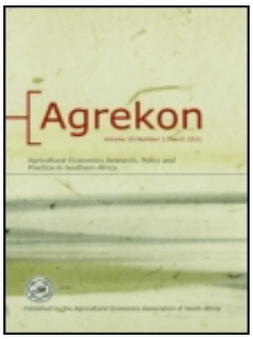

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DETERMINANTS OF HERD SIZE AMONG SMALL-SCALE CATTLE FARMERS: THE CASE OF SELECTED VILLAGES AT THE MHINGA TRADITIONAL AUTHORITY IN LIMPOPO, SOUTH AFRICA

N.P. Sikhweni[ab] and R. Hassan[a]

ABSTRACT

This study employed a negative binomial model to analyse determinants of herd size among smallholder cattle farmers in the villages of the Mhinga Traditional Authority (TA) in Limpopo province. Contrary to the popular belief that rural households in developing countries generally own large herds of livestock for social reasons, communal livestock farmers in the study area who kept livestock for social reasons were found to own smaller herd sizes of cattle. This particular finding indicates that economic reasons for livestock ownership are more important than social reasons among smallholder livestock farmers in this study area. Access to markets and the ability to sell cattle were found to be the strongest influencing factors compared to socio-economic attributes such as marital status, social grants and off-farm employment. Losses due to theft and death were associated significantly with herd size. Recommended policy interventions aimed at increasing the herd size and income of smallholder livestock farmers include government introducing appropriate livestock subsidy programmes that could potentially assist farmers in expanding their herds, investments in efficient protection against wildlife intrusion from game parks, the establishment of well-functioning markets, improved access to roads and market information, and investments in farmers' education to create awareness of new innovations and practices in breeding and veterinary services.

Keywords: small-scale cattle farmers, herd size, income

JEL CLASSIFICATION

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1 INTRODUCTION

Agriculture remains the single largest source of income and livelihoods for rural households in the developing world, providing more than 50 percent of household

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income (Jayne et al 2003; Otte and Chilonda 2002). Nearly three quarters of the extremely poor, who number about one billion people, live in rural areas (World Bank 2008) and 90 percent of them are small-scale farmers depending directly on agriculture as part of their livelihoods (Lipton 2005). In most developing countries, rural populations continue to grow while land for sustainable agricultural production diminishes. Thus, in order to raise rural incomes and provide food security in developing countries, diversification into livestock and a strategy to increase livestock productivity become essential because most rural households, particularly small farmers, already contribute to their livelihoods by keeping livestock, which mainly consists of cattle (Thorton et al 2002). Thus, the livestock sector has the potential to play a much more important role in improving livelihoods in rural areas and reducing poverty (Ogundeji, Jooste and Oyewumi 2011).

However, small-scale cattle farmers in rural areas face many challenges which reduce their ability to generate higher incomes from the cattle they own. These challenges include: lack of access to land and water, lack of access to marketing channels, smaller herd sizes and risks associated with animal diseases, drought and theft (Montshwe 2006). In particular, factors such as the high transaction costs associated with marketing become major hindrances that prevent small-scale cattle farmers from participating in formal markets where they could potentially earn higher incomes (Musemwa et al 2007). However, while improving access to more efficient marketing channels can certainly assist small-scale cattle farmers to earn higher incomes, other factors limiting the ability of these farmers to expand their holdings or herds need to be studied and understood.

A study by Hangara, Teweldemedhin and Groenewald (2011) established that livestock ownership by small-scale cattle farmers in Namibia had a significant effect on their incomes. The authors found that an increase in the number of cattle owned by an individual farmer led to an increase in sales volume and hence his or her income. The estimated coefficient for herd size was relatively bigger than other variables included in the model. Other variables included factors such as family size, input cost, accessibility to local markets and rainfall. This implied that ownership of larger herds was a key factor influencing farmers' capacity to generate income from selling in organised markets. Similar findings were reported for South Africa (Montshwe 2006) where herd size was the main determinant of a farmer's participation in the market, implying that farmers with smaller herd sizes had limited participation in the market and hence lower incomes. It is clear that previous studies treated herd size as an important factor in determining farmers' market participation and offtake levels. The study recognises that larger herd size is an important factor for market participation. However, the factors that affect herd size remain unclear or under-researched. Several studies of the behaviour of

