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Abstract

This article leverages on the application of the sustainable livelihood framework (SLF) to analyze quantitatively the broader livelihood factors confounding cattle market participation in the Okhahlamba Local Municipality (OLM) for the purpose of informing agricultural extension programmes in South Africa. It uses a dataset compiled from a household survey of 230 randomly selected cattle farm households from 12 dip-tank users associations (DUAs). Within the framework of household model, it uses a Double-Hurdle econometric estimation technique to calibrate the effects of factors in various components of the SLF on market participation and supply volumes decisions. On the basis of sample evidence, the study finds that cattle market participation by OLM smallholders is significantly hindered by inadequate access to agricultural extension and financial systems, limited productivity of local breed, as well as non-compliance with cattle registration regulations. It reveals further that the differences in livelihood strategies explain the observed rates of market participation among smallholder cattle farmers in the municipality, whereas price signals are taken into account only after positive market participation decisions have been made. Based on these results, the study outlines potential extension models required for the South African public extension architecture to promote innovation that addresses the complexity of revealed challenges. Generally, this bottom-up approach gauges the need for a pluralistic agricultural extension approach (mainly by the farmer extension groups model) for a pro-poor agricultural market development in South Africa.

Introduction

Market participation is an important ingredient for agricultural and rural development among developing countries. The smallholder farming systems' commercialization through active cattle market participation has the potential to exploit developing regions' comparative advantages and transform their rural economies (Boughton et al. 2007; Rios, Shively and Masters 2009). Notably, commercializing farming systems leads to increased productivity and improved quality of produce which may contribute to improved incomes generated from market participation. Hence, market participation by smallholder cattle farmers have the potential to lead to specialized, market-oriented farming systems (Rios, Shively and Masters 2009).

Market participation is such a unique factor in the rural development field since it is a result of development and a factor that brings about development (Barret 2008). In South Africa, the recent cattle market revolution brought about by high population and income growths, urban migration, globalization, and their associated changes in lifestyles and consumer preferences, has presented new opportunities for smallholder livestock farmers to integrate in the market economy (Delgado, Rosegrant and Meijer 2001; Coetzee, Montshwe and Jooste 2005; Uzchezuba et al. 2009). Cattle production contributes to the South Africa's national agricultural GDP to levels between 25-30% per annum (Musemwa et al. 2008).

In addition to its national economic importance, cattle production is a key livelihood strategy of the rural livelihood systems in South Africa, where around 40 % of the total cattle herd size is owned by communal and emerging farmers (South Africa 2011). Cattle production by smallholder farmers constitutes a major livelihood strategy particularly for farm households living on in marginal areas with degraded lands and meager economic opportunities and such as the Okhalhamba Local Municipality (OLM) of the uThukela District, KwaZulu-Natal Province. The most recent municipality's Integrated Development Plan reports that around 36% of household do not receive any income, whilst 37% earn only R1-R9,600 per annum (Okhahlamba Local Municipality 2012). As documented by studies such as Bollinger (2007) and Elledoubt (2012), around 55% of these economically underserved households own livestock.

Nevertheless, empirical evidence shows that the livestock market in South Africa remains characterized by low participation rates among smallholder cattle farmers. Indeed, cattle supply was found to be directly proportional to the holding, with rates of 33% for herder of 10 or less cattle, 52% for 11-20 cattle herders, and 85% for 20 or more cattle herder (Coetzee, Montshwe and Jooste 2005; Lehloenya, Greyling and Schwalbach 2007; Musemwa et al. 2007; Groenewald and Jooste 2012). According to the land tenure, there is a

low off-take rate of between 5-10% among communal farmers compared to 25% for commercial farmers (Musemwa et al. 2010).

As the economic theory explains, agricultural markets, particularly in developing countries, are characterized by high incidence of transaction costs (Key, Sadoulet and de Janvry 2000). The extent of these costs largely depends on household's capability, as defined by its endowment (education, physical infrastructure, social networks, etc) and access to public goods such as extension, roads, information broadcasting (Barret 2008). Moreover, there is a body of economic literature contending that in southern African countries cattle is kept for a wealth storage rather than income generation motive (Doran, Low and Kemp 1979).

Within the framework of transaction cost economics, the results of a number of recent economic studies calibrating the effects of household-level and access factors on cattle market participation in South Africa have positioned agricultural extension at the forefront of policy strategy that addresses this challenge, as access to agricultural extension is revealed as a significant constraining factor (Bahta and Bauer 2007; Uchezubal, Moshabele and Digopo 2009). Indeed, the recent decades were marked with a considerable paradigm shift in the extension intervention approaches in South Africa, from a top-down, commodity-focused, production-technology-led 'diffusion model' or 'technology transfer model' of extension delivery towards models that emphasize on the farmer-centered, participatory and system approaches to rural development addressing real farmers' needs and spurring innovation (Duvel 2000; Coetzee, Montshwe and Jooste 2005; Ponniah et al. 2008; Swanson and Rajalahti 2010).

Nevertheless, empirical studies in South Africa continues to consider agricultural extension hypothetically as a discrete or standalone ingredient to estimate the extent to which access to extension services can offset or moderate the incidence of high transaction costs and other challenges and barriers to livestock market participation. To the best of authors' knowledge, there is no study that has explored the integrative nature of modern agricultural extension approaches to solving agricultural market participation issues in a participatory manner. This creates a vacuum in the understanding of their relevance of their models and methods in approaching the complexity of real farmers' issues.

