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Effects of droughts and animal diseases on smallholder farmers' participation in the South African beef market

By

Musowe Nsakilwa

A dissertation submitted in partial fulfilment of the requirements for the degree of

MSc. Agric (Agricultural Economics)

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DECLARATION

I, Musowe Nsakilwa, hereby declare that this dissertation, which I submit for the degree of Master of Science in Agricultural Economics at the University of Pretoria, is my own work and has not been submitted by me for a degree at this or any other tertiary institution.

Signature:……  …… Date: 14. July. 2021

DEDICATION

To my awesome parents, Phillip Nsakilwa and Christine Musowe.

ACKNOWLEDGEMENTS

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ABSTRACT

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There is global recognition that climate variability and its impacts are affecting most aspects of our lives, and frequently. Climate variability includes aspects like rising global temperatures, changing rainfall patterns, and elevated carbon levels in the atmosphere. Some of the climate variability impacts are observed with the regularity of incidences of drought and animal disease. These occurrences affect smallholder farmers and the vulnerable members of society. Most rural households depend on agriculture and are primarily involved in livestock production. There are 1.3 billion people in the world who depend on the livestock sector, which uses 45 percent of the planet's land surface. As a result, livestock marketing is crucial for agricultural transformation and economic development, especially in developing countries. Livestock marketing alleviates poverty in agricultural households, while also allowing smallholder farmers to commercialize their operations. In South Africa, 80 percent of agricultural land is ideal for extensive grazing, with a total beef herd of 13.69 million animals. However, smallholder farmers, despite owning 40 percent of the total cattle herd in South Africa, have a low market participation rate, with only a 5 percent offtake rate. Drought and animal disease outbreaks have been linked to regional differences in cattle offtake rates in the literature. This study used data from a four-wave panel survey of 2,534 South African livestock owners to provide empirical evidence on the effects of drought, animal diseases, and the combined impact of both drought and animal diseases on smallholder farmers' market participation. Since market participation is a binary response variable, the discrete choice logit model was chosen for this analysis. The pooled model, the fixed effects model, and the random-effects model were all examined. The random effects

parameter was found to be accurate by the likelihood ratio test; as a result, the random-effects model was more consistent than the pooled model was. The panel structure of the data and the disaggregation of smallholder farmers by province were not considered by the pooled model. Provincial effects accounted for 17.03 percent of the overall residual variance, reflecting a marginal but significant relationship between consumer participation and region. Between fixed effects and random-effects models, the Hausman test was used to determine which model was more suitable. At a one-percent significance level, the Hausman test result (24.06) was significant, suggesting that the fixed effects model was the best fit. Individual effects of animal disease on smallholder farmers' market participation were found to be negative and significant, while the individual impact of drought was found to be insignificant. Drought and animal disease outbreaks had a negative combined impact on smallholder farmers' participation, which was greater than the individual effects of drought and animal disease. As a result, the study found that outbreaks of animal disease, as well as the combined impact of drought and animal disease occurrences, decreased the probability of smallholder farmers participating in livestock markets. The results suggested the need for the government to enhance smallholder farmers' access to livestock vaccines and medicines through improved extension service provision. Smallholder farmers should also receive compensation commensurate to whether they are exposed to the individual effects of drought or the combined effects of both drought and animal diseases to increase their participation in livestock markets.

Keywords: beef market, livestock market, market participation, drought, animal diseases, smallholder farmers, South Africa.

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ACRONYMS

BFAP	Bureau for Food and Agricultural Policy
CFP	Custom Feeding Programme
CSM	Continuing Sample Member
DAFF	Department of Agriculture, Forestry and Fisheries
DPME	Department of Planning, Monitoring and Evaluation
GDP	Gross Domestic Product
IPCC	Intergovernmental Panel On Climate Change
LRT	Likelihood Ratio Test
MI	Multiple Imputation
NIDS	National Income Dynamics Study
PSU	Primary Sampling Unit
RMAA	Red Meat Abattoir Association
SACU	Southern African Customs Union
SALDRU	Southern Africa Labour and Development Research Unit
SHF	Smallholder Farmer
STATSSA	Statistics South Africa
TSM	Temporary Sample Members