livestock owners in Africa have found that in many nomadic societies, as well as in pastoral and agro-pastoral communities with less mobile herds, livestock provides important non-market benefits. For instance, in traditional pastoral societies the herd size is often of greater importance for cultural reasons and serves as an asset signalling social status (Perrings 1993, 1994; Dasgupta and Mäler 1995; Fafchamps Udry and Czukas 1998). The benefit pastoralists derive from such non-marketed or non-consumptive values may lower the marginal utility of the livestock offtake relative to livestock inventory, resulting in larger herds compared to those kept in situations where such non-marketed values are absent or low (Perrings and Walker 1995). It is therefore necessary to consider non-market objectives among the factors determining herd size, which could outweigh market benefits for nomadic and agro-pastoral farmers. This paper uses survey data from five villages adjacent to the Kruger National Park (KNP) in the Limpopo province of South Africa to analyse and study the main determinants of herd size for small-scale cattle farmers.

2 MATERIALS AND METHODS

2.1 Study area

The study was conducted in the five communal villages which fall under Mhinga Traditional Authority (TA) of the Vhembe district in Limpopo, South Africa. According to Statistics South Africa (StatsSA), Limpopo covers an area of 12.46 million hectares which accounts for 10.2 percent of the total area of South Africa (StatsSA 2007; DAFF 2010). Like the rest of South Africa, Limpopo is characterised by two distinct types of agricultural production systems, namely: large-scale commercial and smallholder farming systems (StatsSA 2002; Aliber and Hart 2009). Commercial farmers who practice large-scale farming using advanced production technology occupy approximately 70 percent of the land (DAFF 2010). At present, there are approximately 2 934 commercial farming units in Limpopo (StatsSA 2007).

Limpopo had its highest average real economic growth rate of 3.8 percent between 1995 and 2001 (GCIS 2004). However, StatsSA (2012a) indicates the real average growth of 2.2 percent for Limpopo as the lowest of the nine provinces. The province is also characterised by high unemployment levels estimated at 20.2 percent (StatsSA 2012b), but unemployment specific to the study area (Mhinga TA) ranges between 60 and 80 percent (Chaminuka, McCrindle and Udo 2012).

Mhinga TA has ten villages under its jurisdiction, namely Mhinga 1, Mhinga 2, Mhinga 3, Matiyani, Josepha, Botseleni, Maphophe, Mabililigwe, Makuleke and

Nthlaveni. These villages fall under the Thulamela municipality situated 180 km northeast of Polokwane, the main city in Limpopo and it is the gateway to the KNP which is the second-largest park in the world. Mhinga TA covers an area of about 20 000 ha, mainly comprised of communal grazing areas and village settlements with an estimated 6 880 households and 43 450 people (Chaminuka et al 2012). The villages mentioned above are populated by smallholder communal farmers who mainly depend on agricultural and livestock farming for their livelihoods. However, only five villages were chosen as the target populations for conducting our surveys, namely, Matiyani, Josepha, Botseleni, Maphophe and Mhinga (Mhinga 1, 2 and 3) (figure 1). These villages were selected because they are representative of the demographics and socio-economic conditions of most villages bordering KNP on the northern and western sides (Anthony 2007). All the above villages are between 0 and 9 kilometres from the KNP (Chaminuka et al 2012).

