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Livestock Farmer Demography and Adaptive Capacity to Climate Change and Variability in Limpopo and Mpumalanga Province of South Africa

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Abstract. The study investigated the demographic characteristics of smallholder livestock farmers in Limpopo and Mpumalanga Province of South Africa and their effect on the capacity of the farmers to adapt to climate change and variability. Respondents were mainly heads (58.7%) and parents (25.7%) to heads of households and were mostly male (63.4%) with good health (97.8%) associated with high adaptive capacity to climate change and variability. Regarding socio-economic status, four in five (81.5%) of the livestock farmers had only secondary education at most, and incomes were generally low, probably associated with low capacity to adapt to climate change and variability. On the contrary, the quality of housing for the livestock farmers was either top (48.5% of farmers) or medium (47.4%). Some 45.9% of farmers owned 4 to 5 rooms, 44.5% owned six or more rooms, with 88.5% of them having financed their houses. Almost all the respondents (97.3%) had access to electricity, and these suggest the high capacity to adapt to climate change and variability. With regards to aspects of livestock farming, one male (40.1% of households) and female (39.3%) member was fit to work in farming, livestock was owned by heads (52.9% of the households) and by children (29.0%), affirming the high capacity to adapt to climate change and variability. Almost all respondents (99.2%) used communal land, had fewer livestock, lacked training (99.5%), never belonged to a farmers' union (99.7%) or a producer organization (100.0%), and had no access to financial support from the government (99.2%) associated with low adaptive capacity. The findings of the study revealed that demographic factors had different influences on the capacity of smallholder livestock farmers to adapt to adverse effects of climate change and variability on the farming enterprises. This was true for all the three types of demographic factors studied, namely: personal characteristics, economic status, and aspects of livestock farming.

Keywords. Vulnerability, Exposure, Sensitivity**,** Smallholder livestock farmers, Communal land

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1. Introduction

1.1. *Effect of climate change*

Climate change may involve gradual changes in long-term average conditions of climate, greater variability in normal conditions; or changes in the frequency, magnitude, and distribution of extreme events (Smit et al., 2000). Climate change and variability have adverse effects both environmentally and socio-economically (Scholze, Knorr, Arnell, & Prentice, 2006). Agriculture is dependent on environmental conditions such as temperature, nutrient availability, and water accessibility (Rosenzweig and Hillel 2008; Lobell et al. 2011; Lin et al., 2007) and is hence vulnerable to climate change. In South Africa, climate change is predicted to result not only in higher temperatures but also in sporadic rainfall patterns and frequent droughts (Turpie and Visser, 2013). These severe weather events, coupled with the country's already scarce water resources, are expected to have a significant effect on the forestry and agricultural sectors, which are substantial components of the country's rural livelihoods and economies (Quinn et al., 2011; Turpie & Visser, 2013).

Climate change manifestations in the form of rising temperatures, changes in water availability and increased levels of carbon dioxide are expected to affect farming and forest-based livelihoods in various ways (Sonwa et al., 2012). Rural communities are believed to be particularly vulnerable to climate change (Holmes, 2007; Turpie and Visser, 2013) resulting from the effect of climate change on social and economic factors (David et al., 2007). It may therefore be affirmed that climate change poses social and economic challenges for rural communities with high dependence on natural resources (Fairbanks and Scholes, 1999; Turpie and Visser, 2013), and these include farmers, especially smallholder farmers estimated at 450-500 million or 85% farms globally (Nagayet, 2005). In affirmation of the occurrence of adverse effects induced by climate change in agriculture, O'Brien et al. (2004) revealed that smallholder farmers in the tropics already face numerous risks to their production, including pest and disease outbreaks, extreme weather events and market shocks. Smallholder farmers typically depend directly on agriculture for their livelihoods and have limited resources and capacity to cope with shocks. Resultantly, any reduction in agricultural productivity can have significant impacts on their food security, nutrition, income, and well-being (McDowell & Hess, 2012).

1.2. Vulnerability to climate change

Ncube et al. (2016) define vulnerability as the extent to which one is prone, at-risk or likely to be food insecure. As further indicated by Ncube et al. (2016), vulnerability has two sides, namely an external side with risks, shocks, and stress to which an individual is subject and an internal side with a lack of means with which to cope when facing loss. Vulnerability is most often associated with poverty, but can also arise when people are isolated, insecure, and defenceless in the face of risk, shock or stress (Birkman, 2006). Gbetibouo & Ringler (2009) conceptualized vulnerability as a state that exists before encountering a climatic shock. In general, climate change researchers agree that vulnerability is determined by the level of exposure to an event or impact and the corresponding adaptive capacity (IPCC, 2001; Yohe and Tol, 2002). Vulnerability is a state or a process, rather than a set of biophysical impacts arising from a particular event (Adger et al., 2004; O'Brien et al., 2004) while adaptive capacity is the ability of a system to adjust to or cope with, stress (Adger and Vincent, 2005; Brooks et al., 2005; Luers et al., 2005). Therefore, vulnerability can be summarized as a function of three attributes, exposure, sensitivity, and adaptive capacity.

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(a) Exposure

Exposure relates to the degree of climate stress upon a particular unit of analysis; it may be represented by either long-term changes in climate conditions or climate variability, including the magnitude and frequency of extreme events (O'Brien et al., 2004). Exposure can be interpreted as the direct danger (i.e., the stressor), and the nature and extent of changes to a region 's climate variables (e.g., temperature, precipitation, extreme weather events). Exposure as an attribute of vulnerability is linked to the type, magnitude, and frequency of the climate stimuli (Smithers and Smit 1997) and is sometimes considered as an external property of socioecological systems (Gallopín 2006).

(b) Sensitivity

Sensitivity is the extent to which a body is either adversely or beneficially, directly, or indirectly affected by climate change and variability (IPCC, 2007). Sensitivity emerges from the interface between climate events and socioeconomic systems, reflecting the susceptibility of a system to certain disturbances (Finan and Nelson, 2001). Sensitivity describes the human-environmental conditions that can worsen the hazard, ameliorate the hazard, or trigger an impact. Gallopín (2003) referred to sensitivity as the degree to which a system is modified or affected by an internal or external disturbance or set of disturbances. This measure, which herein reflects the responsiveness of a system to climatic influences, is shaped by both socio-economic and ecological conditions and determines the degree to which a group will be affected by environmental stress (SEI, 2004; Turner et al., 2003).

