketing channel m.

The first-order condition for the unconstrained optimization involves the following equations:

$$\frac{\partial \log \hat{\lambda}}{\partial \bar{\beta}} = \sum_i\sum_m \delta_m^i\left[\frac{\partial P_m^i(\bar{\beta})/\partial\bar{\beta}}{P_m^i(\bar{\beta})}\right] = 0 \qquad (5.6)$$

where

$$\frac{\partial P_m^i(\overline{\beta})}{\partial \beta_k} = P_m^i(\overline{\beta})X_{mk}^i - P_m^i(\overline{\beta})\sum_c P_c^i(\overline{\beta})X_{ck}^i; \quad k = 1...K \tag{5.7}$$

$$\frac{\partial P_m^i(\overline{\beta})}{\partial \beta_{0m}} = P_m^i(\overline{\beta})\big[1 - P_m^i(\overline{\beta})\big]; \quad m = 1...M \tag{5.8}$$

Substituting (5.7) and (5.8) into (5.6):

$$\frac{\partial \log \lambda}{\partial \overline{\beta}} = \sum_i \sum_m P_m^i(\overline{\beta})X_{mk}^i - \sum_i \sum_m \delta_m^i X_{mk}^i = 0; \quad k = 1...K \tag{5.9}$$

and

$$\frac{\partial \log \lambda}{\partial \beta_{0m}} = \sum_i P_m^i(\overline{\beta}) - \sum_i \delta_m^i; \quad m = 1...M \tag{5.10}$$

where $\sum_i \sum_m \delta_m^i X_{mk}^i \equiv \overline{X}_k$ and $\sum_i \delta_m^i = \overset{0}{N}_m$ reflect the aggregate value of kth market channel attribute over the sample and the observed frequencies of farmers choosing each of the m marketing channel alternatives, respectively.

All the elements of $\overline{\beta}$ are obtained by solving $K+J$ equations in (5.9) and (5.10) simultaneously. This is what constitutes a MNL model of market channel choices with K generic attributes and a set of alternative-specific constants, all but one of which are identified.

5.2.3. Empirical model

The hypothesis to be tested is that transaction costs affect the selection of cattle marketing channels by smallholder farmers. After dropping the marketing mix due to lack of sufficient observations, the outcome variable (MARKCHAN) captured three channels of cattle marketing, i.e. PRIVATE, SPECULATOR and AUCTION. The former two represent farm gate sales, whereas the latter serves as the reference channel in the model. Following previous reports (e.g. Hobbs, 1997; Gong *et al*., 2006; Shiimi *et al*., 2012), transaction cost factors (i.e. the predictors) are categorised into three major classes: information, negotiation and enforcement costs, to which producer characteristics

are added as control factors (Hobbs, 1997). The empirical model is specified as the following equations:

$$\ln\left(\frac{\text{Pr(MARKCHAN= PRIVATE)}}{\text{Pr(MARKCHAN= AUCTION)}}\right) = \beta_{10} + \beta_{11}(\text{PRICEINFO}) + \beta_{12}(\text{SEASONSALE}) + \beta_{13}(\text{DISTDUKUZA})$$
$$+ \beta_{14}(\text{KNOWBUYER}) + \beta_{15}(\text{CATTLEINCRANK}) + \beta_{16}(\text{EXPDAMAGE})$$
$$+ \beta_{17}(\text{TRUSTBUYER}) + \beta_{18}(\text{TOTSOLD}) + \beta_{19}(\text{BODYCOND}) + \beta_{110}(\text{AGEHH})$$
$$+ \beta_{111}(\text{OLCMEMB}) + \beta_{112}(\text{EDUCATION}) + \beta_{113}(\text{OWNVEHIC})$$

$$(5.11)$$

$$\ln\left(\frac{\text{Pr(MARKCHAN= SPECULATOR)}}{\text{Pr(MARKCHAN= AUCTION)}}\right) = \beta_{20} + \beta_{21}(\text{PRICEINFO}) + \beta_{22}(\text{SEASONSALE}) + \beta_{23}(\text{DISTDUKUZA})$$
$$+ \beta_{24}(\text{KNOWBUYER}) + \beta_{25}(\text{CATTLEINCRANK}) + \beta_{26}(\text{EXPDAMAGE})$$
$$+ \beta_{27}(\text{TRUSTBUYER}) + \beta_{28}(\text{TOTSOLD}) + \beta_{29}(\text{BODYCOND}) + \beta_{210}(\text{AGEHH})$$
$$+ \beta_{211}(\text{OLCMEMB}) + \beta_{212}(\text{EDUCATION}) + \beta_{213}(\text{OWNVEHIC})$$

$$(5.12)$$

where βs are the parameters to be estimated.

Information about prevailing market price (PRICEINFO) captures price discovery (or price information) costs. It is commonly argued that the cost of accessing price information depends on the extent to which market information is readily available to farmers (Hobbs, 1997; Gong *et al.*, 2006; Shiimi *et al.*, 2012). Therefore a positive effect of availability of price information on market channel selection was expected, particularly for selling to private buyers vs. selling at the auction.

The season during which the sale transaction took place (SEASONSALE) is a dummy variable capturing sales transacted in December or otherwise. It serves as an indicator of price and market uncertainty in the model. According to Hobbs (1997), price or market uncertainty is heightened if the farmer is not sure about the number of buyers that will turn up at the marketplace. To the extent that the demand for beef peaks during the end-

of-year festive season, this variable was expected to influence the choice of marketing channel.

Distance to the auction (DISTDUKUZA) indicates the transportation cost that is specific to the auction market and therefore the opportunity cost of the farmers' time and effort to organize the transportation of cattle to the auction. *A priori* expectation was a positive effect of this variable on the choice of farm gate sales vs. auction.