Towards a more practical approach, the sustainable livelihood framework (SLF) (see figure 1 in the appendices) presents two unique advantages over any other analytical frameworks for analyzing and addressing the market participation challenge by agricultural extension stakeholders. 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 drivers of market participation outcome) (DFID 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). In line with appropriate extension models for South Africa (Duvel 2000), the SLF is, in principle, a responsive and participatory

programming framework that builds on people strengths when attempting to overcome the challenges and barriers on a multi-level basis (DFID 1999).

Leveraging on this unique appeal, this article aims to estimate empirically the effects of factors under different SLF components on market participation decisions among smallholder cattle farmers in the context of OLM for the purpose of programing appropriate agricultural extension models and methods.

The remainder of this article is subdivided into five sections. The subsequent section pictures the cattle farming in OLM, the study area of this research. It is followed by a methodological section outlining the theoretical basis as well as the empirical strategy of this article, a section describing and discussing the results of empirical models, and a section drawing the implications for agricultural extension programming. A concluding section is drawn thereafter.

Study area

This study was conducted in Okhahlamba Local Municipality (OLM), a 344,000ha municipality in the UThukela District of the KwaZulu-Natal Province. The 2007 population census indicates that the municipality is inhabited by 151,414 people (or 28,508 households), majorly traditional households (56%), illiterate (38%), and living on communal lands (OLM 2012). Vast majorities 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) (OLM 2012). As reported by the municipality's reports, the harsh economic conditions are such that around 36% of household do not receive any income, whilst 37% earn less than R9,600 (around US$1,100) per annum (OLM 2011).

As shown by the land cover map in figure 2, commercial and subsistence farming coexist in this region, although geographically separated (a legacy of the segregationist regime). Smallholder farmers, mainly engaging in maize, vegetable, and livestock production, occupy the marginal areas, majorly the foothills of the Drakensberg mountain chain, characterized by low-fertility lands (Elleboudt 2012). Although only 22% of the economically active population engage in agriculture (OLM 2012), 55% of households living on communal land report to engage in livestock farming, mainly consisting of cattle, goats and sheep (Elleboudt 2012). Mixed livestock-crop farming system is a special feature of agriculture in the foothills of Drakensberg region, where grazing is scheduled such that cattle is sent uphill during cropping season (summer), while all the land becomes grazing land off-season (winter) (Elleboudt 2012). This creates overstocking tendencies among locals (with the associated environmental consequences), and the status quo is reinforced by the lack of property rights and enforcement mechanisms (such as fencing). The area is also know to experience harsh climatic conditions, characterized by an interchange of droughts conditions in summer and heavy snow in winter, making the palatability of the natural grasslands very seasonal, and farmers have to provide supplementary feeding (Elleboudt 2012).

Material and methods

The theoretical basis

The conceptual underpinning of this study relies on the agricultural household model elicited by Bellemare and Barrett (2006), a dynamic generalization of the structural model developed by Key, Sadoulet and de Janvry (2000). Under this framework, in period *t*, a livestock farmer, even before knowing about the shadow prices for buying or selling ($p^{b}*$ or $p^{s}*$), decides whether or not to participate in the cattle market at time r=0. Subsequently, at time r=1, if he/she has decided to participate in market (in r=0), he/she receives additional market information and decides on the quantity of cattle he/she will supply. The shadow prices are obtained by correcting the observed market price (p^{m}) for the proportional transaction costs (υc_{rt}), such that $p^{*b}=(1+ \upsilon c_{rt})p^{m}$ and $p^{*s}=(1 - \upsilon c_{rt})p^{m}$ (observed prices in future period, $t+1$, are adjusted for random variation with a stochastic term $z^{k}\ \forall\ \mathrm{k} \in \{p, fc, \upsilon c\}$.

Assuming that his/her livelihood objectives is to maximize the present value of future consumption streams (C_{rt}), the framework relates his optimal quantity bought ($Q^{b}*$) and (cattle) sold ($Q^{s}*$) to his livelihood attributes at the beginning of period *t*, including liquid but non-productive assets (W_{rt}), herd size (H_{rt}), and land (A_{rt}). These productive assets generate income streams measured as household consumptions ($Y_{rt}=y(H_{rt},A_{rt})$) and payment for other exogenous expenses such as dowry (X_{rt}). Considering g and δ as his within-period cattle growth rate and discount rate, respectively; fc_{rt} and e_{rt} as the fixed production costs and prevailing environmental conditions (including transport and fixed transaction costs), respectively; and I_{rt} as a selection indicator dummy variable that takes the value of 1 if the farmer decides to sell (i.e. $Q^{s}*>0$) or buy (i.e. $Q^{b}*>0$) at the market, and 0 otherwise; the sequential livestock market participation and supply decisions are solved by optimizing the following set of equations:

$$\underset{C_{rt}, I_{rt}^{j}, Q_{rt}^{j}}{Max}\ E_{rt}\sum_{r=0}^{1}\sum_{t=0}^{\infty}\delta^{t}U(C_{rt})\forall j \in \{b,s\} \tag{1}$$

