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Factors Influencing Livestock Production Losses in Drought-Prone Semi-Arid Region of South Africa: A Case Study of Limpopo River Basin

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Abstract: Livestock constitute a major enterprise for income generation and storage of wealth in rural South Africa. In the Limpopo river basin, production is confronted with several climate-related factors among which localized or regional drought is of utmost importance. In this study, factors influencing losses of livestock (cattle) were analyzed. The data were collected by the International Food Policy Research Institute using multi-stage sampling procedure. Livestock farmers constitute 29.81% (237) of the total samples. The Tobit Regression Method was used for data analysis along with some simple descriptive methods.

Key words: Production losses, livestock, cattle, semi-arid, drought

INTRODUCTION

Rural livelihoods in South Africa's semi-arid agro-ecological zone are largely dependent on agriculture and its cottage industries. Although, crop farming is common, majority of the farmers keep livestock as a primary income generating enterprise or as supplementary income or food sources. Livestock husbandry is also important for some cultural, prestige and insurance reasons (Swinton, 1988; Fafchamps *et al*., 1998; Kabubo-Mariara, 2008). Farmers often engage in different enterprises because of their consciousness of the need to allocate production resources in a way that gives optimum returns. However, production risks and uncertainties often constitute unavoidable limiting forces. Presently, about 3% of South Africa's Gross Domestic Product (GDP) is contributed by primary agriculture which also accounts for about 7% of formal employment. However, existence of strong forward and backward linkages within the economy makes agro-industrial sector to account for 12% of GDP DAFF (2012).

With its elegant urban settings many South African rural areas are lacking in some basic social services. The post-apartheid development agendas are addressing growing inequality and poverty, especially among the black population. It had also been estimated that more than halve of South African population is poor and majority live in rural areas (Madzwamuse, 2010). The situation in the Limpopo river basin is more devastating due to small land holdings of majority of the farmers. Commercial farming occupies 85% of the countryside farming activities. The area is also susceptible to adverse climatic situations like drought, flood and hailstorms.

Current climatic records confirming the Intergovernmental Panel on Climate Change alarms on the reality of climate change.

Due to its geographical location, South Africa is among the countries expected to be more adversely affected by climate change. However, livestock farming is expected to be adversely affected by these changes because of changes in temperature, solar radiation, humidity and wind. Given IPCC prediction of between 1.8° and 4.0°C rise in global average temperature by 2100 about 20-30% of plant and animal species are expected to be at risk of extinction (FAO, 2007).

Increasing population pressure in the Limpopo river basin is also putting serious pressure on the natural resources with persistent degradation resulting from intensification. Therefore, currently available natural resources cannot provide rural people guaranteed livelihoods to escape from poverty. This is more pressing because external influences resulting in climate change are now part of the equation (Madzwamuse, 2010). What is more appalling is the negative impact that climate change has on livelihoods of the poorest and most vulnerable segment of the rural population. Similarly as climate change persists, livestock production is further affected by climatic impacts on feed digestibility, pasture availability and the distribution and intensity of pests and diseases.

In some instances, unfavourable climate induces vigorous growth of poisonous weeds, thereby constituting risks to livestock health and survival (McGregor, 1993; Easterling *et al*., 1993; SASAS, 2011). Agricultural statistics by the DAFF (2012) revealed that livestock production in South Africa has fluctuated in the

past few decades. It was noted that while cattle heads increased to 9.29 millions in 1977, the number sharply declined to 7.83 millions in 1985. However, in 2008, 2009, 2010 and 2011, cattle heads steadily declined with 8.28, 8.24, 8.22 and 8.18 millions, respectively.

Seasonal rainfall in semi-arid regions is concentrated in the summer months when high temperatures and evaporation reduce moisture availability. Therefore, agropastoral drought can result if rain refuses to fall at the appropriate time within the crop-planting and livestock-birthing season (Scoones, 1995). It should be noted that in order to have sufficient rains for farming activities, traditional communities in Southern Africa historically conducted rainmaking ceremonies at the beginning of the wet season. In some instances, crop and livestock losses due to prolonged drought and diseases were blamed on incompetent traditional chiefs that were front liners in such ceremonies. Also, perceptions of welfare losses as a result of environmental damages is a relative and personal issue because a farmer that lost 50 out of 200 head of cattle to drought will perceive conditions to have been less severe that someone that had lost 50 out 75 (Mortimore, 1998).