(c) Adaptive capacity

Adaptive capacity is considered ''a function of wealth, technology, education, information, skills, infrastructure, access to resources, and stability and management capabilities'' (McCarthy et al., 2001, p. 8). The number of livestock owned, ownership of radio and quality of residential homes are commonly used as indicators of wealth in rural African communities (Vyas and Kumaranayake, 2006). According to Smith and Lenhart (1996), countries with well-developed social institutions are considered to have greater adaptive capacity than those with less effective institutional arrangements. Wealth enables communities to absorb and recover from losses more quickly (Cutter et al., 2000). Adaptive capacity describes the ability of a system to adjust to actual or expected climate stresses or to cope with the consequences. Adaptive capacity can be defined as the "ability of socioecological systems to administer, accommodate, and recover from eventual environmental disturbances" (Smit and Wandel 2006). In socioecological systems, it is linked to governance aspects that allow rapid transitions between options every time response to an environmental change becomes necessary (Smit and Wandel 2006; Adger et al., 2009; Holling and Meffe 1996).

Therefore, the strengthening of institutions and organizational landscapes—social capital, legislation, information flows, resources, learning capacity, and accumulated knowledge—are vital to adaptation (Dietz et al., 2003; Eakin and Lemos, 2010). Adaptive capacity also relies on the availability of technical support to implement adaptation strategies and access financing mechanisms (Smit and Wandel, 2006; Jones and Boyd, 2011). Adaptive capacity is highly dependent on the capacity of farmers and their families to access key information and to collectively self-organize (Smit and Wandel, 2006; Jones and Boyd, 2011). Reading and writing are basic conditions for farmers to have the ability to access information available in written and electronic media and to use that information for the exercise of their citizenship, thus creating conditions for adaptation to climate change (O'Brien et al., 2004).

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The objective of this research was to conduct a demographic study on the livestock farmers in Limpopo and Mpumalanga Provinces of South Africa and to subsequently assess their capacity to adapt to the adverse effects of climate change and climate variability.

2. Research Methodology

2.1. *Sampling frame and procedure*

2.1.1. *Sampling frame*

A sampling frame refers to a list of all units in a population from which a sample is drawn. In practice, not all units in a population might be available for sampling for one reason or another. The importance of a sampling frame in scientific research was shown by Welman *et al.* (2005) who revealed that it is impossible to properly judge the representativeness of the obtained sample unless a sampling frame is borne in mind. A representative sample is a requirement for subsequent research results to be credible and trustworthy (Leedy and Ormrod, 2010). In Limpopo Province, the sampling frame consisted of a database of village households owning livestock in the Vhembe District municipality in 2013. All four local municipalities of the Vhembe district were considered, i.e., Makhado, Musina, Collins Chabane and Thulamela. The population of interest included 23 283 households owning livestock from 362 villages.

In the Mpumalanga Province, the sampling frame consisted of a database of village households owning livestock in Gert Sibande District Municipality in 2016 (StatsSA, 2018). All seven local municipalities of Gert Sibande District were considered i.e. Chief Albert Luthuli, Msukaligwa, Mkhondo, Dr Pixley Ka Isaka Seme, Lekwa, Dispalesing and Govan Mbeki. The population of interest included 27 706 (57 962 including chicken production) households owning livestock from 183 villages. In all the provinces, only the total number of households owning livestock in a particular village was available and not the individual household identities. For sampling, a household list was ordered from *1 to* n_k where n_k is the total number of households owning livestock in a village.

2.1.2. *Sampling procedure*

At least 400 smallholder livestock farmer households were sampled for interviews to elicit responses on demographic issues that would in one way or the other influence the adaptive capacity of the livestock farmers to adverse effects of climate change and climate variability. Systematic purposive sampling was used to select farmers within the five identified agro-ecological zones of Limpopo and four such zones in Mpumalanga Province (Figure 1). An effort was made to have a minimum of 10 randomly sampled farmers per village.

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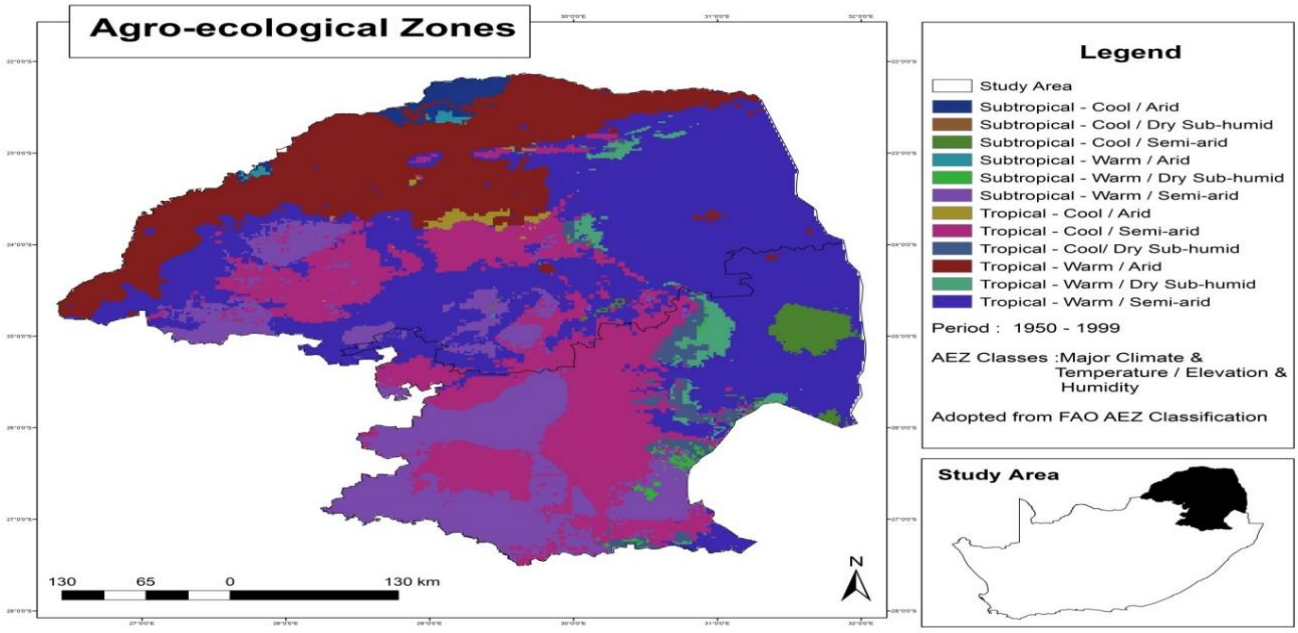

Figure 1. Agro-ecological zones, derived from FAO (1978)

Stratified sampling was used to obtain a representative sample of villages and households for interview. A two-stage random sampling process was conducted using *SURVEYSELECT* procedure of SAS. The *PROC SUREVEYSELECT* allows the selection of probability-based random sampling, where sampling in different categories or classes depends on the number of units within that class.

2.2. Data collection

Data and pertinent information for the study were mainly collected through interviews of the sampled respondents (smallholder livestock farmers) and the study of relevant literature.