Subject to

$$C_{rt} \le y(H_{rt}, A_{rt}) + W_{rt} - X_{rt} - (1-r)(I_{rt}^{s} + I_{rt}^{b})\, fc_{rt} + p_{rt}^{*s} I_{rt}^{s} Q_{rt}^{s} - p_{rt}^{*b} I_{rt}^{b} Q_{rt}^{b} \tag{2}$$

$$H_{1t} = H_{0t} + g(H_{0t}, e_{1t}) \ge 0 \tag{3}$$

$$H_{0t+1} = H_{1t} + g(H_{1t}, e_{0t+1}) + I_{1t}^{b} Q_{1t}^{b} - I_{1t}^{s} Q_{1t}^{s} \ge 0 \tag{4}$$

$$W_{1t} = W_{0t} - X_{0t} - C_{0t} + y(H_{0t}, A_{0t}) - (I_{0t}^{s} + I_{0t}^{b})\, fc_{0t} \ge 0 \tag{5}$$

$$W_{0t+1} = W_{1t} - X_{1t} - C_{1t} + y(H_{1t}, A_{1t}) + p_{1t}^{*s} I_{1t}^{s} Q_{1t}^{s} - p_{1t}^{*b} I_{1t}^{b} Q_{1t}^{b} \ge 0 \tag{6}$$

Based on the Bellman's necessary condition for optimality associated with the above-mentioned dynamic programming, Bellemare and Barrett (2006) draw the reduced form of livestock household's optimum decisions as follows:

$$I_{0t}^{b*} = i^{b}(A_{0t}, H_{0t}, W_{0t}, X_{0t}, e_{0t}, p_{1t-1}^{m}, fc_{0t}, \upsilon c_{1t-1}) \tag{7}$$

$$I_{0t}^{s*} = i^s(A_{0t}, H_{0t}, W_{0t}, X_{0t}, e_{0t}, p_{1t-1}^m, fc_{0t}, \upsilon c_{1t-1}) \quad (8)$$

$$Q_{1t}^{b*} = i^b(A_{1t}, H_{1t}, I_{0t}^s, W_{1t}, X_{1t}, e_{1t}, p_{1t}^m, \upsilon c_{1t}, z_{1t}^k) \quad (9)$$

$$Q_{1t}^{s*} = i^s(A_{1t}, H_{1t}, I_{0t}^s, W_{1t}, X_{1t}, e_{1t}, p_{1t}^m, \upsilon c_{1t}, z_{1t}^k) \quad (10)$$

By treating the pair of $\left\{I_{rt}^{b*}, I_{rt}^{s*}\right\}$ as an ordinal variable of net sales (from the net buyer, to autarkic, and net seller) and nesting the simultaneous choice equations (7 – 10) within the proposed sequential specification, Bellemare and Barrett (2006) demonstrate that when a household makes the participation and volumes decisions, the sub periods disappear and the following behavioral equations prevails:

$$Q_{1t}^{b*} = q^b(A_t, H_t, W_t, X_t, e_t, fc_t p_t^m, \upsilon c_t, \delta) \quad (11)$$

and

$$Q_{1t}^{s*} = q^s(A_t, H_t, W_t, X_t, e_t, fc_t p_t^m, \upsilon c_t, \delta) \quad (12)$$

Empirical Model

Following the prescriptions of Bellemare and Barrett (2006) and other previous studies such as Winter-Nelson and Temu (2005) and Alene et al. (2008), it is appropriate to use sample selection models when studying market participation behaviors among farmers. Hence, to estimate the influence of livelihood factors explaining participation and supply decisions among cattle farmers, this study adopts the Double-Hurdle (DH) econometric technique, as initially proposed by Cragg (1971).

Under this empirical strategy, a cattle farmer has to cross two hurdles to become participant in cattle market. 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; Ground and Koch 2008), as depicted in the equation (13).

Considering I_i^* as a binary choice variable, Q_i^{s*} as a latent variable which reflects the number of cattle sold (therefore the observed variable, Q_i, being determined as $Q_i = I_i^* \cdot Q_i^{s*}$), Z and α being the vectors of factor explaining the decision of participation and their influences respectively, and X and β being the vector of factors explaining the intensity of participation and their influences respectively; the DH model can be written as follow:

$$\begin{aligned} I_i^* &= Z_i'\alpha + \varepsilon_i \quad \text{first hurdle} \\ Q_i^{s*} &= X_i'\beta + \mu_i \quad \text{second hurdle} \end{aligned} \quad (13)$$

Where, $\begin{pmatrix} \varepsilon_i \\ \mu_i \end{pmatrix} \sim N\left[\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} 1 & 0 \\ 0 & \sigma^2 \end{pmatrix}\right]$

The log-likelihood function for the DH model is:

$$LogL = \sum_{0} \ln\left[1 - \Phi(Z_i'\alpha)\Phi\left(\frac{X_i'\beta}{\sigma}\right)\right] + \sum_{+} \ln\left[\Phi(Z_i'\alpha)\frac{1}{\sigma}\phi\left(\frac{(Y_i - X_i'\beta)}{\sigma}\right)\right] \quad (14)$$

The analysis of marginal effect helps to assess the impact of the exogenous variables on the dependent variables. 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:

$$E[Q \mid X_i] = P(Q_i > 0) \cdot E(Q_i \mid Y_i > 0) \quad (15)$$

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

$$P(Q_i > 0) = \Phi(Z_i'\alpha)\Phi\left(\frac{X_i'\beta}{\sigma}\right) \quad (16)$$

and

$$E(Q_i \mid Q_i > 0) = \Phi\left(\frac{X_i'\beta}{\sigma_i}\right)^{-1} \int_0^{\infty} \left(\frac{Q_i}{\sigma_i\sqrt{1+\theta^2 Y_i^2}}\phi\left(\frac{T(\theta Q_i) - X_i'\beta}{\sigma_i}\right)\right) dY_i \quad (17)$$

Sampling and data collection

The above-outlined model was fed with household-level data collected in two phases. The first phase, the researcher conducted participatory rural appraisals (PRA) during the period of June to October, 2012. Over the course of this period, key informant interviews with extension personnel were conducted, followed by focus groups with knowledgeable members of various dip-tank users associations (DUAs), through their mother cooperative, the Okhahlamba Livestock Cooperative (OLC). This phase was meant to picture the livelihood systems, the institutional environment, and the challenges and barriers around cattle marketing, as perceived by OLC members. The information gathered during this phase was used to device a structured household survey questionnaire that was pilot-tested and administered by trained field enumerators during the second phase, spanning from November, 2012 to February, 2013. Farm households were randomly selected for structured

interviews based on a two-stage random sampling technique. In the first stage, 12 out of 31 DUAs were randomly selected using simple random selection technique, i.e. with a random number generator. In the second stage, 20 members of each pre-selected DUA were selected randomly based on a systematic random sampling procedure. In total, 230 heads of cattle farm households were interviewed.