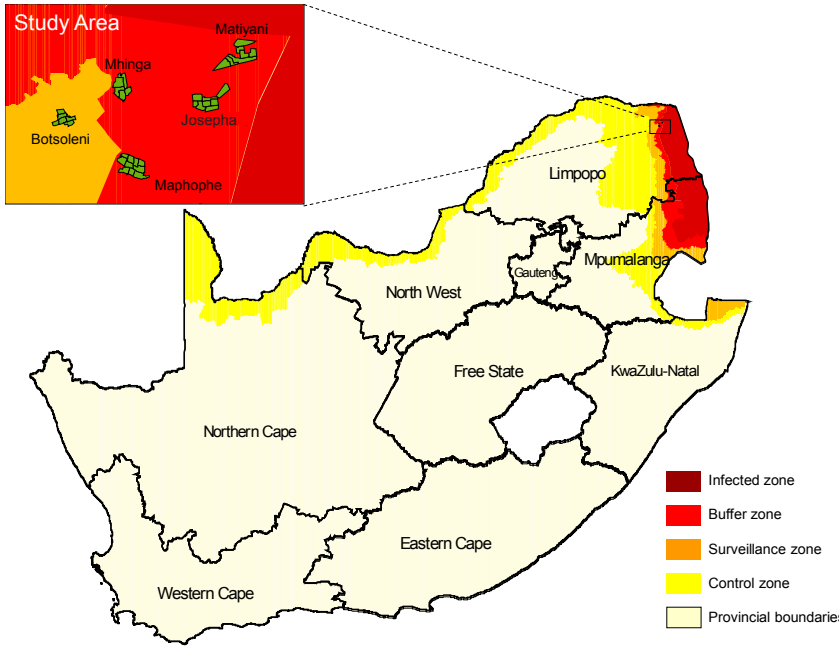

Figure 1: The map of South Africa and the study area
Source: Adapted from Department of Agriculture, Forestry and Fisheries (2012)

2.2 Data collection methods

A cross-sectional survey was conducted using a semi-structured questionnaire that was administered to the livestock farmers residing in the study sites. The main aim of the questionnaire was to gather information on the demographic and economic characteristics of the farmers, livestock and land ownership, marketing channels used by farmers to sell their livestock as well as factors leading to losses in livestock. The study was based on a simple random sampling design. A list of all farmers from the target villages was obtained from the Department of Agriculture of the local municipality, Thulamela. The cattle-owning farmers were identified through the dip register kept by the local animal health authorities. Farmers were then randomly selected using the farmer's identity card number from the available list and interviewed. The interviews were conducted using local languages which were either Tshivenda or Xitsonga. The estimation of the sample size for the survey was based on the method proposed by Cochran (1977) assuming a 95 percent confidence interval, ie 5 percent desired absolute precision. Fieldwork for data collection was implemented between June and August 2011 and a total of 253 questionnaires were successfully completed.

2.3 Empirical model and variables

In addition to understanding the small-scale cattle farmers in the study area, the research also examined the main determinants of herd size among this particular group of farmers in the selected villages at Mhinga TA, which was, ultimately, the main objective of the study. The response (dependent) variable of the study was measured as the number of cattle owned by an individual farmer (count variable). Count data is best modelled using Poisson or negative binomial models and the choice between the two models depend on the distribution of the response variable. Negative binomial models (that can be considered as a generalisation of Poisson regression) are best suited for the analysis of over-dispersed count data, that is when the conditional variance exceeds the conditional mean (Osgood 2000). For this analysis the study utilised a negative binomial model because significant over-dispersion in the number of cattle owned by farmers in the study area was observed (α: 0.4; χ^2: 818; $p<0.001$).

The general empirical model for the study was specified as an additive multivariate model:

$$\hat{Y} = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_n X_n + \varepsilon_i \quad (1)$$

where:

Y denotes the number of cattle owned by an individual farmer, X_is refer to

explanatory variables, the β_is are model parameter estimates and ε is the random error term.

Equation 1 suggests that livestock ownership by small-scale farmers is affected by multiple factors. Definitions of factors influencing herd size are shown in annex 1. The literature suggests that livestock ownership differs widely among ecological zones, production systems (small-scale or commercial) and social factors such as gender and marital status (Niamir 1990). Generally, men and women tend to own different animal species. In many societies, cattle and larger animals are usually owned by men, while animals such as goats and backyard poultry are more women's domain (Yisehak 2008). This could be due to the fact that women lack capital to purchase these animals. It is therefore hypothesised that male farmers will tend to have a larger number of cattle than their female counterparts. The study also hypothesised a positive relationship between marital status and herd size, such that married farmers would tend to have larger herd sizes compared to unmarried farmers. This association could be attributed to the observation that married farmers might use their livestock as a source of income for their families.

Other social factors such as family size also have an effect on the number of cattle farmers own. Due to the relatively larger family size in most rural areas, the study hypothesised a positive relationship between herd size and family size. De Bruyn, De Bruyn, Vink and Kirsten (2001) argue that older producers will tend to have larger herds of cattle than younger farmers. Accordingly, the study hypothesised a positive relationship between age and herd size. Teweldemedhin and Kafidi (2009) indicated that access to other sources of income may give farmers more buying power and hence the ability to purchase additional stock of cattle. It is also argued that access to other forms of income may in fact discourage farmers from selling their cattle to meet their daily needs and production costs, which may, in turn, increase their existing herd as they use the extra income to buy additional cattle (Nthakheni 2006). Accordingly, the study hypothesised a positive relationship between off-farm employment and herd size. In contrast, the study hypothesised a negative relationship between welfare grants and herd size. This association is based on the argument that recipients of welfare grants in rural communities often depend on the grants as their main source of income, without alternative sources of income they can use to buy additional stock of cattle.