2.2.1. Respondent interviews

A semi-structured questionnaire was used to interview the smallholder livestock farmers. Among the issues included in the questionnaire were demographic and economic household characteristics as well as livestock production issues. The focus was on investigating the demographic factors and hence describing the adaptive capacity of interviewed smallholder livestock farmers to climate change and variability. Primary data were collected from the sampled respondents through interviews which were conducted by trained enumerators using a semi-structured questionnaire. The questionnaire contained both open- and closed-ended questions which included demographic factors such as gender, and education. The closed-ended questions collected quantitative data while the open-ended questions recorded qualitative data (Leedy and Ormrod, 2010). Qualitative techniques were directed towards improved understanding of the demographic factors and their possible influence on the capacity of respondents to adapt to adverse effects of climate change and climate variability. This research method that combines the collection and analysis of quantitative data with that of qualitative data is referred to as a mixed study (Hurmerinta-Peltomaki and Nummela, 2006).

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2.2.2. Literature review

A review of literature is an exercise where the researcher works from a 'sample' of texts that he/she reads to come to a proper understanding of a specific domain of knowledge. As a result, the sources of the literature must be representative to achieve a good quality review (Mouton, 2001). In this study, local, national, and international literature was reviewed based on the objectives of the study. An effort was made to include as much as possible pertinent and latest articles from peer-reviewed journals in the literature review. The literature review was conducted with a focus on identifying thematic issues.

2.3. Guiding model

Before proposing the guiding model of this study, it is perhaps necessary to attempt to define the concept 'model'. Although there is wide agreement that models are important elements in scientific practice, no unique definition of models has been established. Even scientists who consider models to be central to their research have different meanings of these models (Van der Valk *et al.*, 2007). A model may be defined as an interpretative description of a phenomenon (Bailer-Jones, 2003). As stated by Bailer-Jones (2003), the word 'description' in this definition includes various forms of representation. The ability of a model to describe a specific phenomenon depends on the interpretation that goes beyond pure phenomenological reality (Bulle, 2009). The phrase 'interpretive description' is therefore key in this definition. Also, a model may be regarded as a representation of how some aspect of the world works (Windschitl and Thompson, 2006). There is a great variance in what can be represented by a model, and this includes the different descriptors of the modelled world, e.g. targets and systems (Oh & Oh, 2011). A model is a representation of some target in the sense that it stands for that target as its substitute. Instead of obtaining information about the target by examining it directly, one may therefore examine the properties of the model and indirectly acquire information about the target (Grune-Yanoff, 2011). The guiding model for this study, also referred to as a framework, was described by Lindoso (2011) and presents adaptive capacity as one of the three attributes of vulnerability and enlists the indicators for each attribute (Table 1).

Table 1. Framework for the vulnerability of small-scale farmers (Lindoso, 2011)

Vulnerability attribute	Indicator
Exposure	Aridity Index (AI)
	Annual Distribution of rainfall
Sensitivity	Municipal population occupied by smallholder agriculture (%)
	Establishments with access to water (%)
	Establishments with rain-fed farming (%)
Adaptive capacity	Smallholder system product diversification (%)
	Establishments in which the producer is the landowner (%)
	Establishments in which the administrator can read and write (%)

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Establishments in which a producer is a member of the association or union (%)

Establishments that receive technical assistance (%)

Agricultural establishments with access to electricity (%)

The investigation focussed on demography and adaptive capacity and hence the indicators (for adaptive capacity) as presented by Lindoso (2011) received thorough consideration. Also, considering McCarthy et al. (2008, p. 8)'s definition of adaptive capacity, Lindoso (2011) model seemed rather deficient. Resultantly, the Lindoso (2011) was adapted and not adopted in its original form. The adapted model used in this study enlists up to 16 indicators that influence the adaptive capacity of smallholder livestock farmers to adverse effects of climate change and variability. The expanded list of indicators is all in per cent and are categorized under three thematic areas, namely:

(a) Personal characteristics (five indicators): Position of the respondent in a household, gender, age, health, and educational status.

(b) Economic status (five indicators): Employment status, household income, quality of housing, size of housing, and household energy supply.

(c) Aspects of livestock farming (eight indicators): Fitness to work in agriculture, land ownership, livestock ownership, farming status, number of livestock owned, livestock ranking, exposure to capacity building, and number of dependent household members staying off the farm.

This study adopted the adapted model with the expanded list of indicators for livestock farmers adaptive capacity to climate change and climate variability.

3. Results and Discussions

Studies addressing the demographics such as personal factors, decision making, access to agricultural information, socio-economic variables and the sociocultural milieu of small-scale farmers have been limited (Bembridge & Tshikolomo, 1998). While seeking to describe the adaptive capacity of livestock farmers to adverse effects of climate change and variability, the demographic study will be based on (a) personal characteristics of respondents, (b) economic status, and (c) various aspects of their involvement in livestock farming.

3.1 *Personal characteristics*

3.1.1 *Position of the respondent in the household*

For any demographic study, the position of the respondent in the household has a huge influence on the quality of the information provided. According to Bembridge and Tshikolomo (1998), heads of households are the main decision-makers in rural farming households and as a result, the information they provide is more likely to reflect on farming and other developmental decisions of the household. It was evident in this study that three in five (58.7%) respondents were heads of households, suggesting that the information provided by most respondents highly likely reflected the decisions of livestock farming households (Table 2).

It is interesting to note that following the heads of household, the next largest categories of respondents were the mother (17.8%) and father (7.9%) to the head. In a rural setup, the parents to the (often male) head of household usually stay in the same homestead as their son's family and are often consulted (or at least informed) when major decisions are made. As a result, one in four respondents (25.7% - 17.8% mothers and 7.9% fathers) who were

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parents to the heads of household could also have provided valuable information that would accurately reflect on the adaptive capacity of the small holder livestock farmers to adverse effects of climate change and variability.

Table 2. Position of respondents in surveyed livestock farming households in Limpopo and Mpumalanga Province of South Africa

Category	Frequency	Percent
Head	215	58.7
Spouse	11	3.0
Mother	65	17.8
Father	29	7.9
Son	19	5.2
Daughter	9	2.5
Niece/ Nephew	1	.3
Grandpa	12	3.3
Other	5	1.4
Total	366	100.0

3.1.2 *Gender, age, and health status*

Personal characteristics of farmers such as gender, age, and health status have some influence on farming decision making and indeed the profitability of a farming enterprise. In a society, there is inequity among different groups (Malakar and Misha, 2017), populations belonging to lower castes, old age, disability, and illiterates are assumed to be the weaker sections of the society who either have less access to resources or are restricted by their physical incapability.

(a) Gender

It is necessary to establish the differences in the roles played by males and females in farm households since these gender differences are likely to influence their capacity to adapt to climate change as well as their choices of climate change adaptation strategies (IFPRI, 2015). Most of the livestock smallholder's farmers in the current study were males (63%), while 37% were females (Table3), which implies that livestock farming is dominated by males. Similar observations were made in a study of youth agricultural projects in Limpopo Province, Maele *et al.* (2015) revealed that the majority of farmers (74%) were male. The finding that men were the majority owners of agricultural projects was also affirmed by Bembridge and Tshikolomo (1998) who revealed that 90% of fruit growers in the Phaswana area of the Limpopo Province were males. Also, Ijatuyi *et al.* (2017) revealed that up to three in four (75%) of Nguni producers in the North-West Province of South Africa were men, further affirming the dominance of men in livestock production compared to their female counterparts.