The information gathered during the survey was on the various livelihood characteristics of the farm household, based on various components of the SLF, including the vulnerability context, the livelihood assets, transforming structures and processes, livelihoods strategies, and livelihood outcomes. The selected sample turned out to be representative of other regions of the country, as 48% of interviewed farm households had reportedly engaged in cattle market as sellers over the last 3 years. This market participation rate corroborates the municipality-wide figure (Bollinger 2007; Elledoubt 2012).

Empirical Estimation

To estimate the effect of livelihood factors on the market participation decisions (Equation 12) this study used probit regression. The intensity of participation levels, the second stage (equation 13), was estimated using a truncated regression model (Wooldridge 2002). Prospective variables were first shortlisted based on the information gathered during the PRA phase as well as key factors unveiled by previous empirical studies. Thereafter, a prospective variable was selected for the regression based on the significance of its contribution to the improvement of the model's fit, i.e. the Log-Likelihood ratio (LR) test (Wooldridge 2002). This technique guaranteed that the selected variables give the best fit. Multicollinearity was tested using a correlation matrix (see table 2), results of which suggest that multicollinearity was not a serious problem in the data. At the outset, we suspected some scope of heteroscedasticity, since cattle farm households from different DUAs had different probabilities of being sampled due to differences in DUA membership portfolio. To curb the potential heteroskedasticity in the model, this study used the heteroskedacticity-robust standard errors for parameter estimates (Wooldridge 2002).

For the intensity model, the self-selection bias was corrected for each participating household by generating the Inverse Mills Ratio (IMR) from the predicted probabilities of the probit model and subsequently including it as an explanatory variable in the truncated regression (Wooldridge 2002). Although theory does not point to the necessity of imposing exclusion restrictions in the Double-Hurdle model, we impose an exclusion restriction in our 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). Wooldridge (2002) recommends 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 explain, to some

extent, the fixed transaction costs, since they influence only the first participation decision model (Key, Sadoulet and de Janvry 2000; Alene et al. 2008). Using the LR test, we excluded the distance to market.

Based on the above-mentioned technicalities, and in line with the SLF, the variables selected for empirical estimation are described in table 1. This study used the SPSS 15.0 for data management, while Stata 11 software served for data analysis.

Regression results and discussions

The results of the participation and supply models are presented in table 3 and table 4. The variables are presented based on the component of the SLF to facilitate their discussion.

The livelihood assets

The results of both regressions show that among human and social capital factors, the coefficient of farmer-to-farmer extension variable is significant for the supply model. This finding infers that, given positive participation decision, potential participants that received extension trainings and information sharing sessions through their groups tend to supply more cattle in the market. Therefore, based on this sample evidence, this result suggests that farmers do capitalize but on the (market) information exchange networks when deciding the amount of cattle to be supplied on the market. This vindicate 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 (DFID 1999; Kirsten et al. 2009).

On household's financial capital, participation in saving groups turns out to be a major predictor of the decision to participate in cattle as 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 seller by 33%. Indeed, as Mashigo and Schoeman (2010) contend, stokvels in South Africa are characterized by homogenous membership, catering for the specific needs of the members, including thrive of their individual businesses. They further argue that violating the rules of the groups (including payment of the contribution, loan repayment, etc) does not normally happen due to important loss of implied privileges (reputation, loyalty, trust, interpersonal networks, etc). Therefore, farmers would have access to production and marketing resources, through these microfinance institutions, or simply sell their cattle in order to maintain their membership.

On natural capital, the regression results indicate that cattle market participation and supply decisions are significantly and positively governed by the cattle herd size. Adding one cattle to the herd increases significantly the chances of participating in cattle market as a seller by 1.8%, *ceteris paribus*. These findings vindicate the hypothesis that agricultural market

participation is associated with its productivity (Lapar, Holloway and Ehui 2003; Rios, Shively and Masters 2009) and the empirical evidence that shifting to commercial cattle farming systems in Southern Africa requires growth in herd sizes (Behnke 1987).

The results of the probit model also show 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 breed (Nguni) herd to mixed/crossbred herds, towards exotic breed reduces significantly the farmer's prospect of cattle market participation, implying that farmers who keep indigenous breed are more likely to participate in 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 this indigenous breed of the eastern and northern South Africa is more fertile, matures earlier, is well adapted to low quality feed, and therefore easily replaceable compared to other breeds (Bayer, Alcock and Gilles 2004; Musemwa et al. 2008). This finding, combined with the previous one, suggests that not only the quantity, but also the quality of herd matters for pro-poor market development strategy.

The results further show that the coefficient of walking distance to the nearest source has a significant positive effect, inferring that OLM cattle farmers staying far from water sources (rivers and dams) have more chances of participating in cattle market as sellers. This finding signals the potential of distress sales among smallholder farmers, particularly during prolonged drought spells (Elledoubt 2012).