The study also hypothesised a positive relationship between land ownership and herd size. A study conducted by Rahman, Hashan, Shahjahan and Islam (2001) found a positive relationship between land and livestock ownership for farmers in the semi-arid area of Bangladesh. Similar results were also reported by Baset, Hossain and Saadullah (1997) who observed significant differences between land ownership and the number of animals owned by farmers. It has

been argued that farmers who received an education are able to adapt to new technological innovations relating to cattle production and are able to acquire skills faster than those who had received no education; this tends to translate into higher productivity, often resulting in larger herd sizes (Musiguzi 2000). Thus a positive relationship between herd size and education is hypothesised in this study.

Lack of marketing facilities imposes a serious constraint on small-scale farmers' ability to market their cattle (Mahabile, Lyne and Panin 2002). Having access to market facilities and information can have a significant impact on the ability of small-scale farmers to generate sustainable profits (Hobbs 1997). Moreover, market accessibility in terms of access to infrastructure and better roads will boost farmers' ability to negotiate better prices for their cattle and thus boost production in terms of quantity and quality (Musemwa et al 2007). It is therefore hypothesised that increased access to marketing facilities in terms of reduced distance and improved roads will encourage farmers to have larger herd sizes.

The study also hypothesised a positive relationship between herd size and various motives for livestock ownership. As already alluded to in the introduction, several authors studying the behaviour of cattle farmers in Africa have found that in many nomadic societies as well as in pastoral and agro-pastoral communities with less mobile herds, in addition to market benefits such as an important insurance asset, herd size can also provide other important non-marketed benefits (Perrings 1993, 1994). The study also hypothesised a positive relationship between livestock losses (due to theft, livestock predation as well as death) and herd size. It is expected that the higher incidence of losses due to the above risk factors will encourage farmers to have larger herds in order to minimise the effects of losses. Incidences of livestock losses for farmers living adjacent to national parks were also reported in other parts of Africa, such as Botswana and Tanzania (Holmern, Nyahongo and Roskat 2007; Kgathi, Mmopelwa, Mashabe and Mosepele 2012). Following Montshwe (2006) and Hangara et al (2011) who found a positive relationship between an increase in the number of cattle owned by an individual farmer and an increase in the sales volume, the study hypothesised a positive relationship between herd size and sales volume.

3 RESULTS

3.1 Attributes of the population in the study area

Descriptive information on the main attributes of the population in the study area is presented in table 1. Both men and women were involved in cattle farming and men constituted 77 percent of the livestock farming community in the study area. This figure is similar to that reported for other areas in South Africa. For

example, Musemwa et al (2007) found that 80 percent of men were engaged in cattle farming in Kamastone village, Eastern Cape while Spies (2012) reported that 98 percent of farmers in the Free State were engaged in cattle farming. The average age of the head of the family was 58 while the average family size for the study area was six. Most farmers in the study area had some form of schooling. About 51 percent, 26 percent and 4 percent had primary, secondary and college education respectively. Only 19% of the farmers in the study area had no form of education. This figure clearly differs from the one reported for Kamastone village in the Eastern Cape where 57 percent of farmers were not educated (Musemwa et al 2007). The majority of farmers (67%) in the study were married. Similar findings were reported for the Free State where 88 percent of farmers were married (Spies 2012).

Besides cattle farming, some farmers were involved in other forms of employment. About 67 percent of the farmers interviewed were solely committed to cattle farming while 33 percent had employment outside farming such as working as government officials. As one would expect in communal areas, most farmers owned land which was allocated to them by the local chief. In the study area, about 63 percent of farmers owned an average of 2 ha of land each. The herd size of the farmers varied between a minimum of one to a maximum of 134 heads of cattle with a mean of nine heads of cattle, thus suggesting that the majority of farmers had small herd sizes. Similar figures were reported in other parts of South Africa such as in Rustenburg where herd size varied between five and 149, with a mean of 29 heads of cattle per household (Schwalbach, Groenewald and Marfo 2001). The average number of heads of cattle per farmer in Thaba Nchu and Botshabelo was 10.8 and 7.2, respectively (Moorosi 1999). A mean herd size of eight was reported in Venda (Nthakheni 1996). The herd structure of the farmers interviewed in the study area was distributed as follows: 44 percent had 1–5 heads of cattle while 32 percent had 6–10 heads of cattle. Twelve percent of the farmers had 11–15 heads of cattle while another 12 percent had more than 16 heads of cattle. This confirmed that the bulk of farmers in the study area had smaller herd sizes.