With majority ownership of agricultural projects, men are probably able to make appropriate farming decisions that reflect improved adaptive capacity to challenges such as climate change and variability. Despite the effort of the democratic government to promote women empowerment and their equal participation in socio-economic activities (Maele *et al.*, 2015), men constituted most respondents on livestock projects, further affirming the dominance of men in livestock farming.

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Table 3 Gender, age and health status of livestock owners in Limpopo and Mpumalanga Province of South Africa

	Frequency	Percent
Gender		
Male	232	63.4
Female	134	36.6
Total	366	100
Age		
<18 years	2	0.55
18-35 years	25	6.87
36-54 years	98	26.92
55-65 years	102	28.02
>65 years	137	37.64
Total	364	100
Health status		
Good	348	97.8
Infrequently sick	8	2.2
Total	356	100

(b) Age

In the current study, the participation of youth in livestock farming is very frightening with only 7.4 % of the livestock farmers aged 35 years or less (Table 3). Mulinyac, (2017) reported that farmers within the ages of 30-34 years are likely to understand well issues involved in farming and therefore are armed with necessary information regarding climate change adaptation strategies that can be well achieved and adhered to. Two in three (65,7%) of farmers were aged 55 years and above of which almost two in five (37,6%) were aged >65 years. This observation agrees with Simotwo et al. (2018) who revealed that farmers were ageing. Older farmers could be resistant to change and thus may not see the need of employing new technologies and would prefer the traditional models of farming that they are familiar with other than adopting new methods (Fussel and Klein, 2006).

Farm productivity has been shown to deteriorate with the farmers' age, especially among the smallholders who largely rely on their physical labour to execute many farming responsibilities (Uddin et al., 2014, Labbe et al., 2016). However, Hassan & Nhemachena (2008) in determining farmers‟ strategies for adapting to climate change reveals that for farmers' age, in particular, older farmers are more experienced and expect older farmers to adapt to climate change better than farmers whose age are lesser. However, they also assumed younger farmers to have a longer planning horizon and to take up long term measures that will influence their decision to increase production levels. Deressa et al. (2010) report that age has a positive influence on the choice of livestock sale as an adaptation strategy by farmers during extreme climatic events.

(c) Health status

Almost all (97.8%) of the livestock owners in the study area had good health (Table 3). The health status of a farmer has a strong influence on his / her productivity and adaptive capacity to adverse effects of environmental factors such as climate change and variability to the success of the farming enterprise. This was affirmed by Ajani and Ugwu (2008) who

revealed that good health is related to better production and can enhance farmers' income and economic growth.

As stated by Ajani and Ugwu (2008), poor health will result in loss of workdays or decreased worker capacity, decrease innovation ability and ability to explore diverse farming practices. The livestock farmers would therefore be expected to have more workdays, increased work capacity, increased innovativeness and more ability to explore diverse farming practices. As a result, the livestock farmers may be expected to have a relatively better adaptive capacity to adverse effects of climate change and vulnerability.

3.1.3 *Educational status*

The importance of education in successful developmental activities such as farming cannot be overemphasized. The level of education has a strong influence on the extent to which a farmer can access new information and technology, not only through improved literacy that enables the farmers to access written information but also through the increased ability to search for information using modern information technologies. Citing Appleton and Balihuta (1996), Oduro-Ofori *et al.* (2014) described the effect of education on agricultural productivity as cognitive and non-cognitive.

Cognitive effects reportedly emphasize basic literacy and numeracy that farmers achieve from education while non-cognitive effects emphasize the change in the attitude of farmers who attended school due to improved discipline introduced by formal schooling. Better education may therefore be associated with the improved adaptive capacity to adverse effects of climate change and variability. One in six (18.2%) smallholder livestock farmers was completely illiterate, about two in five (37.5%) had primary education at most, with one in four (25.8%) having had some secondary/high school education. Only 17.5% of respondents had College or University education (Table 4). Based on these findings, four in five (81.5%) of the livestock farmers only had secondary education at best. Reading and writing are basic conditions for farmers to have the ability to access information available in written and electronic media and to use that information for the exercise of their citizenship, thus creating conditions for adaptation to climate change (O'Brien et al., 2004a).

Uddin et. al. (2014) found that the education level of farmers also positively and significantly affect climate change adaptation. The level of education of the livestock farmers in the current study proved to be generally low, a situation that may be associated with the reduced adaptive capacity to adverse effects of climate change and variability. The development of human assets in terms of education and skills enhances proper utilization of existing other assets and internalization of information related to early warning systems and community preparedness plans, which may help them and the communities in districts prepare for extreme weather events (Hahn et al., 2009). Unfortunately, only 4.1% of the farmers reported that they were improving their education (attending school) at the time of the survey, and reasons for non-improvement of education were revealed to be a lack of funding and poor health. Resulting from the lack of improvement of education, there may therefore be no expectation for improvement of the adaptive capacity of the current group of farmers.

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Table 4. Educational status (highest education) of livestock owners in Limpopo and Mpumalanga Province of South Africa.

	Frequency	Per cent
Educational information		
Illiterate	53	18.2
Some primary school	87	29.9
Completed primary school	22	7.6
Some secondary school	23	7.9
Completed basic secondary school	27	9.3
Completed high school	25	8.6
Professional college certificate	33	11.3
University education	18	6.2
Adult education	3	1.0
Total	291	100
Currently going to school?		
Yes	15	4.1
No	11	3.0
Not applicable	340	92.9
Total	366	100
If not scholar, reasons		
Lack of finance	1	20.0
Health	3	60.0
Work	1	20.0
Total	5	100
If scholar, who is your sponsor (N=8)		
Government	2	25.0
Parents	6	75.0
Total	8	100

3.2 *Economic status*

The economic status of livestock farmers has a huge influence on their capacity to adapt to adverse effects of environmental factors such as climate change and variability. Among the important economic factors influencing the ability of livestock farmers to adapt to adverse effects of climate change are employment status, income, type and size of housing, sources of energy, and ownership of various household equipment (radio, television, stoves, tele- / cell phone, computer, etc.). As stated by Ijatuyi *et al.* (2017), income is a potential proxy for livelihood. As highlighted, literature is explicit about the five pillars of livelihood which includes financial capital (stocks of money or assets in liquid form), natural capital (land, water, and biological resources), social capital (rights or claim derived from group membership), physical capital (infrastructure, resources created through economic production), and human capital (Ijatuyi *et al.*, 2017).