Knowledge of the buyer (KNOWBUYER) captures the *a priori* knowledge of the buyer during cattle sale transactions. It is a common argument that a (good) relationship with the buyer in a certain channel reduces the cost of negotiating sales and may lead to a positive channel selection outcome (Hobbs, 1997). A positive influence of this variable on the choice of farm gate channels was thus expected.

The importance of cattle incomes in the household (CATTLEINCRANK) indicates the degree of specialization, thereby capturing the household's supply elasticity to new market information discovery, hence the bargaining power. As Bellemare and Barrett (2006) contend, (pre)committed households have lower levels of flexibility in market transactions, giving more market power to the traders (buyers). Therefore a negative influence on the choice of farm gate sales was expected.

Experience with damages (EXPDAMAGE) captures the importance of monitoring costs incurred when a farmer is trying to minimize skin and horn damage during marketing, to avoid potential sellers discounting the price they are willing to pay (Hobbs, 1997). Therefore, to the extent that such risks are inherently associated with auction sales (i.e. market transportation), it was expected that such experiences could discourage selection of this channel.

Trust in buyers (TRUSTBUYER) captures the opportunity costs of mobilizing the producer's time and efforts against the grading and pricing information asymmetry problem between buyers and sellers. Lack of sellers' involvement during the grading and

price setting process may create an incentive for the buyer to act opportunistically (Hobbs, 1997). Trust in buyers was thus expected to influence positively the choice of farm gate sale.

With regard to producer characteristics serving as control variables in the model, the volume supplied (TOTSOLD) and body condition score (BODYCOND)[1] influences the willingness of buyers to deal directly with the seller, attracted by economies of scale (Hobbs, 1997). These variables were meant to control for the related gains in bargaining power. Age of head of the household (AGEHH) indicates the managerial capital of the farm firm and therefore the level of internal uncertainty. Membership of OLC (OLCMEMB) is an indicator of access to social capital. It was meant to control for the overall role played by local institutions in places to minimize the incidence transaction costs in cattle marketing.

Education of the household head (EDUCATION) indicates the role played by human capital in minimizing transaction costs. As Bywaters and Mlodkowski (2012) and Pingali *et al*. (2005) argue, education reduces the cost of searching for information, as well as the time taken to process and act on such information. Vehicle ownership (OWNVEHIC) serves as an indicator of household wealth in the model. As Fafchamps and Hill (2005) demonstrate, wealthier farmers have high opportunity cost of time, due to high income (i.e. their leisure is a normal good) and productive capitals, and this can particularly affect the effect of distance on market channel choice.

5.3. Results and discussion

5.3.1. Patterns of cattle marketing in the surveyed communities

Table 5.1 shows the household-level cattle marketing behaviour among the interviewed farm households that sold cattle. The supplying households adopted four forms of marketing channels, including auction sales (~35%), private sales (~50%), speculators (~14%), and a mixture of auction and private sales (~2%). Whilst private sales dominated

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[1] Body condition score (BCS) is based on the Scottish scoring system (Lowman *et al*., 1976; Roche *et al*., 2004).

the sample, selling at the auction was the dominant form of cattle marketing in Ogade and selling to the speculator was predominant in Potchini. It is also noteworthy that, in Gqomu-B, no private sale was recorded.

Table 5.1. Household-level cattle marketing patterns among surveyed households

Community	Number of interviewed households that sold cattle	Percentage of selling households per marketing channel			
		Auction	Private buyers	Speculators	Auction and private buyers
Hambrook	8	50.00	50.00	0.00	0.00
Potchini	6	33.33	16.67	50.00	0.00
Woodford	5	40.00	40.00	20.00	0.00
Mafhefheteni	8	0.00	75.00	25.00	0.00
Rookdale	4	25.00	50.00	25.00	0.00
Nokopela	9	11.11	88.89	0.00	0.00
Gqomu	15	33.33	46.67	20.00	0.00
Gqomu-B	2	50.00	0.00	50.00	0.00
uMzimukulu	9	33.33	44.44	22.22	0.00
Intumbane	16	43.75	50.00	0.00	6.25
Olivia	12	33.33	41.67	25.00	0.00
Ogade	8	87.50	12.50	0.00	0.00
Moyeni	11	18.18	72.73	0.00	9.09
Total	113	34.51	49.56	14.16	1.77

5.3.2. Description of transaction costs incurred by the sampled households

Table 5.2 shows that, on average, each interviewed farmer had little to no market information at the time of the transaction of the sale. The table also shows that most of the recorded sale transactions did not take place during the festive month of December. In the sample, the average distance to the dip tank was about 20 km. Table 5.2 points out lower levels of knowledge of the buyers among the surveyed households.

Table 5.2. Descriptive statistics for independent variables in the MNL model

Variable	Description	Mean	Std. Dev.	Min	Max	Expected sign
Information costs						
PRICEINFO	1= I was not aware of the prevailing market price at all; 2= I had very little information about the prevailing market price, 3= I was somewhat aware of the prevailing market price; 4= I was fully aware of the prevailing market price	2.741	1.554	1	4	+/?
SEASONSALE	1 = cattle sold in December; 0 = otherwise	0.101	0.079	0	1	–
Negotiation costs						
DISTDUKUZA	Shortest road distance (km) from the community's dip-tank to the Dukuza dip tank auction (measured using GPS devices)	20.909	13.466	0	51.8	+
KNOWBUYER	1= knew the buyer ; 0= otherwise	0.141	0.110	0	1	+
CATTLEINCRANK	The rank of income from cattle sales in the household's income portfolio	3.369	1.765	1	5	–
Monitoring costs						
EXPDAMAGE	1 = experienced bruising and horn damages during transportation and handling at the market place; 0= otherwise	0.106	0.933	0	1	+
TRUSTBUYER	0= no trust in buyers in matters of grading and pricing; 1= somehow trust buyers; 2= total trust in buyers.	1.619	0.617	0	2	+
Farmer characteristics (i.e. control variables)						
TOTSOLD	Total number of cattle heads sold since 2009	1.773	4.275	0	40	+
BODYCOND	Body condition score for sold cattle. 1=very flat, 2=flat, 3=medium, 4=round, 5=very round	3.194	1.259	1	5	+
AGEHH	Age (in years) of the head of household	57.524	12.156	28	83	–
OLCMEMB	1= membership in Okhahlamba Livestock Co-operative; 0=otherwise	0.791	0.407	0	1	–
EDUCATION	0= no education, 1=primary/adult basic education, 2=secondary, 3=matriculated, 4=tertiary	1.239	0.798	0	4	+
OWNVEHIC	1= own a vehicle; 0=otherwise	0.356	0.480	0	1	+