Table1: Attributes of small-scale cattle farmers in the study area

Attribute	n	Percentage (%)
Gender (N=251)		
Female	58	23
Male	193	77
Marital status (N=253)		
Married	170	67
Unmarried	83	33
Education (N=252)		
No schooling	47	19
Some schooling	205	81
Employment (N=253)		
On-farm employment (full-time)	169	67
Off-farm employment (part-time)	84	33
Welfare grants (N=253)		
Not receiving	30	12
Receiving	230	88
Land ownership (ha) (N= 159)		
No	92	37
Yes	159	63
Marketing channels (N=252)		
Local people	150	60
Local butcheries	102	40
Theft of livestock (N=253)		
No	245	97
Yes	8	3
Losses due to natural death (N=253)		
No	194	77
Yes	59	23
Losses due to predation (N=253)		
No	225	89
Yes	28	11
Reasons for keeping livestock		
Keeping livestock for income (N=252)		
No	1	1
Yes	251	99
Keeping livestock for insurance (N=252)		
Yes	252	100
Keeping livestock for social status (N=251)		
No	9	4
Yes	242	96
Cattle sales		
No	133	53
Yes	120	47
Selling cattle for household consumption (N=251)		
No	1	1
Yes	250	99

Attribute	Min	Average	Max
Age (N=253)	18	58	92
Family size (N=253)	1	6	22
Herd size (N=253)	1	9	134
Herding costs (N=252)	0	161	800
Private land (ha) (N=159)	0	2	6
Income from selling cattle (N=253)	0	6400	120000

Farmers in the study area kept livestock for various reasons. Almost all farmers kept livestock to provide income (99%) and as insurance against unforeseen conditions such as loss of employment or severe droughts (100%). Similar numbers were reported by Schwalbach et al (2001) for South Africa indicating that 91 percent of farmers kept cattle to generate cash, 25 percent for the provision of financial security, while 17 percent kept livestock to provide for emergencies or insurance. In the study area, 96 percent of farmers kept livestock for social reasons such as acquiring social status within the community. This finding is in agreement with the thesis that communal farmers tend to keep large herds in order to gain social standing within the society (Borge-Johannesen and Skonhoft 2011).

While most of the farmers in the study area kept livestock to generate income, about 53 percent of the surveyed farmers had not sold any cattle during the past year, which could be attributed to their relatively small herd sizes. Farmers who sold their cattle (47%), on average generated R120 000 per annum. Scholtz, Bester, Mamabolo and Ramsay (2008) also found that 47 percent of the famers in South Africa sold their cattle mainly to generate cash and provide food. Most farmers (99%) used the generated income for current household needs such as buying groceries and paying school fees. Cattle farmers in the study area used various channels to market or sell their cattle. The most commonly used method was private sales to local people for slaughter for socio-cultural functions like funerals, weddings or religious celebrations and butchers buying livestock for different reasons such as retailing for income (USAID 2003). About 60 percent of the farmers sold their cattle directly to local people while 40 percent sold to local butcheries. In contrast, 25 percent of farmers in the Kamastone village in the Eastern Cape used private sales, while the majority of the farmers (46%) used auctions (Musemwa et al 2007). These differences in the marketing channels used by farmers can be attributed to factors such as infrastructure or quality of the roads, high transactional costs as well as lack of information in different regions (Musemwa et al 2008).

In addition to challenges related to marketing channels, farmers in the study area faced risks such as losses due to theft and predation from wildlife that had escaped from the KNP. Almost all farmers interviewed (99%) indicated seeing wildlife roaming in grazing areas. Interaction between livestock and wildlife often result in incidences of livestock predation. According to Holmern et al (2007), 27 percent of the households interviewed in seven villages outside the Serengeti National Park in Tanzania reported that they had lost 4.5 percent of their livestock due to predation. Much higher figures were reported for Shorobe village in northern Botswana where 63 percent of respondents reported that predators had killed some of their livestock (Kgathi et al 2012). However, findings in the study area indicate that 11 percent of livestock losses were due to predation, 3 percent due to theft

and 23 percent due to death as a result of animal disease such as foot and mouth disease (FMD) transmitted by wildlife (buffalo) that had escaped from the park.