This study seeks to determine involvements of farm households in different livestock enterprises and determine the impact of climate related factors on mortality. The hypothesis of no significant relationship between animal mortality and climate related variables was tested.

MATERIALS AND METHODS

Data and sampling methods: This study used the data that were collected by the International Food Policy Research Institute (IFPRI) and the Center for Environmental Economics and Policy in Africa (CEEPA). Permission to download the data was granted by IFPRI. The survey was based on 794 households that completed the questionnaires out of 800 that were initially targeted.

Out of the respondents, 237 households were identified as livestock farmers that keep cattle. These constitute the respondents for the analysis. Data were collected using multi-stage sampling method of 20 districts from South Africa's Limpopo river basin. The selected districts reflect key Water Management Areas (WMAs) and agricultural production activities. At the first stage, total number of sample districts was identified. At the second step, 20 districts were selected out of the 5 WMAs. The third step involved determining the distribution of the 20 districts across the 4 provinces in the basin. The Gauteng (2), Limpopo (9), Mpumalanga (6) and North West (3) were selected. The fourth step involved random sampling of farm households that undertook some farming activities during the April 2004 to May 2005 farming season. The survey was carried out between August and November, 2005.

Estimated model: Factors explaining cattle mortality were estimated using the Tobit Model. This is due to the fact that the data were continuous but with possibility of zero value where the farmer did not record any mortality. The model is stated as:

$$Y_i = \eta + \beta_i \sum_{i=1}^{15} Z_i + e_i \quad (1)$$

Y_i is number of cattle that died. The independent variables (Z_is) are grazing land area (ha), drug (litre) number of initial beef cattle stock number of cattle born, cattle price (Rand), credit obtained (Rand), report of theft (yes = 1, 0 otherwise), report of disease (yes = 1, 0 otherwise), missing (yes = 1, 0 otherwise), drought (yes = 1, 0 otherwise), sex (male = 1, 0 otherwise), age (years), job hours, university education (yes = 1, 0 otherwise), trained on livestock production (yes = 1, 0 otherwise), extension contact (yes = 1, 0 otherwise) weather information from television (yes = 1, 0 otherwise), weather information from radio (yes = 1, 0 otherwise), weather information from neighbour (yes = 1, 0 otherwise), member sick during winter (yes = 1, 0 otherwise), member sick during summer (yes = 1, 0 otherwise) and market distance (km). η and β_i are the parameters to be estimated and e_i is the error term.

RESULTS AND DISCUSSION

Socio-economic characteristics of livestock farmers: Table 1 shows some socio-economic characteristics of livestock farmers. It reveals that 72.57% of them were males. Average age of the farmers is 52.41 with standard deviation of 17.764. Average number time spent on primary job per day is about 8 h. Also, 11.81% had university education while 34.18% were trained on livestock production. Extension contacts were had by

Table 1: Summary statistics of livestock farmers' socio-economic variables

Socio-economic factors	Mean	SD
Sex	0.7257384	0.4470856
Age	52.4050600	17.7643600
Job hours	8.0886080	7.7697640
University education	0.1181435	0.3234610
Trained on livestock production	0.3417722	0.4753075
Extension contact	0.2911392	0.4552490
Weather information from television	0.3333333	0.4724022
Weather information from radio	0.3670886	0.4830311
Weather information from radio neighbour	0.2953586	0.4571693
Member sick during winter	0.4852321	1.1917770
Member sick during summer	0.2194093	0.8093488
Market distance	27.8565400	46.8845100

29.11% while 33.33% got some information on weather from television. Also, 36.71% obtained weather information from radio and 29.54% from neighbours. About 48.52% of the farmers indicated that someone was sick in the winter while 21.94% indicated same for summer. Average market distance is 27.86 km with standard deviation of 46.885.

Stock of livestock owned by farmers: Table 2 shows the number of livestock owned by farmers in 2004 and 2005. The results show that average number of beef cattle increased from 47.38 in 2004 to 51.33 in 2005. However, average numbers of dairy cow decreased from 2.54 in 2004 to 1.46 in 2005. Average number of breeding bull also decreased from 0.30 in 2004 to 0.93. Goat is another livestock that is kept against drought due to their ruggedness. The table reveals that average number of goats increased from 4.38 in 2004 to 6.18 in 2005.