On average, cattle (sales) were the third most important income earner in the household, reflecting the importance of non-commercial motives among surveyed households. Experience with incidents of damage during cattle marketing was minimal among surveyed households. Information in Table 5.2 shows that the level of trust between farmers and buyers was considerably higher in the sample.

5.3.3. MNL model diagnostics

The results of the MNL model are shown in Table 5.3. Each predictor was selected for the MNL regression based on the significance of its contribution across all outcome categories in the model, i.e. the Log-Likelihood ratio (LR) test for independent variables (Wooldridge, 2002). The correlation matrix in Appendix A3 shows that multicollinearity among selected independent variables was not a serious problem in the data. To test the assumption of independence of irrelevant alternative (IIA) in the MNL model, the study employed a classical procedure consisting of using a generalization of the MNL, called the nested logit model (Hausman and McFadden, 1984). Using a restricted choice set based on the deletion of auction or speculator alternative, significant changes in the estimated coefficients were not observed. This result was verified using the suest-based Hausman test (Long and Freese, 2005), based on which the null hypothesis of IIA could not be rejected. These diagnostics give credence to the results of the MNL model in Table 5.3.

5.3.4. The transaction cost effect in smallholder cattle marketing

Regarding information costs, the coefficient of the season of sale variable is negative and significant for both private sale (p-value=0.009) and speculator channel selection (p-value=0.010). Selling during the December festive month is associated with 18.8 and 13.0% decrease in the probability of selling to private buyers and speculators versus selling at the auction, respectively. To the extent that the increase in demand for beef towards the end-of-year festive season induces increased buyer turnout at the auction and auction scheduling, this finding suggests that selling at the auction is associated with seasonality-related market uncertainty. If a farmer is not sure about the buyer turnout at the auction barns, he/she may perceive a higher risk of uncompetitive price formation.

This perception could considerably reduce his/her willingness to incur the cost of cattle transportation to the auction pens. This finding confirms the view that, by marketing cattle at different times of the year, producers reduce the effect of market seasonality and mitigate the risk of selling in a bad market (Feuz *et al*., 2013).

Table 5.3. Determinants of cattle marketing channel selection using the multinomial logit model

Reference category: AUCTION	PRIVATE			SPECULATOR		
	Coefficient	Marginal Effect	p value	Coefficient	Marginal Effect	p value
Variable						
Information costs						
PRICEINFO	0.182	0.035	0.598	0.051	-0.008	0.877
SEASONSALE	-0.990	-0.188	0.009	-1.576	-0.130	0.010
Negotiation costs						
DISTDUKUZA	0.003	0.007	0.737	0.049	0.006	0.068
KNOWBUYER	2.531	0.211	0.132	3.005	0.172	0.002
CATTLEINCRANK	0.102	0.010	0.554	0.181	0.024	0.391
Monitoring costs						
EXPDAMAGE	-0.750	-0.124	0.401	-1.058	-0.032	0.503
TRUSTBUYER	-0.069	-0.071	0.800	0.622	0.074	0.286
Farmer characteristics (i.e. control variables)						
TOTSOLD	-0.213	-0.055	0.001	-0.101	0.013	0.085
BODYCOND	-0.630	-0.130	0.191	-0.925	-0.033	0.202
AGEHH	-0.071	-0.009	0.049	-0.025	-0.011	0.002
OLCMEMB	-0.808	-0.121	0.256	-1.221	-0.092	0.226
EDUCATION	0.241	-0.008	0.645	0.465	0.040	0.303
OWNVEHIC	0.338	0.186	0.114	0.129	-0.053	0.887

With regard to negotiation cost factors, Table 5.3 shows that the coefficient of distance to the auction marketplace is only significant for the choice between selling to a speculator or at the auction (p-value=0.068). As expected, this result suggests that, as distance between the community and auction marketplaces increases, cattle farmers selling at auctions face higher opportunity costs of time and effort to transport cattle if they can sell directly to speculators. These findings corroborate the findings of Musemwa *et al*. (2007), showing that accessibility and reliability constitute major attractions for auction sales among smallholder cattle farmers.

Expectedly, the coefficient of buyer knowledge turned out to be positive and significant for marketing with speculators (p-value=0.002). As the marginal effect suggests, this variable is a major predictor of marketing with speculators in the model. Other factors remaining unchanged, *a priori* knowledge of a prospective buyer increases the probability of selling to the speculator, vs. selling at the auction, by 17.2%. This finding indicates that the relationship with speculators decreases the cost of negotiating sales. This finding indicates the extent to which farmers selling to speculators face higher negation costs. If farmers' knowledge about the buyer is based on the previous sale transactions, this finding can portray the incidence of monitoring costs. As Dorward and Omamo (2009) document, repeated interaction is one of the mechanisms to ensure compliance in vertical co-ordination, as the prospect of continuing gains from future transactions may create incentives for not behaving opportunistically.