The transforming structures and processes

The empirical results of the participation model yield a positive and significant coefficient for cattle tagging. These results suggest that compliance with the Livestock Identification Act is a key factor in cattle marketing, and perhaps the most important predictor in the cattle market participation in empirical model. *Ceteris paribus*, registering (branding and marking) the cattle herd increase market participation propensity by 56%. This finding vindicates the assertions of Coetzee, Montshwe and Jooste (2005) and Groenewald and Jooste (2012) that registration legislation is an important challenge for a pro-poor cattle market development policy in South Africa.

The livelihood strategies

On the basis of the sample evidence, households whose cattle farming is the primary income earner are more likely to participate in cattle market, suggesting that the portfolio of livelihood strategies explains the differences in cattle market participation rates among smallholder farmers. This suggests that the degree of specialization in cattle farming is an important predictor of cattle market development. Another interesting result in this regard is that cattle farmers who regularly secure more unearned incomes such as remittances from their family members and friends are not likely to participate in 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 livelihood outcomes

The results show that the coefficient the expected price variable is only positively significant in the supply model. Consistent with the findings of previous studies done in developing countries such as Alene et al. (2008), this empirical finding reveal that smallholder farmers do not necessarily consider information on prevailing price incentive when deciding to sell their cattle. Nonetheless, sample 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 (price).

These findings, to an extent, indicates that there is a considerable scope of non-commercial motivations for cattle selling such as satisfying the pressing cash needs (Doran, Low and Kemp 1979; Groenewald and Jooste 2012), and seems to validate the previous finding under the livelihood strategies that farmers who manage to secure more incomes from alternative sources are less likely to participate in cattle market.

Such consideration has important implications for the welfare of cattle farmers. As studies such as Jarvis (1980) assert, if commercial and economic motivation coincides in cattle farming sector, producers receive low rates of returns on their investments compared to those who produce cattle for commercial purpose only. Neverthless, Bellemare and Barrett (2006) show that it is the sequence in which participation and supply decisions are taken that determines the market power exerted by traders and other buyers in the rural market. Nevertheless, for farmers under consideration in this study, the significance of supply elasticity with respect to price suggests that cattle suppliers are less likely to be vulnerable to exploitation by their market counterparts.

Implications for agricultural extension programs

This sample evidence on the effect of various livelihood factors on cattle market participations has considerable implications for the design of livestock extension programs in OLM, and South Africa in general.

The significantly positive effect of farmer-to-farmer extension on cattle market supply suggests that farmer extension groups (FEGs) are key players in the livestock market development. Public livestock extension systems designed in such a way to support cattle farmers' group formation and involvement, not just as "contact groups" that transmit messages from public extension staff, but as active players of extension service function (Ponniah et al. 2008; Swanson and Rajalahti 2010) are therefore expected to spur smallholder cattle farmer's ability to participate in rural markets. This objective can be achieved through creation of an open, democratic and supporting environment through which these groups can thrive, supporting capacity building to improve their management, injecting basic resources

to improve their internal functioning, and extending their links with other group (DFID 1999). This result supports the imminent role of a pluralistic extension environment for a pro-poor cattle market development strategy.

This latter strategy has even further appeal. Given the significantly positive effect of access to saving groups for cattle marketing in the region, the livestock extension programs that extend cattle farmers' access to financial institutions are expected to scale up market participation among smallholders in South Africa. This can be achieved by encourage individual cattle farmers and their organizations to save with advocacy programs for tailoring inclusive financial products and for overcoming barriers related to lack of collateral (for example by identifying mechanism that enable farmers natural capital to act as collateral) (DFID 1999).

The finding that endowment in natural capital matters for market participation implies that continued efforts by agricultural extension to uplift the productivity of local breeds through access to quality feeds and veterinary services are expected to increase both cattle productivity and market participation in OLM. These efforts can be channeled through a centralized commodity-specialized approach using commodity extension models to ensure access to required inputs (including technology and finance), marketing facilities, as well as financial gains (see an overview of Nguni farmers marketing challenges outlined Musemwa et al. 2008), although farmers' feedback can be better accounted for by other approaches such as training and visit (T&V) (Ponniah et al. 2008). However, this productivity emphasis does not need to detract attention from complexity of the issues surrounding the management of natural ecosystems (such as water and land) for livestock-based livelihoods development in the area. This complexity requires participatory and system approaches to agricultural extension (such as the farming system development approach) build on a broader understanding of livelihood systems, the combination with other assets to sustain livelihoods, the role of structures and processes that govern the use of these resources (environmental laws, land and water allocation systems).

The significant effect of compliance with Livestock Identification Act implies that public extension strategy focusing on programs that aims to alleviate this challenge can be expected to unlock markets for stallholders. These challenges, as outlined in Coetzee, Montshwe and Jooste (2005) and Groenewald and Jooste (2012) includes high cost of registering unique brands and marking & branding equipments, high possibility of filing claims after stray animals cause road accident or intrude neighboring fields, and lack of branding and marking facilities. Notably, direct support during the identification process such as penetrating villages with branding and marking facilities or subsidizing the branding cost can be envisaged (Groenewald and Jooste 2012). Equally appropriate is an indirect support through support to structures that represent smallholder cattle farmers to expand their scope to include fast tracking the identification process both in terms of accessibility of facilities and cost reduction for smallholder farmers, access to appropriate forums for decisions making and/or action (DFID 1999).