CHAPTER 1: INTRODUCTION

1.1 BACKGROUND

Climate variability has had a major effect on the environment and is one of the most pressing issues of the twenty-first century (Pandey, 2016; Alabdulkader, Al-Amoud and Awad, 2016). Changing rainfall patterns, a rise in global temperatures, and an increase of carbon dioxide levels in the atmosphere due to the use of fossil fuels are all examples of climate variability (Singh and Singh, 2012). In comparison with the past 50 years, the forecast for 2050 prepared by the US National Center for Atmospheric Research has suggested a pattern of decreasing rainfall and rising temperatures (Mitchell and Tanner, 2006). Droughts and floods are predicted to become more common in Southern Africa because of the same climate pattern (Nhemachena, Chakwiziraand Mashiri, 2008).

Since many African rural households rely on agriculture, especially livestock production, climate variability is extremely important (Kabubo-Mariara, 2008; Masih, Maskey, Mussá and Trambauer, 2014). Smallholder livestock farmers account for roughly 20% of the global population, the majority of whom live in abject poverty (Bishu, O'Reilly, Lahiff and Steiner, 2018). Livestock farming uses about 45 percent of all land on the planet (Baumgard, Rhoads, Rhoads, Gabler, Ross, Keating, Boddicker, Lenka and Sejian, 2012). The global livestock sector employs approximately 1.3 billion people and contributes roughly 40% of global agricultural production (Matthews, 2006). However, according to several reports, the major challenges associated with livestock farming include pasture degradation, low rates of technical adoption, drought, and animal diseases (Matsaert, Kariuki and Mude, 2011; Hill, Hoddinott and Kumar, 2013; Bishu et al., 2018).

Droughts present climatic shocks that have had a direct effect on global agriculture and have caused significant production losses (Kogan, Guo and Yang, 2019). Drought is characterised as a situation in which an area's average rainfall falls below the normal average, over time (Wilhite and Glantz, 1985). Despite having the lowest crop production levels and capacity to adjust to droughts, Africa has experienced the worst droughts in the last decade (Wilhite and Glantz, 1985). Droughts cause food shortages, asset depletion, ecological corruption, impoverishment, a lack of jobs, and forced migration to other areas (Scheffran, Marmer and Sow, 2012; Noelle, Weru, Rodrigue and Karlin, 2018). Droughts often cause contamination of communal land water sources, resulting in a variety of animal diseases (Jordaan, Sakulski and Jordaan, 2013). During droughts, groundwater levels, as well as water levels in dams and

reservoirs, fall, thereby increasing the susceptibility to water contamination in a given region. Greenhouse gas emissions have also increased global temperatures, thereby contributing to climate variability. Climate variability has a major effect on the environment, and it is leading to more animal disease outbreaks (Bett, Kiunga, Gachohi, Sindato, Mbotha, Robinson, Lindahl and Grace, 2017; Zinabu, Kebede, Ferede and Dugassa, 2018).

Animal diseases and drought have had a detrimental effect on the global livestock industry, and particularly the beef industry. The beef industry is important in South Africa because it produces the second-most consumed product in the agricultural sector, after broilers. The Department of Agriculture, Forestry and Fisheries (DAFF) estimates that 80 percent of South Africa's agricultural land is suitable for extensive grazing. South Africa has a total beef herd of 13.69 million cattle (Makube, 2017). The gross value of beef production has increased significantly, from R13.6 billion in 2008 to R37 billion in 2017 (Department Of Agriculture Forestry And Fisheries (DAFF), 2019). The industry also provides food and income, especially to rural communities that sell their cattle during lean seasons (Nevondo, Chaminuka, Nhundu and Liebenberg, 2019). Commercial and smallholder farmers are completely delineated in the South African beef industry. As a result, the industry has a dual nature, with commercial farmers having a higher level of development than smallholder farmers do (Department Of Agriculture Forestry And Fisheries (DAFF), 2018). According to the Department of Trade and Industry (DTI) (2018), South Africa has about 22 000 commercial producers and 3 million smallholder farmers.

Smallholder farmers trade their cattle in both formal and informal beef markets. Sales to abattoirs and auctions are within the formal market channels, while direct sales to individual consumers are the informal market channels (Togarepi, Thomas and Kankono, 2016). Markets are essential because they enable buyers and sellers of livestock to transact. Livestock markets are also essential for smallholder farmers to transform and commercialise their business operations (Groenewald and Jooste, 2012). However, inefficient markets result in higher transaction costs in negotiations, incomplete contracts being enforced, weak contract compliance mechanisms, and a lack of proper information flow between buyers and sellers, all of which may lead to one party taking advantage of the other. The marketing channel used by smallholder farmers is determined by market availability, current market rates, and distance to the market.