Some producer characteristics (i.e. control factors) turn out to be significant in the model. Contrary to the *a priori* expectation, the volume supplied has a significant effect on selling at the auction compared with private sale (p-value=0.001) and selling to speculator (p-value=0.085). *Ceteris paribus*, adding one animal to the supply volume increases the probability of selling at the auction compared with private sales and speculator by 5.5 and 1.3%, respectively. A plausible explanation is that, since the objective of transaction cost minimization goes hand in hand with production cost minimization, channel volume is an important factor (McNaughton, 1999). Farmers are able to spread transaction costs inherent in a market channel over the number of units sold as the channel volume increases. This constitutes the link between TCE and neoclassical microeconomics (McNaughton, 1999).

Lastly, the results show a significantly negative coefficient of farmer's age on the choice of speculator (p-value=0.002) and private sale channels (p-value=0.049) compared with dip tank sale. This result indicates that older and experienced farmers are not likely to sell at farm gate when they can sell at the auction. In line with the theoretical expectation, this result infers that, as cattle farmers get more managerial and marketing skills through

experience, they gain ability to co-ordinate market transactions at much lower cost. This result indicates higher costs of transaction associated with marketing at the dip tank sales. However, the positive effect of age on the decision to sell at the auction is contrary to the findings of the case study in the Eastern Cape province, showing that older farmers do not sell their cattle at the auctions (Musemwa *et al*., 2007). The authors argued that this negative effect of age is because older farmers tend to keep their cattle mainly for cultural purposes. However, as mentioned in section 1.2.3, the analyses in Musemwa *et al*. (2007) were only descriptive and case-specific.

5.4.   Summary

In this empirical chapter, the effects of transaction costs on smallholder farmer's choice of cattle marketing channel are investigated. Unlike previous studies that provide descriptive, case-specific information about various transaction costs faced by smallholder ranchers in different parts of rural South Africa, this study tests the effects of three major categories of transaction costs, namely information, negotiation and enforcement costs for the purpose of drawing inferences. As the MNL estimation results show, selling during the December festive month is associated with a decrease in the probability of selling to private buyers and speculators versus selling at auction, respectively, suggesting the scope of market uncertainty during off-peak seasons. The coefficient of distance to auction marketplace is only significant for the choice between selling to speculator or at the auction, suggesting high opportunity cost of time and effort to sell at the auction pens. The positive and significant coefficient of buyer knowledge turned for marketing with the speculator indicates the higher cost of negotiation and monitoring when dealing with speculators. The significant effect of volume supplied on selling at the auction versus farm gate sale shows that the transaction costs are spread over the number of units sold. Lastly, a significantly negative coefficient of farmer's age on the choice of speculator and private sale channels versus dip tank sales suggests that marketing skills are acquired with experience.

CHAPTER 6 : CONCLUSIONS AND RECOMMENDATIONS

6.1.   A recapitulation of the purpose of the study

The poor performance of agriculture in SSA, where the agricultural sector remains the engine of overall growth, poverty alleviation and food security, has been attributed to the lack of access to basic market infrastructure and other public goods in regions of high-potential for agricultural production. This situation is the source of South Africa's dual agricultural market economy, characterized by multiple equilibria, with a high-level equilibrium associated with technological advance and access to private and public goods, and a low-level equilibrium pertaining to smallholder farmers.

The challenges to pro-smallholder market development are more pronounced in the country's livestock sub-sector in which cattle farming remains a multifunctional livelihood strategy for over three million subsistence farmers living in marginal and remote areas. Despite the increasing demand for livestock products in the country, and the current policy strategies aimed at transforming the sector towards a fully fledged commercial industry, empirical evidence shows that the livestock market remains characterized by low participation rates among smallholder cattle farmers citing, among other challenges, lower productivity and poor marketing conditions.

In KZN, a province contributing about 11% to South Africa's total beef production, despite the higher provincial budget allocated to agricultural extension, empirical studies investigating the demand for, and effectiveness of, the current extension models are rare. Moreover, there are no studies investigating the challenges and barriers to cattle commercialisation among smallholder farmers such as transaction costs and non-commercial motives. Therefore major insights into the sustainability of commercial cattle farming are lacking for policy formation purposes. Against this backdrop, the present study conducted four empirical investigations. Based on the PSM approach, the first and second objectives were to estimate the influence of certain micro-level factors on the demand for agricultural extension information and to calibrate the impact of such information on cattle production, respectively. The third objective was to examine the

transaction cost and motivational effects on cattle market participation and supply volume decisions, using a Double-Hurdle regression model. The fourth objective was to empirically measure the various transaction costs influencing cattle marketing channel selection, using the multinomial logit model. The models were based on a dataset compiled from a household survey of 230 cattle farmers in 13 communities of the Okhahlamba Local Municipality.

6.2. Conclusions

The probit model of extension programmes participation showed that more educated farmers, Nguni cattle farmers and farmers with relatively fewer cattle have lower propensity to participate in government-run extension programmes. The propensity increased with group membership, distance from the extension office and use of forage and feed supplements.

As part of the second objective, the propensities from the extension participation model were matched using the Nearest Neighbour and Kernel algorithms, to estimate the average treatment effect on the treated. Signs of benefits from participating in livestock extension programmes in terms of cattle production and input use were not sufficiently strong. The matching results suggest that farmers participating in livestock extension programmes produce more calves than their counterparts, whereas those that participate in farmer-to-farmer extension sessions have higher rates of use of veterinary services than their counterparts. However, these findings were not robust across different estimates. This indicated the limited success of the T&V approach. Together with the results of the participation model, these findings revealed that the livestock extension service delivery in KZN remains largely supply-driven and technology-focused.

With regard to the third objective, the results of the Double-Hurdle econometric estimation showed that farmers with larger herd sizes are more likely to participate in cattle markets and, given positive decisions, they tend to supply larger volumes of cattle to the market. The results showed that the decision to participate in cattle markets is positively influenced by saving groups (or *stokvel*) membership, Nguni breed farming

and cattle tagging. It was negatively affected by proximity to water sources and reliance on unearned income. Given positive participation decisions, further results indicated that the volume supplied tends to increase with participation in farmer-to-farmer extension and decreases with expected price. These findings indicated both transaction cost and motivational effects in cattle commercialization.