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3.2.1 *Employment status*

The employment status of livestock farmers tends to have some influence on their adaptive capacity to adverse effects of climate change and variability. Smallholder livestock farmers may need to be employed elsewhere to supplement the farming income and be able to buy required inputs to mitigate the adverse effects of climate change and variability. Such inputs may include feeds and provision of water during droughts, and vaccines and medication to treat livestock parasites and diseases associated with changing climatic conditions. For these smallholder livestock farmers, involvement in additional employment increases their adaptive capacity to adverse effects of climate change and makes their livestock enterprises recover faster when hit by climate-related disasters.

Table 5. Employment status of livestock farmers in Limpopo and Mpumalanga Province of South Africa.

Employment status	Frequency	Per cent
Unemployed	143	49.5
Homemaker/ Not applicable	17	5.9
Subsistence farmer	12	4.2
Artisan/ Skilled tradesman/ woman	24	8.3
Petty trade	12	4.2
Formal employment	77	26.6
Harvesting natural resources	4	1.4
Total	289	100.0

For large scale livestock farmers often characterized by being highly profitable, additional employment may not be necessary as it may deprive them of the much-required time to monitor their livestock and make prompt decisions to mitigate the adverse effects of climate change and variability. For these livestock enterprises, the farmer can afford inputs and other production factors without having to resort to additional employment and resultantly, acceptance of additional employment may reduce the farmers' capacity to adapt to adverse effects of climate change and variability. Depending on the profitability of the livestock farming enterprise, half (49.5%) of the respondents would have more (for non-profitable, often smallholders) or less (for profitable, often large-scale farmers) adaptive capacity to adverse effects of climate change and variability (Table 5).

About half (50.5%) of the livestock farmers were involved in various types of employment, and these would somehow influence the adaptive capacity of their enterprises to adverse effects of climate change and variability, depending on the level of income from the employment activities, e.g., livestock farmers with formal employment would use their funds to purchase livestock feeds in times of need.

3.2.2 *Household income of livestock farmers*

Income tends to be an important determinant of the economic status of any household, including livestock farming households. High-income households can afford their needs much more than low-income households. According to Nouman et al. (2013), household income is also one of the determinants of the amount of credit that can be borrowed by the farmers, including those in livestock farming.

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High income, livestock farming households can therefore not only better afford needs such as production inputs and other livestock production factors but would also easily qualify for credit to procure the assets that would otherwise not be affordable. As a result, high income, livestock farming households will be better adapted to the adverse effects of climate change and variability when compared to their low-income counterparts. Three in ten (29.0%) livestock farmers reported a monthly income of R3001-R5000 while half (50,4%) of them revealed their annual income to be R5 001-R20 000. The top income households were one in five (18.6%) who earned R10 001 and above per month and 4.4% who earned R60 001 and above per annum (Table 6).

Table 6. Household incomes of livestock farmers in Limpopo and Mpumalanga Province of South Africa

	Income category	Frequency	Per cent
Monthly			
	Less than or equal to R1000	18	4.9
	R1001-R3000	95	26.0
	R3001-R5000	106	29.0
	R5001-R10 000	79	21.6
	R10 001 and above	68	18.6
	Total	366	100
Annual			
	Less than or equal to R5000	33	9.1
	R5001-R20 000	183	50.4
	R20 001-R40 000	90	24.8
	R40 001-R60 000	41	11.3
	R60 001 and above	16	4.4
	Total	363	100

Based on the said discussion, higher-income earners would be expected to have a relatively higher adaptive capacity to adverse effects of climate change and variability compared to their low-income counterparts. Farmers with higher incomes are likely to embrace and will be interested in adapting by changing practices and modern methods such as irrigation to cope with the changing climate (Gbetibou, 2009). Generally, the income levels of the smallholder livestock farmers were at best adequate for basic household needs and would not significantly increase the adaptive capacity of the farmers to the negative effects of climate change and variability on the livestock enterprises.

3.2.3 *Quality of housing*

The quality of a house owned by a farmer tends to be positively influenced by the amount of income earned and may positively influence the adaptive capacity of the farmer to adverse effects of climate change and variability. Farmers earning higher incomes are expected to afford better quality houses compared to their lower-income counterparts. Accordingly, livestock farmers with higher incomes are expected to reside in better quality houses than their lower-income counterparts.

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Livestock farmers and other members of the community may, however, be the beneficiaries of the government housing scheme and own higher-quality houses, even if their income levels are low, hence the interest on the source of funding for house construction. Almost half (48.5%) of the livestock farmers stayed in top quality houses with cement brick walls and corrugated irons or tile roofs (Table 7). About the same number (47.4%) of livestock farmers dwelled in medium quality houses, of which one in eight (12.5%) stayed in the mud-brick wall and corrugated iron/tile roof houses with one in three (34.9%) staying in cement brick wall and thatch roof houses.

Table 7. Quality of housing owned by livestock farmers in selected areas of the Limpopo and Mpumalanga Provinces of South Africa.

	Frequency	Per cent
Type of housing		
Mud brick wall & thatch roof	15	4,2
Mud brick wall & corrugated iron/ tile roof	45	12,5
Cement brick wall & thatch roof	126	34,9
Cement brick wall & corrugated iron/ tile roof	175	48,5
Total	361	100
Source of funding		
Own finance	323	88,5
RDP (government fund)	35	9,6
Family-owned (inherited)	7	1,9
Total	365	100

Only 4.2% of the livestock farmers lived in houses of a mud-brick wall and thatch roof that could be regarded to be of poor quality. Up to 88.5% of the livestock farmers revealed that their houses were built through their finance with 9.6% funded by the government and 1.9 % inherited. The 9.6% government-funded houses would most certainly be part of the top-quality category, and so could be the case with the 1.9% inherited houses, implying that livestock farmers themselves could have funded some 37.0% (and not the reported 48.5%) of houses in this category. If the 4.2% completely poor-quality houses were part of those funded by livestock farmers themselves, it may be inferred that some 37.0% of the farmers could afford top-quality houses while about 47.4% would have funded their medium quality houses.

Considering the quality of housing, some 37.0% of farmers would likely possess the high adaptive capacity to adverse effects of climate change and variability affecting their livestock enterprises. About 47.4% of the livestock farmers would possess the medium adaptive capacity while only 4.2% would likely have a complete lack of adaptive capacity. However, when considering the low-income levels for the livestock farmers, it could be assumed that they prioritize the housing and had to sacrifice some of the basic needs to fund the construction of the houses. The same sacrifice could be made to invest in building the adaptive capacity to climate change and variability affecting the livestock enterprises.

3.2.4 *Size of housing*

As is the case with the quality of the house, the size of a house owned by a farmer tends to have some influence on the extent to which he/she can adapt to adverse effects of climate

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change and variability. Considering the total number of rooms, one in ten (9.6%) households had between one and three rooms, and these were probably the poorest.