On the significant effect of livelihood strategies, the public livestock extension service system that take into account the diversity of livelihood strategies when designing their programs can have a significant positive effect on market participation. FEGs and T&V models can be best developed around households that depend more on incomes from cattle sales, and those that have less sources of unearned incomes (remittances and pensions), if market participation is to be developed. Once again, this results support the need for a participatory extension program to gauge the extent to which different cattle farming systems rely on cattle incomes.

Finally, the results that price incentives drives cattle market supply volumes gauges a positive expectation from the public extension framework that advocates for a good functioning of institutions that facilitate positive market outcomes by reducing the associated transaction risks and costs in order to sustain better returns to cattle farming and increase its attractiveness. Validating the need for FEGs as previously outlined, the provision of cattle market information to potential participants through farmers' social capital is an important strategy to integrate them into lucrative market chains and high value channels. Using the mass media extension method to disseminate market information also remains an appropriate option. However, as Coetzee, Montshwe and Jooste (2005) cautions, the format of the information needs to be well understandable by the target farmers (e.g. farmers cannot clearly estimate the total value of their cattle based on information on beef price per kilogram live weight).

Conclusion and recommendations

This study falls within the participatory agricultural extension approach. Its purpose is to investigate the livelihood drivers of smallholder cattle farmers' participation and supply decisions in OLM within framework of addressing the design of the livestock extension architecture in South Africa. The goal is to explain the low rates of cattle market participation by smallholder farmers in the region and suggest appropriate extension models for extension programming in the context of OLM.

The empirical results of this study reveal that the low rate of market participation cannot be simply explained endowments and access factors (the determinants of transaction cost), but the broader aspects of livelihoods of smallholder cattle farmers in South Africa. Notably, this study finds that the difference in access to finance, natural capital endowments, and livelihood strategies could explain the low rate of market participation. It also provides evidence of a motivational aspect in cattle marketing in South Africa. To a certain extent, the results reveal that cattle market participation in OLM is essentially a reactive livelihood strategy, a fallback plan against harsh environmental and/or economic conditions.

This bottom-up approach supports a community-based agricultural extension mechanism, placing FEGs in the midst of livestock extension models for market development in South Africa. Involving farmers' groups as active players of extension service functions not only gauges market and production information exchange, but also extension of cattle farmers'

access to financial institutions, and compliance with Livestock Identification Act. Moreover, these groups facilitate participatory and system approaches to agricultural extension required for further livelihood analyses, such as the analysis of the complexity of farming systems and their natural resources management.

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Appendices

Table 1. Description of Variables and T test of equality of means for independent variables used in the empirical model

Variable category, SLF component, and variable name	Variable description	Measurement	Value labels	Theoretical Counterpart	Participants N=113	Non-participants N=117	p-value
Dependent variables							
MARKPART	Decision to participate in cattle market during the last three years	Dummy	1 = the household has participated in cattle market as a seller, and 0 = otherwise.	***I***			
TOTSOLD	Number of cattle sold over the period of the last three years	Count		Q^s*			
Independent variables							
1. Vulnerability context							
SNOWLOSS	Experience with cattle deaths resulting from heavy snow over the last three years	Dummy	1= the household experience cattle death attributable to heavy snow over the last three years; 0= otherwise.	*E*	.49	.41	.246
DROUGHTLOSS	Experience with cattle deaths resulting from prolonged period of droughts over the last three years	Dummy	1= the household experience cattle death attributable to drought conditions over the last three years; 0= otherwise.	*E*	.20	.26	.273
Asset pentagon							
Human capital							
BIRTHDAYHHH	Year of birth of the head of	Continu			1955.94	1953.08	.076

	household	ous					
GOVEXTVISIT	Access to extension training and visit from government extension agents over the last three years	Dummy	1= the farmer received a government extension training or visit over the last three years; 0=otherwise.		.6460	.5043	.030
Social capital							
OLCMEMB	Membership in OLC	Dummy	1= the head of household is a member of OLC; 0= otherwise.		.84	.74	.071
F2FEXT	Access to farmer-to-farmer extension trainings over the last three years	Dummy	1= the farmer received farmer-to-farmer extension training or information sessions over the last three years; 0=otherwise.		.1239	.0684	.154
Financial capital							
SAVGROUP	If the household is a member of a stokvel	Dummy	1= The head of household save money in a stokvel; 0= otherwise.		.42	.34	.198
Physical capital							
TRACTOR	Ownership of tractor – an indicator of fixed cattle production cost	Dummy	1=The head of household owns a tractor; 0=otherwise.	fc_{rt}	.10	.11	.734
RDDISTTODUKUZA	Shortest driving distance (Km) from the community's dip tank to Dukuza cattle market place (measured	Continu ous			21.5770	20.2650	.461

	using GPS navigation software) – an indicator of fixed cattle transaction cost						
Natural capital							
HERDSIZE	Total number of cattle owned at the time of interview – – an indicator of managed ecosystem goods and services	Count		*H*	14.68	8.92	.000
CATTLEBREED	Type of breed owned by the farmer – an indicator of managed ecosystem goods and services	Categorical – Ordinal	1= Nguni; 2= Mixed; 3= Exotic breed		1.73	1.77	.578
WATERSOURCEDIST	Walking distance (in minutes) between the household and the nearest cattle water source – an indicator of access to natural ecosystem services.	Continuous			21.61	14.74	.097
Transforming Processes and structures							
CATTLETAG	Cattle are tagged - an indicator of compliance with Livestock Identification Act	Dummy	1=Cattle conforms to the required identification tags, 0= otherwise.		.95	.85	.020
Livelihood strategies							