Regarding the fourth objective of the study, the results of the MNL model unveiled some unique insights into cattle marketing behaviour. With regard to information costs, the results suggested that market uncertainty during off-peak season pushes smallholder farmers to self-select out of cattle auctions. They also showed that farmers selling to speculators face considerable challenges related to low bargaining power, while those who participate in dip tank auction sales face higher opportunity costs of time and efforts to transport their cattle. Lastly, the results indicated that farmers spread auction-specific transaction costs over the number of units sold as the channel volume increases, and they gain the ability to co-ordinate market transaction at much lower cost through experience. Overall, the effect of transaction costs was more pronounced among farmers who market their cattle with auctioneers and speculators. These findings endorse the view that a private sale is the simplest form of cattle marketing in rural South Africa.

6.3. Policy recommendations

This study comes at a time when South Africa is at a crossroads in its quest for appropriate extension models. Recently, the national DAFF undertook a consultation process expected to culminate in drafting of the first national policy on extension and advisory services. A broad-based, research-led dialogue underpins the process. The empirical findings of this study can be informative to extension strategists in the design of effective strategies to ensure improved cattle productivity, increased commercialization and better marketing among smallholders in rural South Africa.

The limited impact of the largely supply-driven extension model underscores the need to improve the effectiveness of public agricultural service delivery. This suggests a need for exploring alternative agricultural extension approaches that focus more on the specific

needs of farmers. Alternative models should actively engage farmers and researchers in a learning process to which extension workers are simply facilitators. Leveraging on farmers' strengths (i.e. their experiences and assets), these approaches can ensure the optimal realization of their livelihoods' potential.

The limited success of current extension programmes signifies the need for making the extension service delivery more demand-driven. In this endeavour, the upcoming policy should provide for strategies to ensure the accountability of extension workers at local level. Decentralization offers an appropriate turnaround strategy through devolution and deconcentration. This includes the transfer of agricultural extension budget authority to smaller local government units such as the ward. The limited success of the state-led livestock extension service delivery can be also addressed by tapping into market-based extension models. To overcome the market failure discussed in section 2.2.3, extension services delivery can be integrated into institutional arrangements such as contract farming.

For cattle commercialization, the significantly positive effect of community based groups, such as farmer-to-farmer extension and *stokvels*, on cattle commercialization implies that livestock extension systems should support cattle farmers' group formation and involvement. This point supports the current extension strategy that provides a supporting environment through which these groups can thrive (including interventions such as management capacity building). Such groups should, however, not be viewed simply as "contact groups" that transmit messages from extension agents, but as active players in the function of extension services. The significant effect of compliance with the Livestock Identification Act necessitates supporting smallholder cattle farmers' groups to expand the scope of their mandates. The groups should ensure the fast-tracking of the identification process through improved access to facilities and reduced costs. Therefore the groups should be facilitated to access appropriate forums for decision-making (e.g. municipal board meetings).

With the significantly negative effects of expected price and unearned incomes on cattle commercialization, the extension policy-makers and strategists in South Africa should be mindful of the wealth storage motive among cattle farmers when designing livestock marketing strategies. Promoting alternative and more attractive investment opportunities, or reducing the attractiveness of cattle as a store of wealth, could have a positive effect on cattle commercialization in the rural areas. Among such avenues, fast-tracking the ongoing implementation of the land reform policy in South Africa can play a catalytic role, as title deeds make landholding an alternative investment option. Also, the natural resource management policy strategies such as grazing control measures (particularly the introduction of permits, subdivision of ranges for private grazing, or direct control over the maximum herd size per individual farmer) can reduce the attractiveness of cattle as a store of wealth (Jarvis, 1980).

The results of the empirical model of cattle marketing channel selection suggests that livestock extension strategists should explicitly take into account the transaction costs of livestock marketing. The market uncertainty and the higher negotiation costs associated with cattle auctioneering signify the need for exploring the feasibility of alternative types of cattle marketing that mitigate the transportation costs and reduce the probability of a non-sale. The video auction, for example, provides an alternative option that allows larger segments of prospective buyers to participate during the auctioneering process (thus allowing the auction price to be a better reflection of the market value), while the producer obtains a "forward" price before transporting his cattle to the auction pens. This requires concurrent efforts to improve the cattle body condition, using strategies such as communal feedlots (e.g. the custom feeding programme in the Eastern Cape province), in order to reduce the gap between farmers' expected prices and bidded prices.

The incidence of negotiation and monitoring costs associated with selling to speculators requires the development of institutional environments through which market co-ordination and soft enforcement mechanisms can thrive. For example, dynamic incentives in the form of trust-based relational exchanges offer an appropriate means for eschewing the scope of opportunism among itinerant speculators. This consideration is

even more appropriate for communities with limited access to legal recourse. The custodians of the livestock extension policy should devise platforms, such as agricultural/livestock shows and field days, to facilitate the formation of bonding and bridging social capital among key industry stakeholders (including farmers, speculators, auctioneers, butchers and feedlot companies). Llivestock extension programmes should facilitate the emergence of an effective reputation mechanism among speculators through transaction information recording and sharing.

6.4.   Areas for further research

It is noteworthy that the empirical basis of these recommendations needs to be furthered and reassessed in different spatial and time circumstances. Methodologically, comparison of findings at different times and spaces is desirable for lending credence to the results and giving additional insights into policy. Further empirical endeavours can validate the robustness of these findings. For example, in-as-much as increased cattle production is expected to alleviate the transaction costs and encourage commercialization, there is a need for empirical investigation into cost-effective and efficient ways of combining resources in producing cattle in rural South Africa. Moreover, given that cattle prices are only known after the production decision and calves have grown up, there is a need to study farmers' adaptive expectations within the supply response framework.