Some 45.9% of livestock farmers lived in 4-5 roomed houses and could be regarded to be of medium wealth, status while the remaining 44.5% lived in 6 or more roomed houses and could be categorized wealthy (Table 8). The livestock farmers with six or more roomed houses would most likely possess the highest adaptive capacity to the adverse effects of climate change and variability compared to those with four to five roomed houses. Similarly, the farmers staying in four to five roomed houses were likely to possess a higher adaptive capacity to adverse effects of climate change and variability than those in one to three rooms. The number of bedrooms owned by livestock farmers may also be expected to be associated with the wealth status of the household and the ability of their farming enterprises to withstand the adverse effects of climate change and variability.

Table 8. Size of houses owned by livestock farmers in Limpopo and Mpumalanga Provinces of South Africa.

	Frequency	Per cent
Size of house		
Total number of rooms		
Total up to 3 rooms	35	9.6
Total of 4-5 rooms	167	45.9
6 or more rooms	162	44.5
Total	364	100
Number of bedrooms		
0	1	0.3
1-2	88	24.2
3-5	255	70.1
>5	20	5.5
Total	364	100

Regarding wealth status, livestock owners with more than five bedrooms would be regarded wealthiest with the highest adaptive capacity, followed by those with three to five bedrooms who would in turn be followed by those with one to two bedrooms.

3.2.5 *Household energy supply*

The type of energy supply to a livestock farming household is also associated with the wealth status of the family and the capacity of the farmer to adapt to adverse effects of climate change and variability. It was pleasing to note that up to 97.3% of the livestock farmers in the study areas had access to electricity. Accordingly, up to 87.4% of the livestock farming households used electricity for cooking (Table 9). The livestock farming households relying on electricity for cooking would have more time to attend to farming activities and would likely possess more capacity to adapt to adverse effects of climate change and variability. Electricity allows access to information through TV media and telephone. Adaptive capacity is highly dependent on the capacity of farmers and their families to access key information and to collectively self-organize (Jones and Boyd, 2011). The 11.7% of livestock farming households who depend on firewood for cooking would likely spend some time collecting firewood and

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have less time for farming activities, except for households who rely on buying and not collecting the firewood. Considering energy supply, the livestock farmers in the study area would be expected to be adaptive to the adverse effects of climate change and variability.

3.3.3 Aspects of livestock farming

The situation regarding livestock farming and types of farming activities practised have some influence on the adaptive capacity of the farmers to adverse effects caused by climate change and variability. Among the important issues likely to influence the adaptive capacity of livestock farmers to negative effects of climate change are the fitness of farming households to work in agriculture, land ownership, livestock ownership, amount of time committed to farming (full time, part-time), and many livestock.

Table 9. Energy supply to households of livestock farmers in Limpopo and Mpumalanga Province of South Africa

Energy supply	Frequency	Per cent
Access to electricity in the house?		
No	10	2.7
Yes	355	97.3
Total	365	100
Source of energy for cooking		
Electricity	320	87.4
Gas	2	0.5
Wood	43	11.7
Other	1	0.3
Total	366	100
An alternative source of energy for cooking		
Electricity	1	0.5
Gas	1	0.5
Wood	217	99.0
Total	219	100
Sources of energy for lighting		
Electricity	358	99.7
Wood	1	0.3
Total	359	100

3.3.1 *Fitness of livestock farmers to work in agriculture*

The extent of fitness of livestock farmers to work in agriculture has some influence not only on the productivity of the farming enterprise but also on the degree to which the farmer can adapt to the negative effects of climate change and variability. The findings of the study revealed that fewer livestock farming households (4.7%) lacked a male member who was fit for farming compared to those (36.3%) who lacked a female member. Most of the livestock farming households had one member who was fit to work in farming. For this category, two in five households had one member who was fit for farming, for both male (40.1%) and female (39.3%) household members (Table 10). Two in five (38.4%) households had two male members compared to one in five (19.9%) households with the same number of female members who were fit for farming. More households (13.8%) had three male members compared to only 1.8% of households with the same number of female members who were fit for farming. The

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analysis of household member fitness to work in farming suggests that male members were generally fit to work in livestock farming than their female counterparts. Total lack of a household member who is fit for farming would render a livestock farming household deficient in capacity to adapt to adverse effects of climate change and variability.

It is therefore hoped that none of the livestock farming households in the area under study had nobody fit for farming, i.e., households without a single male member fit for livestock farming should have some female member(s) fit to work in the farming enterprise and vice versa.

Table 10. Fitness of smallholder livestock farming households of Limpopo and Mpumalanga Province of South Africa to work in farming.

Gender	No.of members	Frequency	Per cent
Male			
	0	17	4.7
	1	145	40.1
	2	139	38.4
	3	50	13.8
	4	8	2.2
	5	2	0.6
	8	1	0.3
	Total	362	100
Female			
	0	120	36.3
	1	130	39.3
	2	66	19.9
	3	6	1.8
	4	4	1.2
	5	3	0.9
	7	2	0.6
	Total	325	100

Generally, livestock farming households had some members who were fit to work in farming and would accordingly have higher adaptive capacity to the adverse effects of climate change and variability.

3.3.2 *Land ownership*

Ownership of land is a strong determinant of the success of farming in general and livestock farming. Farmers owning land for livestock farming would have the possibility of dividing it into camps. managing their stocking rate and consequently their grazing. Resultantly. the livestock farmers would possess the capacity to adapt to droughts and other negative effects of climate change and variability. and this may not be the case with farmers operating on communal land.

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Table 11. Land ownership for smallholder livestock farming in Limpopo and Mpumalanga Province of South Africa.

Land ownership category	Frequency	Percent
Own	2	0.5
Communal	362	99.2
Other	1	0.3
Total	365	100

Almost all the livestock farmers (99.2%) were farming under communal land. Livestock farming in this condition tends to be characterized by overstocking and subsequent overgrazing. With overgrazing under normal rainfall conditions. an occurrence of a climate change associated disaster such as drought would highly exacerbate the issue of lack of grazing.

Considering the issue of land ownership. it could be inferred that the livestock farmers in the study area had a serious dearth of capacity to adapt to adverse effects of climate change and variability. When drought occurs. the livestock farmers would likely lean back on their positive personal and economic characteristics that would promote their capacity to adapt to the adverse effects of climate change and variability. Such characteristics would include good incomes that would enable the farmers to buy fodder from outside their areas. but often this works better when the herd has been reduced to manage the spending on the fodder. Livestock farmers with some education may be better positioned to source information. both for avoiding and for managing the adverse effects while those with formal employment may qualify for loans to buy fodder and other feeds.

3.3.3 *Livestock ownership*

The member of the household owning livestock tends to have some influence on the adaptive capacity of the livestock enterprise to adverse conditions caused by climate change and variability. Where the livestock is owned by a well-resourced. a knowledgeable and experienced member of the household. the enterprises tend to possess more adaptive capacity to adverse effects of climate change and variability. and vice versa. Livestock in the study area was owned by heads of households in the majority (52.9%) of families. Heads of households tend to be the major decision-makers. therefore, the fact that they constituted the majority of livestock owners could be advantageous for appropriate farming decision making. The second-largest owners of livestock comprised one in three (29.0%) and were children of heads of household. the sons (21.1%) and daughters (7.9%) (Table 12).