CATTLESALEINCRATING	The importance of incomes from cattle sales among regular sources of earned income	Categorical – Ordinal	1 = least important ~ 5= most important		3.89	2.86	.000
REMITINCRATING	The importance of remittances among regular sources of unearned income	Categorical – Ordinal	1 = least important ~ 5= most important		2.65	3.44	.000
Livelihood outcome							
EXPPRICE	Expected cattle price at farm gate and from speculators in the community – an indicator of market participation motive	Continuous		p^m	5480.7670	5595.0095	.339
Inverse mills ratio (IMR)	The standard normal probability distribution function over the standard normal cumulative distribution function of the predicted probabilities	Continuous					

Source: Authors' survey, 2012-2013

Table 2. Correlation matrix for independent variables used in the econometric model

	SNOWLOSS	DROUGHTLOSS	BIRTHDAYHHH	GOVEXTVISIT	OLCMEMB	F2FEXT	SAVGROUP	TRACTOR	RDDISTTODUKUZA	HERDSIZE	CATTLEBREED	WATERSOURCEDIST	CATTLETAG	CATTLESALEINCRATING	REMITINCRATING	EXPPRICE
SNOWLOSS	1															
DROUGHTLOSS	0.1452	1														
BIRTHDAYHHH	0.0241	0.0796	1													
GOVEXTVISIT	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								
RDDISTTODUKUZA	-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						
CATTLEBREED	0.0443	-0.0753	-0.0583	0.2056	0.0216	-0.1726	0.1313	0.1221	-0.0158	0.0845	1					
WATERSOURCEDIST	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			
CATTLESALEINCRATING	0.1565	0.0368	0.0271	0.0360	0.1321	0.1435	0.0525	0.0670	-0.0896	0.1739	0.0839	-0.0773	0.1528	1		
REMITINCRATING	-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	-0.1680	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	0.0440	0.0001	1

Table 3. Livelihood Determinants of Smallholder Farmers' Decisions to Participate in Cattle Market in OLM, Results Estimated Using Probit Regression Models

SLF component and variable name	Coefficient	Marginal effects	p>|Z|
Dependent variable: MARKPART			
1. Vulnerability context			
SNOWLOSS	-.127	-.051	0.527
DROUGHTLOSS	-.355	-.140	0.124
Asset pentagon			
Human capital			
BIRTHDAYHHH	.009	.003	0.247
GOVEXTVISIT	.277	.110	0.186
Social capital			
OLCMEMB	.177	.070	0.472
F2FEXT	.444	.173	0.165
Financial capital			
SAVGROUP	.338	.134	0.078
Physical capital			
TRACTOR	-.277	-.109	0.367
RDDISTTODUKUZA	.002	.001	0.729
Natural capital			
HERDSIZE	.046	.018	0.000
CATTLEBREED	-.458	-.182	0.031
WATERSOURCEDIST	.009	.003	0.002
Transforming Processes and structures			
CATTLETAG	.565	.216	0.070
Livelihood strategies			
CATTLESALEINCRATING	-.187	-.074	0.003
REMITINCRATING	.189	.075	0.001
Livelihood outcome			
EXPPRICE	-.000	-.000	0.280
Constant	-18.088	----	0.241
	Number of obs	= 227	
	Wald chi2(16)	= 64.92	
	Prob > chi2	= 0.000	

Source: Authors' survey 2012-2013.

Table 4. Livelihood Determinants of Cattle Market Supply Volumes among Smallholder Farmers in OLM, Results Estimated Using Truncated Regression Models

SLF component and variable name	Coefficient	p>|Z|
Dependent variable: TOTSOLD		
1. Vulnerability context		
SNOWLOSS	2.872	0.728
DROUGHTLOSS	-11.825	0.318
Asset pentagon		
Human capital		
BIRTHDAYHHH	-.135	0.619
GOVEXTVISIT	.922	0.915
Social capital		
OLCMEMB	-11.722	0.197
F2FEXT	21.966	0.029
Financial capital		
SAVGROUP	-3.275	0.631
Physical capital		
TRACTOR	7.991	0.287
RDDISTTODUKUZA		
Natural capital		
HERDSIZE	1.340	0.002
CATTLEBREED	7.648	0.481
WATERSOURCEDIST	.052	0.648
Transforming Processes and structures		
CATTLETAG	-14.332	0.235
Livelihood strategies		
CATTLESALEINCRATING	5.213	0.225
REMITINCRATING	3.147	0.298
Livelihood outcome		
EXPPRICE	.005	0.092
IMR	14.140	0.349
Constant	148.752	0.774
	Number of obs	=111
	Wald chi2(17)	=28.09
	Prob > chi2	=0.030

Source: Authors' survey 2012-2013.