This study has emphasized the production and commercial functions of cattle farming, despite the widely recognized multifunctionality of livestock farming. It provides only a limited perspective to the understanding of the potential of cattle farming for rural development, something that can hamper the formulation of effective policy strategies. There is a need for appraising the costs and benefits of tangible and intangible functions of cattle farming, taking into account the institutional and socio-cultural environment of farmers.

With regards to marketing, although this study has been instrumental in uncovering the transaction cost factors influencing cattle marketing channel selection, little remains known about the optimal number of cattle to be allocated to various channels under

different risk scenarios. This exercise can provide useful insights into the allocation proportions that can ensure optimal earnings under the prevailing market structures and price settings. The role of agricultural extension workers in agricultural marketing needs to be further investigated. There is a lack of empirical assessment of specific marketing-related services performed by extension personnel. This endeavour can be instrumental in identifying trainings gaps in marketing skills that require urgent attention.

6.5. Recommendations for practice

Based on the empirical evidence in this thesis, and bearing in mind its limitations, a number of recommendations can be made to the livestock practitioners in rural areas on how to commercialize cattle farms, with the goal of maximizing productivity and minimizing market transaction costs. The positive effect of farmer groups on participation in livestock marketing, coupled with the positive effects of herd size and supply volume on cattle commercialization and auctioneering, respectively, suggests that farmers in the region should uphold the livestock co-operative. The livestock co-operative allows farmers to capitalize on scale economies to seek direct contact with extension personnel at much lower cost, or increases the ease with which extension workers reach out to a large number of farmers. However, the vanishing impact of extension programmes on cattle production signifies the importance to be attached to the problem-solving approach discussed in section 2.2.2. Co-operative leaders should elect "competent" farmers to decide on the type of extension information required by farmers and serve as a basis for extension advice. Such endeavour could increase the relevance of extension services in the region and change the *status quo*.

Co-operative leaders could play a vital role in the design and implementation of strategies to reduce market uncertainty and reduce the higher negotiation costs associated with cattle auctioneering, as well as the incidence of negotiation and monitoring costs associated with selling to speculators. Co-operative leaders in various regions should set up information management systems to ensure that their members obtain "forward" information about the price and other conditions they can expect at the auction barns.

Collective action is indispensable to promote bonding with itinerant speculators and to record and maintain transaction information.

6.6. Thesis dissemination

The uptake of the recommendations in this thesis can serve as a basis for possible confirmation/rejection of the findings of the study. For wider dissemination of the information contained in this thesis, the empirical findings have been presented in scholarly conferences and published in internationally accredited journals. The thesis has also been electronically archived in digital and physical repositories in the UKZN library. In the study area, the results will be disseminated using oral and poster presentations during the workshops organized for livestock farmers and extension workers.

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APPENDICES

APPENDIX A: TABLES

Table A1. Correlation matrix for independent variables used in the probit model of participation in livestock extension programmes

	Age	Primary	Secondary	Matric	Gender	House hold size	Membership in OLC	Distance to Bergville	Vehicle	Breed	Herdsize	Calves	Salt	Veterinary	Forage	Feed suppl
Age	1															
Primary	0.211	1														
Secondary	-0.258	-0.656	1													
Matriculated	-0.222	-0.239	-0.129	1												
Gender	-0.142	-0.133	0.217	0.0219	1											
Household size	-0.126	0.004	0.017	0.0316	-0.070	1										
Membership in OLC	-0.017	-0.026	0.082	-0.2064	0.194	-0.076	1									
Distance to Bergville	-0.073	-0.102	0.029	0.087	0.196	-0.180	-0.014	1								
Vehicle	0.013	0.019	0.023	0.017	0.01	0.158	-0.139	0.014	1							
Breed	0.091	-0.134	0.050	0.084	0.021	0.095	-0.017	0.024	0.024	1						
Herdsize	-0.214	-0.148	0.249	0.038	0.172	0.110	0.008	0.154	0.174	0.146	1					
Calves	-0.155	-0.109	0.202	0.064	0.061	0.101	-0.074	0.024	0.149	0.092	0.760	1				
Salt	-0.036	-0.082	0.072	0.066	0.089	-0.017	0.038	0.138	0.095	-0.078	0.131	0.025	1			
Veterinary s	-0.023	-0.164	0.132	0.169	0.031	0.041	-0.067	0.184	-0.013	0.247	0.192	0.138	0.086	1		
Forage	0.161	-0.063	0.105	0.069	0.104	-0.028	-0.085	-0.050	0.202	0.168	0.010	0.019	0.189	0.280	1	
Feed suppl	0.004	-0.187	0.185	0.022	0.153	-0.054	0.058	0.095	0.096	0.077	0.191	0.133	0.191	0.402	0.296	1

Table A2. Correlation matrix for independent variables used in the Double –Hurdle econometric model of cattle market participation

	SNOWL OSS	DROUG HTLOSS	BIRTHD AYHHH	EXTCO NTACT	OLCM EMB	F2FEXT	SAVG ROUP	TRACT OR	DISTD UKUZA	HERDSIZ E	CATTLE BREED	DISTWA TER	CATTLE TAG	UNEARN EDRANK	EXPP RICE
SNOWLOSS	1														
DROUGHTL OSS	0.1452	1													
BIRTHHHH	0.0241	0.0796	1												
EXTCONTAC T	0.1205	0.0594	-0.0370	1											
OLCMEMB	0.1163	-0.0147	0.0221	0.2555	1										
F2FEXT	0.0663	0.1317	0.0903	-0.1717	-0.1221	1									
SAVGROUP	0.0418	0.0065	0.0303	0.0696	-0.0800	0.0480	1								
TRACTOR	0.0669	0.0434	0.0267	0.0913	-0.0325	-0.0158	-0.0058	1							
DISTDUKUZ A	-0.0850	-0.1961	0.1165	0.0147	0.0715	-0.0810	0.0331	-0.0281	1						
HERDSIZE	0.2181	-0.0110	0.2058	0.1714	0.0034	0.0208	-0.0798	0.1048	-0.0403	1					
CATTLEBRE ED	0.0443	-0.0753	-0.0583	0.2056	0.0216	-0.1726	0.1313	0.1221	-0.0158	0.0845	1				
DISTWATER	0.0111	0.0598	-0.0814	0.2038	0.0987	-0.1051	-0.0111	0.0153	-0.1732	0.0771	0.1657	1			
CATTLETAG	0.0362	0.1190	0.0276	-0.0510	0.0406	0.1100	0.0545	-0.0745	-0.0042	0.1230	0.0687	-0.0812	1		
UNEARNEDR ANK	-0.0091	0.1165	-0.0196	-0.0799	-0.1016	0.0022	0.0473	-0.0646	-0.2057	-0.1394	-0.0122	0.0618	-0.0691	1	
EXPPRICE	-0.0273	0.0202	0.0150	-0.0494	-0.0362	0.0799	-0.0168	0.0141	-0.2121	-0.0048	0.0779	0.0896	-0.0254	0.0001	1