Smallholder farmers sell their cattle during festivals or religious occasions to ensure their food security (DAFF, 2018). The main reason why smallholder farmers rear cattle is to gain food security, rather than for financial benefit (DAFF, 2018). As a result, commercial farmers who operate to increase their profits participate more frequently in livestock markets than smallholder farmers, who participate sparingly (Department Of Agriculture Forestry And Fisheries (DAFF), 2017). The offtake rate is a percentage ratio of the number of cattle sold in each area to the number of cattle in the area (Musemwa, Mushunje, Chimonyo and Mapiye, 2010). Commercial farmers in South Africa have an offtake rate of about25%, whereas smallholder farmers have an offtake rate of just about 5% (Sotsha, Fakudze, Myeki, Ngqangweni, Nyhodo, Ngetu, Mazibuko, Lubinga, Khoza and Ntshangase, 2017). As a result, smallholder farmers should be provided with the necessary assistance to help them participate more fully in livestock markets (Red Meat Research and Development SA (RMRD SA)), 2018).

In South Africa, there has been an increase in demand for meat, and for hides used in the local automotive industry and in tanneries (Nevondo et al., 2019). The operations of smallholder farmers must be commercialised and they should become engaged in markets to meet the demands of consumers in livestock markets (Labuschagne, Louw and Ndanga, 2010; Gwiriri, Bennett, Mapiye, Marandure and Burbi, 2019). However, smallholder farmers face several obstacles to achieving commercialisation, including disease, parasites, and feed shortages (Mapiye, Chimonyo, Dzama, Raats and Mapekula, 2009; Khapayi and Celliers, 2015). As a result, studies that generate reliable information essential to help these smallholder farmers to develop are necessary.

1.2 PROBLEM STATEMENT

Smallholder farmers have a low market participation rate in South African livestock markets, with an offtake rate of just about 5% (Gwiriri et al., 2019). While efforts have been made to engage smallholder farmers in the South African beef value chain, their participation remains low. The Marketing of Agricultural Products Act of 1996 was enacted by the government to improve the market integration of smallholder farmers by allowing agricultural product markets to function freely and openly. The Land Redistribution for Agricultural Development (LRAD) programme and the Custom Feeding Programs (CFPs) are two other reforms that are considered to be supporting the commercialisation of business operations of smallholder

farmers and increased livestock offtake rates (Gwiriri et al., 2019). Even though smallholder farmers own roughly 40% of the total cattle herd in South Africa, their participation in livestock markets is poor (Sotsha et al., 2017; Gwiriri et al., 2019). As a result, it is important to understand why smallholder farmers only participate in the beef markets on a limited basis.

Previous studies have focused on increasing smallholder farmers' productivity, but these farmers face marketing constraints that limit their participation. Smallholder livestock marketing is hampered by several factors, including poor infrastructure, low marketable livestock numbers, a lack of market information, and owning livestock in poor conditions (Montshwe, 2006). Droughts and animal diseases, on the other hand, affect and cause variations in regional offtake rates, which have the potential to negatively impact upon smallholder farmers' market participation in South Africa. The effects of animal diseases and drought on smallholder farmers has increased due to climate variability in different regions, differing in range and intensity (Kinsey, Burger and Gunning, 1998). Because of their inability to resolve challenges on their own, smallholder farmers face the same barriers to participation year after year, necessitating government intervention. Notwithstanding the government's efforts to improve the situation of smallholder farmers, there is a dearth of available empirical studies that examine the impacts of drought and animal diseases on smallholder farmers' participation in South African livestock markets. This study sets out to fill this gap in the knowledge in this area.

1.3 RESEARCHOBJECTIVES

The main objective of this study was to evaluate the effects of drought and animal diseases on the market participation of smallholder livestock owners.

The specific objectives of this study were to:

- determine the effect of drought on market participation by smallholder farmers;
- evaluate the effect of animal diseases on the smallholder farmers' participation in the market; and
- estimate the combined impact of drought and animal diseases on the participation of smallholder farmers in livestock markets.