3.2 EMPIRICAL RESULTS AND DISCUSSION

The statistical analysis was implemented using STATA® version 11. The estimation results of the negative binomial model for all variables with p-value < 0.05 are presented in table 2. A forward selection method was used where variables to the model were added one at a time and tested for inclusion. All the significant variables retained the expected signs except employment (off-farm) and social status as the motive for keeping livestock.

Table 2: Negative binomial model estimation results for factors influencing herd size (dependent variable) N= 216

Explanatory variables	Percentage	P-value*	Confidence interval**
Marital status (unmarried)	-0.32	<0.05	(0.45)–(0.18)
Education (primary, secondary and college)	0.59	<0.05	0.24–1.04
Off-farm employment	-0.21	<0.05	(0.36)–(0.01)
Receiving welfare grants	-0.23	<0.05	(0.42)–(0.07)
Livestock loss (theft)	0.80	<0.05	0.09–1.98
Livestock loss (death)	0.23	<0.05	0.09–0.33
Cattle sales	0.63	<0.05	0.35–0.97
Marketing to local butcheries	0.19	0.05	0.08–0.23
Social reasons for keeping livestock	-0.41	<0.05	(0.63)–(0.06)

*Level of significance at 0.05

** The brackets indicate negative values

Results from the study show that education, high incidences of theft and death of livestock, cattle sales and access to markets have a positive influence on herd size while being unmarried has a negative influence on herd size. The study found that unmarried farmers kept 32 percent fewer cattle than married farmers. This finding is not surprising given that most farmers in rural communities were generally married with larger families, thereby compelling them to have larger herd sizes to support their livelihoods. Farmers with some form of schooling were found to have 59 percent more cattle compared to those without any form of schooling[1]. Almost

1 Respondents were first grouped into different education levels (primary, secondary and tertiary), but there were no significant statistical differences in performance between the three groups and hence the sample was subsequently split into only two groups namely, those with and those without any education.

universally, studies that analyse income, agricultural production and other forms of welfare measures, find that human capital available in a household (usually measured as the education of the head of the household) is strongly correlated with these welfare measures (World Bank 1999). This result suggests that investing in farmers' education and awareness of new technological innovations such as breeding and detecting sick animals and treatment are critical for improving small livestock farmers' welfare.

Results also suggest that farmers who experience livestock losses due to risk factors such as theft or death resulting from wildlife-livestock transmission diseases (eg FMD) tend to keep larger herd sizes. This is possibly motivated by the need to minimise the impact of losses due to the above-mentioned risk factors. The loss due to disease transmission from wildlife to livestock calls for government to erect efficient game-proof fences that will effectively prevent wildlife escaping from the park, which will result in a reduction in livestock predation and herding costs to small-scale farmers.

The study findings also show that farmers who sold their cattle to local butcheries had larger herd sizes (19% increase in herd size) compared to those who did not sell to local butcheries. This could be due to the fact that farmers are able to command relatively higher prices when selling to a butcher compared to an ordinary individual. This finding is consistent with the findings by Musemwa et al (2007) who reported that the ability of farmers to participate in the market was heavily dependent on marketing channels available to them. This has an implication that the availability of efficient and well-functioning markets is vital for market participation by farmers and improving the potential for farmers to earn higher incomes. This finding is also in agreement with Hangara et al (2011) who found that an increase in the number of cattle owned by an individual farmer in Namibia led to an increase in the sales volume. This implies that a larger herd size has a direct influence on the economic development of communal farmers. Thus, it is important to assist farmers both to expand the size of their herds and manage them optimally. This should, however, take into consideration the objective of ecological sustainability in terms of the optimal herd size given the current carrying capacity of the study area.

Contrary to previous research which reported a positive relationship between non-market benefits for owning livestock and large herds of cattle, the findings from the study show a negative relationship between herd size and social reasons for owning livestock. Farmers who kept cattle for social reasons had 41 percent smaller herd sizes compared to those who did not. This could be attributed to the poverty and unemployment levels in the study area, thereby rendering social reasons as the main reason to view keeping livestock as less important.