Table A3. Correlation matrix for independent variables used in the multinomial logit Model of cattle marketing channel selection

	PRICEINFO	SEASON SALE	DIST DUKUZA	KNOW BUYER	CATTLE INCRANK	DAM AGE	TRUST BUYER	TOT SOLD	BODY COND	AGE HH	OLC MEMB	EDU CATION	OWN VEHIC
PRICEINFO	1.0000												
SEASONSALE	0.029	1.000											
DISTDUKUZA	-0.037	-0.105	1.000										
KNOWBUYER	-0.116	0.040	-0.059	1.000									
CATTLEINCRANK	0.118	0.038	-0.149	0.081	1.000								
DAMAGE	0.014	0.020	0.183	0.104	-0.082	1.000							
TRUSTBUYER	0.019	0.058	0.043	0.043	0.025	0.119	1.000						
TOTSOLD	0.060	0.044	-0.114	0.118	0.076	0.074	0.050	1.000					
BODYCOND	-0.011	0.076	-0.449	0.075	0.103	0.011	-0.038	0.014	1.000				
AGEHH	-0.122	-0.013	-0.033	-0.015	-0.124	-0.049	-0.19	-0.179	0.013	1.000			
OLCMEMB	-0.209	0.008	-0.001	0.041	0.026	-0.161	-0.032	-0.256	0.033	0.086	1.000		
EDUCATION	0.220	0.062	-0.083	-0.111	0.063	-0.085	0.068	0.101	0.166	-0.311	0.000	1.000	
OWNVEHIC	0.051	-0.020	-0.023	-0.147	0.012	0.040	0.247	0.192	-0.078	0.076	-0.077	0.231	1.000

APPENDIX B: HOUSEHOLD SURVEY QUESTIONNAIRE

<div style="text-align:center">

A. SURVEY QUALITY CONTROL

</div>

QUESTIONNAIRE NUMBER _____ ENUMERATOR NAME_____

COMMUNITY NAME _____ NAME OF RESPONDENT _____

DATE OF INTERVIEW: _____ _____ RELATION TO HEAD OF HOUSEHOLD _____ ____

DURATION OF INTERVIEW (MINUTES) _____MIN DIP TANK NAME _____

<div style="text-align:center">

A. Household's human capital

</div>

A.1. Household demographics		A.2. Household Head (hhh)	
a. What is the household size ?		a. What is the year of birth?	
b. What is the number of household members going to school?		b. What is the gender (1=Male 0=Female)	
c. How many household members are employed?		c. What is the marital status? (1=married;2=widowed;3=never married)	
d. How many household members are unemployed?		d. What is their education level? (0= never went to school; 1=Primary/ABET;2=Secondary (incomplete);3=Matriculated 4=Tertiary)	
e. How many are over 60 (pensioners) years old?		e. For how many years have they been a farmer?	
f. How many are pre-school children?		f. Does the household live on the farm? (0=no;1=yes)	

<div style="text-align:center">

A.3. Access to extension services *[Record only for the last 3 years 2009 – 2011]*

</div>

	a. Government extension staff	**b.** Farmer-to-Farmer	**c.** NGOs	**d**. Private companies
1. How many times did you receive a training or participated in information session from this source?				

<div style="text-align:center">

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</div>

2. What training did you receive from the source on cattle? (1=cattle production (breeding, feeding, health, etc); 2= managerial and financial skills; 3= marketing skills).				
3. Which agricultural services did you receive from this source? (0=none; 1=dipping; 2=dehorning; 3=castration; 4=veterinary service; 5=branding/tattoos; 6=supplements)				
4. Did you receive any market information (e.g. prevailing price, standards, grading, and other market conditions, etc.) from this source? (0=no;1=yes)				
5. Did this source provide transport to the market? (0=no;1=yes)				

B. Household's social capital

B1. For how long (in years) have you been living in this community?	
B2. Relationships of trust, reciprocity, and exchange in the community (0=no;1=yes)	
a. Do you have relationships based on mutual trust (including money lending) with neighbouring farmers?	
b. Do share farming equipment and experience/knowledge with neighbouring farmers?	
c. Do you have relationships based on mutual exchange of cattle power (for ploughing…) with neighbouring farmers?	
d. Do relationships based on mutual exchange of gifts (manures, cows, milk) and invites with neighbouring farmers?	
B3. Are you currently a member of Okhahlamba Livestock Co-operative ? (0=no;1=yes) If yes proceed to B4. If no go to section C	
B4. What year did you join the coop/association	

C. Household's financial capital *[Record only for the last 3 years]*

C.1. Savings	(Code: 0=no; 1=yes)	C.2. Credit	(Code: 0=no; 1=yes)
a. Do you have a bank account?		a. Have you ever contracted for a loan from a formal bank?	
b. Are you a member of a formal or informal saving group?		b. Have you ever contracted for a loan from a saving group?	