1.4 RESEARCH HYPOTHESES

The hypotheses of this study are as follows:

- Drought negatively affects the market participation of smallholder farmers.
- Animal diseases have a negative effect on the participation of smallholder farmers in livestock markets.
- The combined impact of drought and animal diseases on market participation is higher than the individual effects.

1.5 METHODOLOGY

A logit model was used to assess the impact of drought and animal diseases on smallholder farmers' participation in livestock markets. The logit model was used to analyse market participation, since it is a binary dependent variable. The independent variables studied influence whether smallholder farmers would participate in the market or not. As a result, market participation takes two values: one and zero, showing the farmer's participation or non-participation in the market, respectively. The logit regression model is suitable because it assesses the likelihood of a farmer making a discrete decision to engage in the market or not. The logit model has been used to investigate several qualitative behaviour responses, including labour force participation, marketing channel choice, and technology adoption(Hsiao, 1996; Howley, Donoghue and Heanue, 2012; Ndoro, Mudhara and Chimonyo, 2015).

This study used a panel data set obtained from South Africa's National Income Dynamics Study (NIDS). The data comes from a panel of individuals who were interviewed every two years, from 2008 to 2017. NIDS is a national representative survey that gathers data on individuals and household characteristics, such as economic activities, across South Africa's nine provinces. However, the focus of this study was placed on individuals who reared cattle during the relevant four years of the NIDS review. Weather South Africa provided data on the long-term annual average rainfall in South Africa for analysis in this report (Weather South Africa, 2018). The Methods and Procedures Section of Chapter Four provides a thorough explanation of the methods and procedures used to answer the objectives.

1.6 JUSTIFICATION OF STUDY

This research is especially important, now that droughts and animal diseases are becoming more common and severe around the world, including in South Africa. The study adds to our knowledge of the impacts of drought and animal diseases on the participation by smallholder farmers in the beef market, and livestock markets in general. This understanding is critical for developing and enforcing policies that would facilitate the increase of participation by smallholder farmers in livestock markets. Participating in the market decreases poverty and increases the well-being of smallholder farmers (Herrero, Havlik, McIntire, Palazzo and Valin, 2014a).

This research contributes to a better understanding of the impacts of drought and animal disease on the market participation by smallholder farmers. Policymakers are best able to develop robust, prudent, and well-informed policies to help smallholder farmers cope with the effects of drought and animal diseases. Policymakers may use empirical results to accurately estimate the losses suffered by livestock owners because of such climatic shocks. As a result of this recognition, adequate budgetary allocation, commensurate reimbursement, and equitable distribution of funds to drought and animal disease victims would be possible. The introduction of drought and disease-tolerant breeds, and water recycling and management comprises part of the coping measures that should also be implemented (Noelle et al., 2018). This research also fills a gap in the literature by examining the empirical impacts of drought and animal diseases on market participation. Other researchers who wish to venture further into the topic of market participation would benefit from the findings.

1.7 STUDY OUTLINE

The study has six chapters, and the chapter that follows, Chapter 2, discusses the livestock sector situation in South Africa. Chapter 3 will provide reviewed literature that relates to the study by considering the theory of market participation. The literature reviewed shows the effects of drought and animal diseases on market participation, which is summarised in the conceptual framework presented. Chapter 4 discusses the methods and procedures used in this study, including the empirical model, the variables, and the data used to answer the objectives. The findings of the study and the related interpretations of the results are

presented in Chapter 5, while Chapter 6 draws the conclusions and makes the recommendations arising from the findings of this study.

CHAPTER 2: AN OVERVIEW OF LIVESTOCK PRODUCTION AND MARKETING IN SOUTH AFRICA

2.1 INTRODUCTION

Livestock production and related activities play an important role in the food system. It is estimated that food production will need to increase by about 70% by 2050 to satisfy the food demands of approximately 9 billion people (Pienaar, Louw and Jordaan, 2019). However, since livestock provides a large portion of the protein and calories consumed, 26 percent and 13 percent, respectively, the demand for meat and meat products is expected to rise (Pienaar et al., 2019). Urbanisation, GDP growth, and changes in consumer preferences in developing countries are some of the factors that will increase the demand for meat.