The average number of sheep that was owned also slightly increased from 2.30 in 2004 to 2.36 in 2005. Average number of chicken increased from 1013.55-23655.93 in 2004 and 2005, respectively. Other livestock where some increases were recorded in ownership include pigs, fish and oxen. Table 3 shows the average number of livestock born within the cropping season of April 2004 to May 2005.

It reveals that average beef cattle is 17.78 which is the highest among the livestock groups. Also, average number of goats that were born is 1.42 while average dairy cow born is 0.78. Table 4 shows the average number of livestock that were lost in 2004. It shows that chicken recorded the highest with 26.52. Also, loss reported for beef cattle is the next highest with 3.97. Average number of goats that were lost is 1.05.

Table 2: Average number of livestock owned by farmers in 2004 and 2005

Livestock	2004	2005
Beef cattle	47.38	51.33
Dairy cow	2.54	1.46
Breeding bull	0.30	0.93
Goats	4.38	6.18
Sheep	2.30	2.36
Chicken	1013.55	23655.93
Lamb	0.22	0.12
Horse	0.05	0.05
Pigs	1.86	2.22
Fish	0.00	6.87
Beehives	0.00	0.00
Donkey	0.11	0.08
Oxen	0.00	0.52

Table 3: Average number of livestock that were born in 2004

Type of livestock	Average born	SD
Beef cattle	17.48	57.30
Cattle (dairy)	0.78	9.84
Breeding bull	0.14	1.04
Goats	1.42	4.41
Sheep	0.96	4.05
Chicken	0.73	6.40
Lamb	0.03	0.52
Pigs	0.50	5.60
Donkey born	0.00	0.06
Horse born	0.00	0.06

Losses of livestock and reasons

Table 5 shows reasons adduced for livestock losses by livestock farmers. It reveals that highest losses were reported in cattle kept for meat where diseases resulted into cattle losses among 52 farmers (21.94%). It should be emphasized that the problem of tsetse-fly is predominant in the Limpopo river basin. This has often resulted into sleeping sickness and death among cattle. Historically, Ford (1971) reported that it had been very difficult eradicating tsetse flies because both wild and domestic animals act as hosts and both the riverine vegetation and C. mopane grassland of the river basin are suitable habitats. Losses as a result of diseases are also reported for goats and sheep. Also, 8.86% of the farmers reported losses of cattle kept for meat as a result of theft. About 12.34 of the farmers reported stolen chicken.

In a community where poverty is pervasive some households decide to steal in order to meet some of their needs. Also, notable among the reasons for livestock losses is drought that was reported by 8.86% of the farmers for cattle kept for meat. Depending on whether it is localized or regional, pastoralists have often migrated

Table 4: Average number of livestock that were lost in 2004

Livestock	Mean	SD
Cattle	3.97	5.98
Bull	0.09	0.74
Goat	1.05	4.02
Sheep	0.55	2.74
Chicken	26.52	376.84
Horse	0.00	0.06
Pigs	0.14	1.10
Dairy cow	0.72	7.91
Lamb	0.11	1.19
Fish	0.04	0.65

Table 5: Frequency distribution of farmers' reasons for reported losses of livestock

Reasons	Beef cattle	Dairy cow	Pig	Bull	Goats	Sheep	Chicken	Lamb	Fish
Disease	52	2	1	4	14	14	8	1	2
Animal fighting	1	-	-	-	-	-	-	-	-
Stolen	18	1	1	1	3	5	29	1	-
Missing	8	1	1	-	6	3	-	-	-
Fell on the rocks	1	-	-	-	-	-	-	-	-
Poisonous food	2	-	-	-	2	-	-	-	-
Red water	1	-	-	-	-	-	-	-	-
Snake bites	2	-	-	-	-	-	-	-	-
Ticks	1	-	-	-	-	-	-	-	-
Birth problem	1	-	-	-	-	-	-	-	-
Drought and lack of feeds	21	1	1	1	5	1	-	-	-
Drowned and bites	1	-	-	-	-	-	-	-	-
Killed by smoke	1	-	-	-	-	-	-	-	-
Others	11	1	1	1	2	1	7	-	-

from place to place in search pasture. However, when drought is regional, it is difficult to migrate and livestock death is inevitable. It should also be emphasized that during period of drought, scarcity of pasture often makes cattle to eat weeds that may be poisonous. This is also part of the reasons reported to have contributed to livestock losses.