The children of the respondents would likely be relatively more educated than their parents and the rest of their predecessors and would likely have better access to modern information and would hence make better-informed decisions. In fact. the participation of children of the heads of household in livestock farming demonstrates some succession in farming and is a positive development. In cases where heads of households and their children made appropriate and better-informed decisions on livestock farming. their enterprises would possess a more adaptive capacity to adverse effects of climate change. and vice versa.

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Table 12. Livestock ownership by members of households in Limpopo and Mpumalanga Province of South Africa

Livestock owners in respondents households	Frequency	Per cent
Head of a family	193	52.9
Other members	172	47.1
Total	*365*	*100*
Other members. specify		
Daughter	*29*	*7.9*
Family	*9*	*2.5*
Grandfather	*7*	*1.9*
Grandmother	*9*	*2.5*
Nephew	*8*	*2.2*
Relatives	*23*	*6.3*
Sister	*9*	*2.5*
Son	*77*	*21.1*
Uncle	*1*	*0.3*
Total	*172*	*100*

3.3.4 *Farming status*

The farming status of livestock owners may determine the length of time invested by farmers in their livestock enterprises and hence the capacity of the enterprises to successfully adapt to the adverse effects of climate change and variability. Livestock owners who are full time in farming are likely to make timely decisions for their enterprises. hence the adverse effects of climate change and variability will be promptly mitigated. The benefits of full-time farming may however be lost if the agricultural enterprise is not profitable. In that situation, the advantage of full-time availability of the livestock owner to his / her business will be counteracted by the lack of income necessary to procure inputs critically required to mitigate the adverse effects of climate change and variability.

Table 13. Farming status of smallholder livestock owners in respondents households in Limpopo and Mpumalanga Province of South Africa

Farming Status	Frequency	Per cent
Head of household - Full time	295	82.2
Head of household - Part-time	48	13.4
Other members - Full time	16	4.5
Total	359	100.0

Some 86.7% of livestock owners were full time. and of those. four in five (82.2%) were heads of the household while 4.5% were other household members (Table 13). Only 13.4% of livestock farmers in the area under study were part-time. Based on the type of farming practised (full-time vs part-time). the smallholder livestock farmers in the study area would mostly possess the capacity to adapt to the adverse effects of climate change and variability.

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3.3.5 *Number of livestock owned*

Livestock occupies a cogent position in assisting households to cope with difficulties since farmers can easily trade their animals for cash (Imai. 2003:271. cited by Ijatuyi *et al.* 2017).

Table 14. Number of livestock owned by smallholder farmers in Limpopo and Mpumalanga Province of South Africa

Stats for No. of livestock	Cattle (N=364)	Sheep (N=24)	Goats (N=176)	Chickens (N=101)	Pigs (N=46)	Donkeys (N=6)
Mean	16.63	10.38	14.50	18.80	10.65	7.33
Median	14.00	10.00	14.00	14.00	10.00	6.50
Mode	15	4	15	10	17	0
Std. Dev	13.743	5.388	9.702	17.416	8.014	7.090
Range	97	20	73	100	48	20
Min	1	0	0	0	0	0
Max	98	20	73	100	48	20

Cattle, in particular, are known for many products such as being reared for meat production, milk production, hides and skins, cash income, and the source of draught power on farmlands (ploughing, traction, and irrigation) (Traore, 2010. cited by Ijatuyi *et al*... 2017). The number of livestock owned influences the capacity of the farming enterprise to adapt to the adverse effects of climate change and variability. Farmers with more livestock tend to benefit from the asset value of a large number of the livestock and often possess more capacity to adapt to the adverse effects of climate change. The benefit of large numbers of livestock is more realized when the farmer can take appropriate decisions regarding the livestock management and the time to sell some of the animals to generate income for procuring required inputs and for other uses. Livestock farmers in the study area owned a mean of 16.63 cattle, 10.38 sheep, 14.50 goats, 18.80 chickens, 10.65 pigs, and 7.33 donkeys (Table 14). The livestock numbers seem rather small to adequately capacitate the farmers to adapt to the negative effects of climate change and variability.

3.3.6 *Livestock ranking*

The ranking of livestock by farmers indicates the extent to which the farmers regard the type of livestock to be important and the level to which they would want to keep the type of livestock. Consequently, the ranking of livestock by farmers reveals the degree to which the farmers are likely to invest resources to mitigate the adverse effects of climate change and variability on the enterprise of the ranked livestock type. The livestock farmers in the study areas were requested to rank their various livestock as Very important (ranked 3), Important (ranked 2), and less important (ranked 1).

Cattle, sheep, and goats were regarded as very important by most livestock farmers in the area under study. As revealed under Table 3.5. almost all (96.6%) the livestock farmers regarded cattle as very important. This ranking was probably informed by the socio-economic value of these animals. Other than the fact that cattle are priced higher when sold, they sometimes also provide draught power, be it for the ploughing of fields or pulling of trail wagons. In these ways, cattle contribute to the household food production and to the provision

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of transport services for basic household chores such as fetching water and distribution of firewood.

Although this is now often handled through cash transactions, cattle used to be the currency for payment of lobola, a payment by a bridegroom to the parents of the bride who would traditionally relocate from the family of her parents to join that of her husband. The livestock owners probably considered these multiple uses of cattle when deciding on the ranking of these animals. Although sheep may not have similar multiple uses as cattle. they were ranked to be 'very important' by about the same number (95.8%) of livestock farmers as those (96.6%) who regarded cattle 'very important'. Goats were ranked 'very important' by seven in ten (69.0%) of livestock farmers. All these three types of ruminant animals (cattle, sheep, and goats) were ranked by the majority of livestock owners to be 'very important'.

Table 15. Ranking of livestock by owners in Limpopo and Mpumalanga Province of South Africa

Livestock type	Rank	Frequency	Per cent
Cattle (N=358)	1	5	1.4
	2	7	2.0
	3	346	96.6
Sheep (N=24)	2	1	4.2
	3	23	95.8
Goats (N=174)	1	1	0.6
	2	53	30.5
	3	120	69.0
Chickens (N=98)	1	12	12.2
	2	44	44.9
	3	42	42.9
Pigs (N=42)	1	5	11.9
	2	29	69.0
	3	8	19.0
Donkeys (N=4)	2	3	75.0
	3	1	25.0

Contrary to the above, the majority of livestock farmers ranked chickens, pigs, and donkeys rather 'important' and did not regard these animals as' very important'. Accordingly, 44.9% regarded chickens as' important', 69% of them ranked pigs 'important', while three in four (75%) of them revealed that donkeys were 'important'. For chickens, the majority ranking was probably informed by their size and subsequent economic value per unit. Although pigs would be expected to be ranked by the majority of livestock owners as 'very important', their ultimate ranking was probably influenced by the fact that some religious groups do not consume pork as they regard it a sin to do so.