The livestock sector in South Africa is divided into two categories: a well-developed commercial formal sector and a non-commercial informal sector, which are made up of commercial farmers and smallholder farmers, respectively. Livestock production is important because it contributes to household food security and provides raw materials, such as hides and wool used in the automotive and clothing industries, respectively (Labuschagne et al., 2010). Livestock marketing, on the other hand, contributes to poverty reduction and GDP growth, and is essential for long-term agricultural sustainability (Zhou, Minde and Mtigwe, 2013). Livestock marketing helps smallholder farmers to develop and commercialise their businesses by increasing their incomes and enabling them to purchase food grains, farm inputs, and implements (Ndoro, Hitayezu, Mudhara and Chimonyo, 2013).

This chapter offers an overview of South Africa's livestock sector. The important considerations addressed assist in determining the degree to which the livestock sector affects livelihoods in South Africa. The beef value chain in South Africa is discussed, with a focus on the difficulties that smallholder farmers face and the opportunities available to help them to participate more fully in livestock markets.

2.2 LIVESTOCK AND BEEF PRODUCTION IN SOUTH AFRICA

The global livestock sector employs about 1.3 billion people and accounts for roughly 40% of the global agriculture sector's GDP (Scollan, Moran, Kim, Thomas and EAAP, 2010). Since most of the populations in low-income countries, such as those in southern Africa, live in rural areas, agriculture is important. A large portion of the South African population lives in rural areas, the majority of which are impoverished.

As a result, the livestock sector in South Africa is critical for improving livelihoods, especially among smallholder farmers (DAFF, 2018). Smallholder farmers depend on livestock for food, revenue, as a safeguard against droughts and diseases, and as a means of building up assets after a crisis (Girma and Abebaw, 2012). Smallholder farmers profit from livestock rearing in a variety of ways, including using milk, meat, and hides from the animals (Motiang, 2017). Smallholder farmers often use some of their livestock for draught power, while others rear livestock for prestige, wealth storage, or traditional reasons like paying wedding dowries and slaughtering during traditional festivals. The growth and commercialisation of smallholder farming will result in even more development of the South African economy.

2.2.1 Livestock Production

Agricultural land accounts for about 80% (100 million ha) of South Africa's total land area (121.9 million hectares (ha) (Statistics South Africa (Stats SA), 2017). A substantial portion of the agricultural land is ideal for grazing and livestock rearing, but not for more intensive uses (Stats SA, 2017). Figure 2.1 below depicts the distribution of grazing land, arable land, and livestock-producing households in each of South Africa's provinces.