Factors explaining cattle losses: Table 6 shows the results of Tobit regression to determine the factors influencing cattle losses among the farmers. It shows that the model produced a good fit for the data given the statistical significance of the Chi-square parameter ($p<0.01$). The sigma is also statistically significant ($p<0.01$). This also implies that the model fits the data properly. Among the parameters that show statistical significance, number of beef cattle is with negative sign ($p<0.05$).

This implies that if the initial stock of cattle increases by one unit, number of cattle lost will reduce by 0.0166 unit. Also, parameter of the number of cattle born is with positive sign and statistically significant ($p<0.01$). This implies that if the number of cattle that is born increases by one unit, cattle losses will reduce by 0.0838 unit. The amount of credit livestock farmers were able to obtain is with negative sign and statistically significant ($p<0.10$).

Table 6: Tobit regression results of determinants of cattle losses

Variables	Coefficient	SE	t-statistics
Grazing land	0.0516096	0.0393357	1.31
Drug	-0.0001874	0.0008359	-0.22
Number of beef cattle	-0.0165985**	0.0066634	-2.49
Cattle born	0.0838172***	0.0133466	6.28
Cattle price	-0.0521263	0.0393365	-1.33
Credit (Rand)	-1.63e-06*	9.62e-07	-1.70
Theft	6.272618***	1.058282	5.93
Disease	5.916522***	0.7686306	7.70
Lost	6.373082***	1.352315	4.71
Drought	9.407972***	1.15705	8.13
Sex	0.3584227	0.8431691	0.43
Age	0.0198839	0.0210245	0.95
Job hours	0.0145673	0.0467756	0.31
University education	1.025826	1.160297	0.88
Trained on livestock production	0.5019957	0.8135892	0.62
Extension contact	-1.061262	0.8316505	-1.28
Weather information from television	0.8473799	0.9307449	0.91
Weather information from radio	0.1724245	0.9249932	0.19
Weather information from radio neighbour	-1.08998	0.803637	-1.36
Member sick during winter	-0.3656873	0.327967	-1.12
Member sick during summer	-0.1649155	0.5197356	-0.32
Market distance	-0.0048709	0.0078037	-0.62
Constant	-2.641008*	1.524412	-1.73
Sigma	4.979715***	0.2785228	

*Statistically significant at 10%, **Statistically significant at 5%, ***Statistically significant at 1%, Log likelihood = -542.89049, LR χ^2 (22) = 184.54***, Pseudo R^2 = 0.1453

This shows that if the amount of credit obtained increases, the number cattle that will be lost will reduce. The parameter of theft experience is positive and statistically significant ($p<0.01$). This shows that farmers that reported theft have their autonomous livestock losses increased by 6.273. Also, the parameter for farmers that reported disease outbreak on their farm is with positive sign and statistically significant ($p<0.01$). This also shows that farmers that reported disease outbreaks have their autonomous livestock losses increased by 5.197. The parameter estimated for those that reported missing livestock is with positive sign and statistically significant ($p<0.01$). This implies that farmers that experienced missing livestock have their autonomous live stock losses increased by 6.373. Drought incidence parameter has positive sign and statistically significant ($p<0.01$). This also implies that farmers that experienced that reported drought theft have their autonomous livestock losses increased by 9.408. It should be noted that this parameter is with the highest value which indicates its importance in explaining cattle losses.

CONCLUSION

Results show that beef cattle, sheep and goats owned increased between 2004 and 2005 but dairy cow number declined. Losses of livestock was largely attributed to theft, drought and diseases. Tobit regression results show that cattle losses reduced significantly ($p<0.01$) with initial stock of cattle and amount of credits obtained while it significantly increased with number born, experience of theft missing drought and diseases. It was recommended that adequate efforts to enhance livestock production should ensure risk insurance among farmers, access to credit, among others.

RECOMMENDATIONS

Livestock production in semi-arid Limpopo river basin is affected by series of factors. The findings show that drought, diseases and theft were very vital to losses incurred by the farmers. There is therefore the need to ensure survival of livestock during drought through adequate supports in the form of subsidized fodders. Adequate veterinary services are also recommended in order to cope with livestock diseases. Livestock theft can be minimized by organizing trainings for farmers on how to ensure adequate security of their livestock and government's initiatives for poverty reduction. It is believed that people steal because they are lacking some

basic facilities. Interventions by faith-based organizations in teaching morals and contentment can also be of assistance. Interventions by government and other stakeholders in providing credit assistance to livestock farmers will reduce the production losses.

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