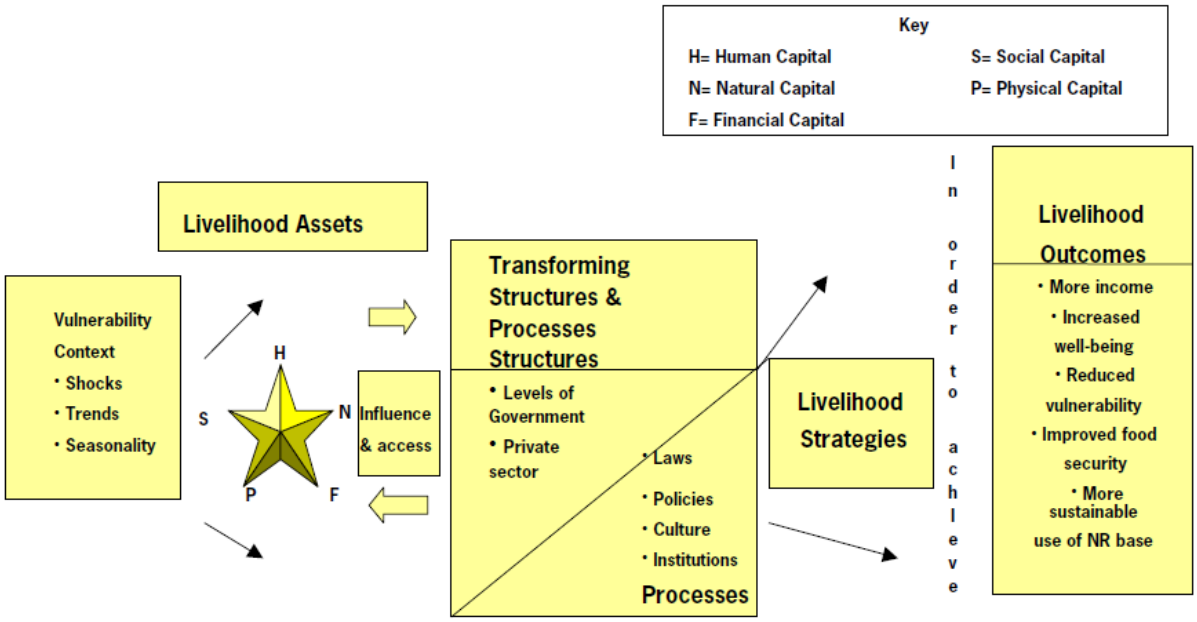

Figure 1. The Sustainable livelihood framework

Source: DFID 1999

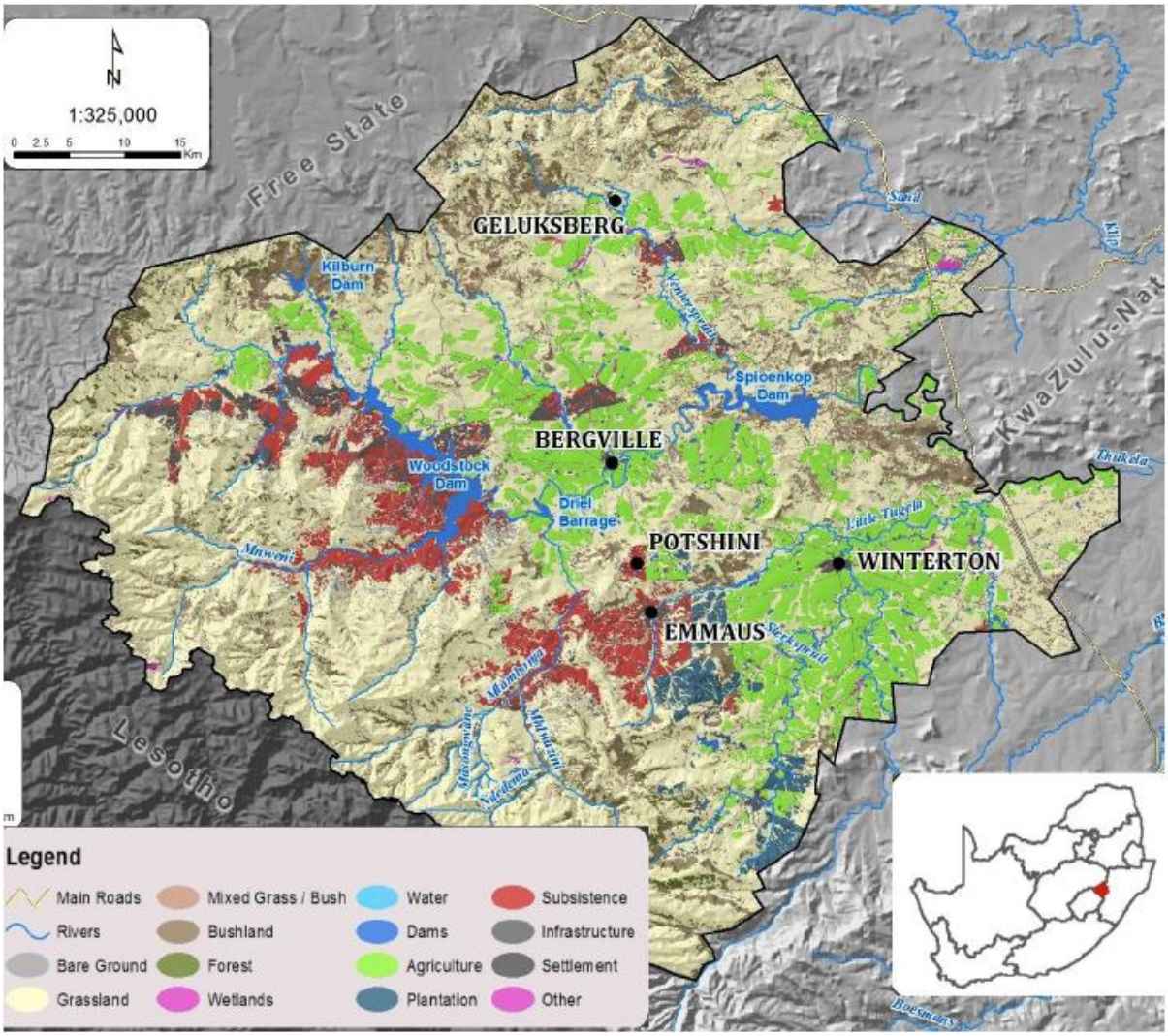

Figure 2. Map of the Okhahlamba Local Municipality with the major land covers

Source: Elleboudt 2012