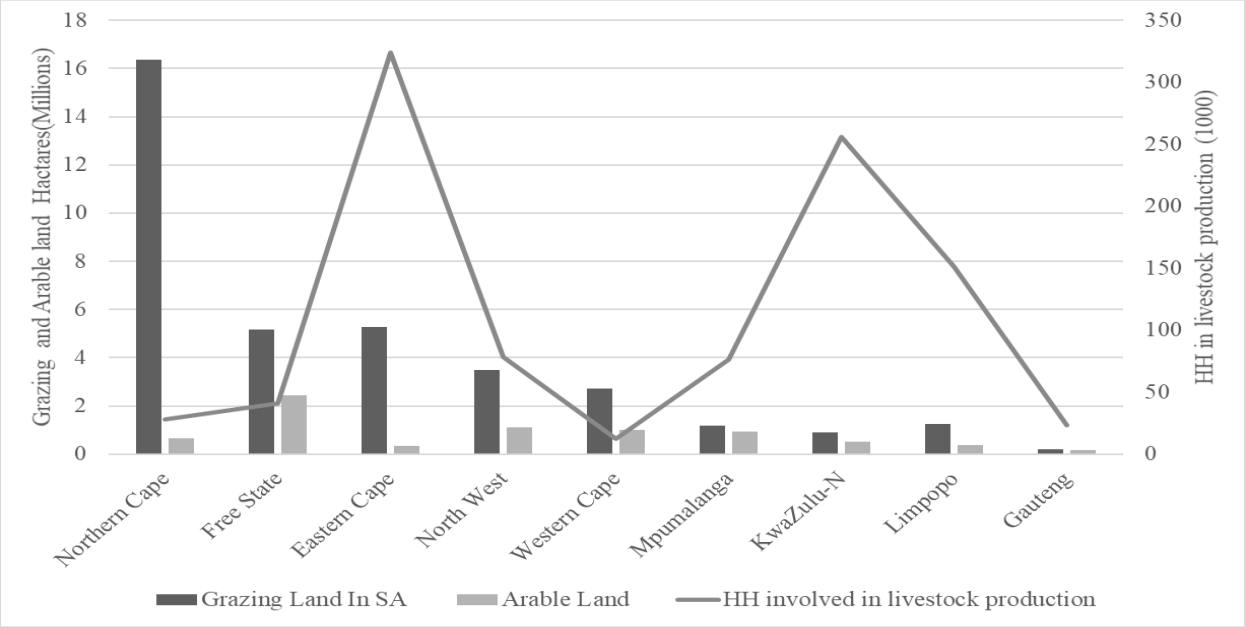

Figure 2.1: Distribution of grazing land, arable land, and numbers of households engaged in livestock production by province, 2016

Source: Stats SA, 2017

The total amount of grazing land in South Africa comprises 36 million hectares. Figure 2.1 above shows that grazing land is distributed in such a way that the Northern Cape (44.8 percent) has the highest share, while Gauteng has the lowest share (0.3 percent). However, it can be noted from Figure 2.1 that although the Northern Cape has the highest amount of grazing land, the number of households engaged in livestock production in the province is quite low. Approximately nine hundred thousand households were involved in livestock production in 2016 (Statistics South Africa (Stats SA), 2017), and the Northern Cape was among the provinces with the lowest ratio of households involved in livestock production, at 2.8 percent (Statistics South Africa (Stats SA), 2017). The contradiction in the amount of grazing land and the number of households involved in livestock production is related to the fact that livestock production is influenced by several factors, including the environment of the province, the population density, production potentiality, biomes, and the distance to factor and commodity markets (Ramsay, Jafta, Botha, Shole, Scholtz and Bester, 2006).

The Northern Cape is less suitable for livestock production, relative to other provinces in the southern and western parts of South Africa, because it has summer rains that lead to heat stress and poor quality of natural pastures in the province. On the other hand, the southern and western parts of South Africa, such as the Eastern Cape and KwaZulu-Natal, have winter

and perennial rainfall, respectively, which makes them more suitable for the extensive production of livestock (Ramsay, Jafta, Botha, Shole, Scholtz and Bester, 2006). Therefore, it can be observed from Figure 2.1 above that, while the number of households involved in livestock production is low in the Northern Cape (2.8 percent), the numbers are relatively higher in Eastern Cape and KwaZulu-Natal, at 32.7 percent and 25.9 percent, respectively.

The high numbers of households involved in livestock production in the Eastern Cape and KwaZulu-Natal arise because both provinces are in coastal areas, with better climatic conditions and natural resource availability (Ramsay et al., 2006). As a result, farmers can use less-expensive production systems and pasture irrigation, instead of relying on feedlots during dry winters. The Northern Cape also has a relatively low amount of arable land, compared with the Free State, KwaZulu-Natal, Western Cape, Eastern Cape, and Mpumalanga, which have high concentrations of arable land, as depicted in Figure 2.1 above. The total amount of arable land in South Africa is 12 million hectares, with the Free State having the highest amount (32.2 percent) and Mpumalanga having the lowest (2.4 percent). The coastal regions are also close to major metropolitan markets, rendering it relatively easier to gain access to input and product markets.

The number of households engaged in livestock production in each of the provinces is also related to the population density of the province. The Northern Cape has the lowest population density of 3.3, while the population densities for Gauteng, KwaZulu-Natal, Mpumalanga, Western Cape, Limpopo, Eastern Cape, North West, and Free State are relatively higher, at 809.6; 120.7; 59.1; 51.1; 46.1; 38.6; 37.9 and 22.8, respectively (South African Market Insights, 2018). Thus, it is expected that the number of households engaged in livestock production in the Northern Cape will be naturally low because of its low population density.

There are approximately 3 million smallholder farmers in South Africa, and approximately 22 000 commercial livestock farmers. Households engage in livestock farming for a variety of purposes, including having livestock as a primary source of food, a source of income, and a hobby or leisure activity (Statistics South Africa (Stats SA), 2016). Other explanations for household livestock rearing include the development of wealth and the provision of social security. Livestock farming also supports rural households by providing employment, and contributes significantly to the total agricultural Gross Domestic Product (GDP) (DAFF, 2018). Cattle, sheep, pigs, and chickens are the most common types of livestock reared in

South Africa. The percentage ratios of livestock sold to total livestock owned in 2007 and 2017 are shown in Figure 2.2 below.