The religion issue probably had a negative influence on the demand for pork and hence the ranking of pigs by the majority of livestock farmers. Based on the majority ranking of the different livestock types by farmers in the study area, the farmers were more likely to invest resources to mitigate the adverse effects of climate change and variability on cattle, sheep, and goats. The ranking of these animals probably reveals the extent to which they would capacitate

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the livestock farmers to respond to household socio-economic demands. The animals would therefore likely capacitate the farmers also to adapt to the negative effects of climate change and variability.

3.3.7 *Exposure to capacity building*

The level of exposure to capacity building activities on livestock issues tends to influence the depth of knowledge the farmer possesses on livestock enterprise issues and the access to resources for effective livestock farming. Farmers with more exposure are likely to possess more knowledge and to make better decisions for their livestock enterprises to be more adaptable to the adverse effects of climate change and variability.

Table 16. Exposure of livestock farmers in Limpopo and Mpumalanga Province of South Africa to capacity building activities

The aspect of capacity building	Frequency	Per cent
Receipt of training in livestock farming		
No	364	99.5
Yes	2	.5
Belonging to any farmers union		
No	365	99.7
Yes	1	.3
Belonging to a producer's organisation		
No	366	100.0
Financial support from the government		
No	362	99.2
Yes	3	0.8

It was disappointing to note that almost all the livestock farmers in the area under study had not received any training in livestock farming (99.5%), and neither belonged to a farmers' union (99.7%) nor a producer organization (100%), and these suggest that they had no exposure to knowledge. Also, the farmers did not have access to financial support from the government (99.2%) (Table 16). Based on exposure to capacity building activities, the livestock farmers in the areas under study seemed to have a dearth of capacity to adapt to the undesirable effects of climate change and variability.

3.3.8 ***Household members staying off the farm***

The number of household members who stay off-farm while still relying on the farming household is an indication of the contribution of the livestock farming enterprise to the economy of the broader community. Livestock farming households supporting more members staying off the farm tend to make an impact on the economy of the broader community than those limited to supporting the core farming household.

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Table 17 Household members staying off the farm and supported by livestock farming households in Limpopo and Mpumalanga Province of South Africa

Number of members		Frequency	Percent
Males	0	214	70.6
	1	67	22.1
	2	19	6.3
	3	1	0.3
	6	2	0.7
Total		303	100
Females	0	234	78.3
	1	47	15.7
	2	12	4.0
	3	4	1.3
	6	2	0.7
Total		299	100

Livestock farming households in the study area had most of their dependent members not staying off-farm. and that was true for both male (70.6%) and female (78.3%) members (Table 17). As revealed by respondents. about one in five (22.1%) farming households had one dependent male member each staying off-farm compared to one in six (15.7%) households with one dependent female member staying off-farm. Fewer households had two or more dependent members staying off-farm. both male and female members. The dependent members staying off-farm were most probably the children of livestock farming households who were either attending school or seeking employment away from home. Should this be the case, the livestock farming households may be regarded to be empowering their members to improve their adaptive capacity to the undesirable effects of climate change and variability. Probably. some of the farming households may be having children and other family members. schooling locally and staying on-farm. hence the adaptive capacity being built could be more.

4. Conclusions and recommendations

4.1 Conclusions

The findings of the study revealed that demographic factors had different influences on the capacity of smallholder livestock farmers to adapt to adverse effects of climate change and variability on the farming enterprises. This was true for all the three types of demographic factors studied. namely: personal characteristics. economic status. and aspects of livestock farming.

4.1.1 *Personal characteristics*

Based on our analysis and literature. factors that enable smallholder livestock farmers to be highly vulnerable to extreme situations of droughts and floods include the age of the farmer. gender. formal education. income and access to information. The position of respondents in households comprised 58.7% heads and 25.7% parents to heads all of whom probably provided accurate information on household decisions.

The respondents were mostly male (63.4%) with good health (97.8%) associated with high adaptive capacity to climate change and variability. The older the farmers are. the more

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they get exposed to an increase in vulnerability. It is suggested that the introduction of new technologies targets young farmers instead of adult farmers. When young farmers take up an adaptation strategy, they will consider and use it for several years before they abandon it. Assessment of the educational status revealed that four in five (81.5%) of the livestock farmers had only secondary education at most. probably associated with a low capacity to adapt to climate change and variability.

4.1.2 *Economic status*

While no definite conclusions could be drawn based on employment status. household incomes seemed low and could be associated with a low capacity to adapt to the negative effects of climate change and variability. On the contrary. the quality of housing for the livestock farmers was described as either top (48.5% of farmers) or medium (47.4%) associated with high adaptive capacity to climate change and variability. Similar conclusions could be drawn to the size of housing with 45.9% owning 4 to 5 rooms and 44.5% owning six or more rooms. especially because 88.5% of the respondents financed their houses. The probability of high adaptive capacity was perhaps affirmed by that almost all the respondents (97.3%) had access to electricity.

4.1.3 *Aspects of livestock farming*

The fact that most households had members who were fit to work in farming (one male and female member for 40.1% and 39.3% of the families respectively; 19.9% of two members for each gender category) suggested high capacity to adapt to climate change and variability. Livestock was owned by heads in 52.9% of the households and by children to heads in 29.0% (sons in 21.1% and daughters in 7.9%) of the households. affirming the high capacity to adapt to climate change and variability. On the contrary. almost all respondents (99.2%) used communal land had fewer numbers of livestock owned (for various types). suggesting a low capacity to adapt to climate change and variability. The dearth of adaptive capacity was perhaps exacerbated by a lack of exposure to capacity building as the respondents had no training (99.5%). never belonged to a farmers' union (99.7%) or a producer organization (100.0%). and had no access to financial support from the government (99.2%). Full-time farming by the majority (86.7%) of farmers and the fact that fewer of their dependents (22.1% male and 15.7% female) stayed off-farm could be positive or negative for adaptive capacity development.

4.2 Recommendations

Following the research on demographic factors and their influence on the capacity of smallholder livestock farmers to adapt to adverse effects of climate change and variability, it is recommended that:

4..2.1 Research be conducted as a follow-up using the principles derived from the sustainable livelihoods approach (SLA) to investigate how that may have some influence on the smallholder farmer capacity to adapt to climate change and variability, be it livestock or crop farmers. The idea is that is it one of several conceptual approaches that take an asset/vulnerability approach to analyze the vulnerability of the poor. This way of approaching recognizes that livelihoods are multi-sectorial, that all aspects of people's lives will impact the livelihood choices that they make and that livelihoods are embedded within an institutional context.

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4.2.2 The results of the research be shared with the government and related agencies to inform policies on farmer support for improved response to adverse effects of climate change and variability.

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