Contrary to the hypothesised statement, the results from the study show that farmers with off-farm employment have smaller herd sizes (21% less) compared to the farmers who depend solely on farm employment. This finding contradicts results of Teweldemedhin and Kafidi (2009) who report that farmers are able to generate additional income from off-farm employment, which is then used to purchase additional stock. This finding can be attributed to the fact that farmers in the study area are relatively poor so that any extra income they generate from off-farm activities is used to buy necessities such as food for daily consumption instead of buying additional stock of cattle. Similarly, the results from the study show that farmers receiving welfare assistance in the form of disability grants or pensions have smaller herd sizes (23% less) compared to those not receiving assistance. This finding is in disagreement with that of Nthakheni (2006) who reports that access to other sources of income such as pension or disability grants may put more buying power at farmers' disposal, which enables them to purchase livestock, thus expanding their existing stock. It is, however, important to note that receiving welfare grants may serve as a disincentive for farmers to look for alternatives to sustain their livelihoods or increase their incomes.

4 CONCLUSION AND IMPLICATIONS OF THE STUDY

This study analysed determinants of herd size among communal livestock farmers in Mhinga district in the Limpopo province of South Africa. A negative binomial model was chosen to implement the empirical analyses given the over-dispersed count data measuring our response variable (herd size). Contrary to the popular belief that rural households in developing countries generally own large herds of livestock for social reasons, communal livestock farmers in the study area who kept livestock for social reasons were found to own smaller herd sizes of cattle. The research indicates that economic reasons for livestock ownership are more important than social reasons among smallholder livestock farmers in the study area. An important implication of this finding is the great potential this presents for economic policy to enhance the welfare of this and similar groups of small-scale cattle farmers in the country. This is because livestock in the study area is a major source of cash income for farmers as 99 percent keep livestock to provide income for their household. One policy proposal is for government to introduce appropriate livestock subsidy programmes that can assist farmers to expand their herds and to find ways to optimally manage their herds.

In addition, the study also found that access to marketing channels such as selling to local butcheries encourage farmers to keep larger herd sizes. This reinforces the potential for economic policy interventions such as the establishment of efficient and well-functioning markets including improved access to better roads as well as other market information such as current market prices for their

products. However, while the study area resembles most regions in rural South Africa where smallholder livestock farming is practiced, these findings need to be carefully assessed and validated through replication of similar studies in other rural areas of the country.

Measures to provide protection against livestock predation and death from transmission of diseases such as FMD from wildlife will contribute to reduction in stock losses and, in turn, to the welfare of these small-scale cattle farmers. This justifies public investments in efficient game-proof fences that will effectively deter wildlife from escaping from game parks and coming into contact with adjacent communal livestock. The study results also suggest that investing in farmers' education and awareness of new technological innovations and appropriate measures and practices in breeding and veterinary services are critical for improving small livestock farmers' welfare. It is also noted that theft presents a major challenge within the farming community living adjacent to the KNP due to shared borders with Zimbabwe as well as the lack of designated fenced grazing areas for their livestock. Policy proposals to address theft could include government being actively involved in policing the criminals or establishing fenced grazing areas.

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ANNEX 1: DEFINITION OF VARIABLES INFLUENCING HERD SIZE OF SMALL-SCALE CATTLE FARMERS

Variables	Variable description	Expected sign
Household characteristics		
Gender	Male=1, 0 female	+
Age of the farmer	Categorical: 19–40; 41–60; 61–80; 81+	+
Marital Status	Unmarried=1, 0 otherwise	-
Family size	Categorical: 1-5; 6-10; 11+	+
Level education	Schooling (primary, secondary and college) =1, 0 otherwise	+
Source of income/livelihood		
Employment	Off-farm-employment=1, 0 otherwise	+
Access to welfare grants	Access welfare grants=1, 0 otherwise	-
Access to marketing channels		+
Selling to local people or local butcheries	Local people=1, 0 otherwise	
Land ownership	Yes=1, 0 otherwise	+
Cattle sale	Categorical : 0; 1+	+
Livestock losses		
Theft	Yes=1, 0 otherwise	+
Death (diseases)	Yes=1, 0 otherwise	+
Livestock predation	Yes=1, 0 otherwise	+