C.3. Regular inflows of money: What are your major sources of income?	Rank (rank from 1=most important sources of income to 5=least important)
Own cattle farming activities	
Farm wage work	
Self employment in non-farm activities	
Wage employment in non-farm activities	
Unearned incomes (pension, social grants, remittances, etc)	

D. Household's physical capital

D.1. Basic household asset	(Code 0=no; 1=yes)	D.2. Household producer goods	
a. Do you own a vehicle?		a. Do you own a cattle sprayer	
b. Do you own a cell phone? (0=no; 1=yes)		b. Do you own a cattle kraal?	
c. Do you own a radio/TV set? (0=no; 1=yes)			
d. Do you have electricity in your house?(0=no; 1=yes)		c. Do you own a tractor?	

E. Household's natural capital

E.1. Cattle grazing	
a. Where do your cattle graze? (1=paddock;2=communal grazing area;3=tehtherd;4=field(not in use);5=forest)	
b. Is the grazing area adequate to feed cattle? (0=no;1=yes)	
c. Is the quality of grazing good? (0=no;1=yes)	
E.2. Ecosystems goods and services	
a. Do you collect grass for animal feed from communal lands? (0=no; 1=yes)	
b. Do you use cattle manure for organic land fertilization? (0=no; 1=yes)	
c. Do you use crop residue for organic land fertilization? (0=no; 1=yes)	
d. Do you use crop residue for cattle feeding? (0=no; 1=yes)	
e. What is the source of drinking water for cattle?(1=dam;2=river;3=pond)	
f. How many minutes does it take to walk to the nearest cattle water source from the household?	

F. Cattle management *[Record only for the last 3 years 2009 – 2011]*

Current cattle herd composition

Number of …	F.1. Total number	F.2. Breed			F.4. Mode of acquisition				
		Nguni	Exotic	Mixed	Bought	Produced on the farm	Given	Inherited	Other (specify)
a. Calves									
b. Heifers									
c. Steers/Oxen									
d. Cows									
e. Bulls									

Input use

F.5. Cattle identification	(Code: 1= given names; 2=tags; 3= other/specify)	
a. How do you identify your cattle?		
F.6. Productivity enhancing inputs	0=no; 1=yes	Expenditure in ZAR
a. Did you use mineral salt blocks ?		
b. Did you use veterinary services?		
c. Did you use forage (grass, silage, legume etc)?		
d. Did you use feed supplements (e.g. grains, soy, etc)?		
F.7. Experience with adverse biophysical conditions	0=no; 1=yes	Number of cattle deaths
a. Heavy snow		
b. Prolonged droughts		
c. Floods		
d. Diseases		
e. Pests/Parasites		

G. Cattle commercialization and marketing transactions *[Record only for the last 3 years 2009 – 2011]*

		Private buyers	Speculators	Auction	Butchery	Abattoir
G.1. Did you sell any cattle through this channel? (1=yes; 0=no)						
G.2. What was the number of cattle sold?	a. Calves					
	b. Heifers					
	c. Cows					
	d. Steers/ Oxen					
	e. Bulls					

G.3. How were you paid in this transaction (1= kind/barter trade; 2=cheque; 3=cash)						
G.4. If cash or cheque, for how much in ZAR did you sell your cattle?						
G.5. Did you sell during the December (festive) month? (1= yes; 0=no)						
G.6. Did you prepare the cattle before selling? (washing, dipping, feeding, supplements, etc)? (0=no; 1=yes)						
G.7. What was the physical condition of the cattle sold? (1=very flat, 2=flat, 3=medium, 4=round, 5=very round)						
G.8. How did you advertise your cattle for sale on the market? (0=did not advertise; 1=announcement at community gathering; 2=poster at farm gate/ in public places/taxi)						
G.9. What was the cost of transportation to the market in ZAR?						
G.10. Did you experience bruising and horn damages during transportation and handling at the market place? (1=yes; 0= no)						
G.11. Did you know the prevailing market price at the time of sale? (1= I was not aware at all; 2= I had very little information, 3= I was somehow aware; 4= I was fully aware)						
G.12. Did you have a priori knowledge about the buyer before the transaction? (0=no; 1=yes)						
G.13. Did you trust the buyers in matters of grading						

and pricing (0= no trust at all; 1= somehow trust buyers; 2= total trust in buyers).					
G.14. Did you try bargain for the selling price on this market? (0=had no bargaining power; 1= had little bargaining power; 2=had sufficient power to bargain for the price)					
G.15. How many negotiation rounds did you have before agreeing on the price?					
G.16. How long did it take for you to get paid (days)					

H. Perceived challenges and barriers to cattle production, commercialization and marketing

H.1.What challenges/barriers do you face in cattle management? (Rank)	**Rank (1=least -8 most important)**	**Possible solution**
Lack of grazing land		
Shortage of quality cattle feed		
Lack of water		
Lack of parasites and disease control		
High mortality		
Lack appropriate skills for cattle production		
Poor extension services (veterinary)		
Lack of functional dip tank		
Stock Theft		
Lack access to markets		
Other (specify)		

H.2.What challenges/barrier do you face when selling cattle	Rank(1=least – 18 most important)	Possible solution
Lack of market infrastructure (loading ramps, sale pens)		
Lack of buyers		
Few buyers		
Market is too far		
Lack of transport to market		
Poor road networks to market		
Expensive to travel to market		
Lack of access to credit (buying cattle feed etc.)		
Lack of markets		
Lack of training (marketing, breeding etc)		
Lack of information(market prices, available markets)		
Lack of bargaining power (ability to negotiate the price)		
Not knowing/understanding how the market operates (how the price is determined, grading system)		
Poor quality animals		
Small herd size		
Lack of market organizers		
Not knowing seasonal price movements		
Market formalities/regulations (veterinary stock movement permit, registered brand mark)		
Other (specify)		

Thank you for your participation