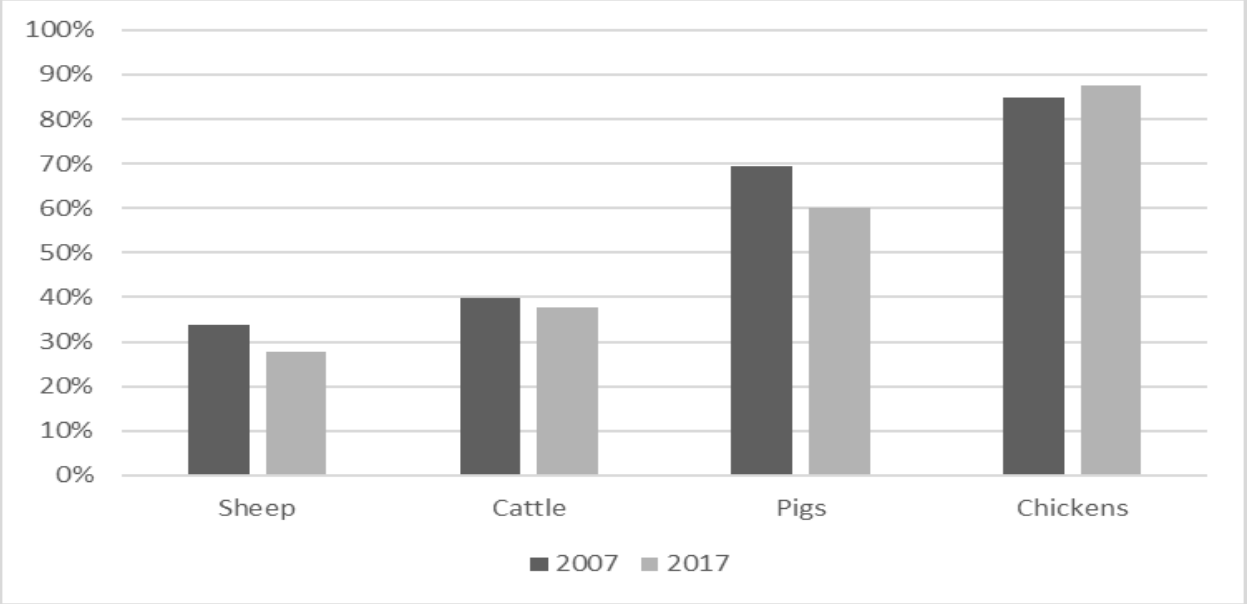

Figure 2.2: Percentage ratios of livestock sold to livestock owned, 2007 and 2017

Source: Stats SA, 2017

The ratio of chickens sold to chickens owned increased during the period from 2007 to 2017 (see Figure 2.2). Pigs, cattle and sheep, on the other hand, experienced a decrease in the ratio of livestock sold to livestock owned. The decrease in percentage ratios for these categories of livestock indicates a decrease in offtake rates. The largest reduction was in the offtake rate for pigs sold, compared to pigs owned, while changes in the offtake rates for cattle and sheep were not very significant. Poultry consumption has increased because of its affordability, and it is perceived as being a safe source of animal protein. The consumption of beef and of pork, on the other hand, are expected to increase by 23% and 24% by2027, respectively, as compared with2015 (The Bureau for Food and Agricultural Policy (BFAP), 2018). Therefore, the rise in the consumption levels of pork and beef demands that the offtake rates (ratio livestock sold to livestock owned) also rise. The rise in offtakes could be achieved with increased participation by smallholder farmers in livestock markets, thereby leading to increased production of pork and beef.

2.2.2 Beef Production

The beef industry is the second-quickest growing industry, after broilers, in the South African agriculture sector. Improved infrastructure, such as roads and supermarkets, comprises one of the factors that have fuelled the South African beef industry's rapid growth (Das Nair and Dube, 2015). However, one other factor that is vital in determining beef production is the number of cattle in a region, as this may impact negatively on the offtake rates. Figure 2.3 below shows the total cattle and beef production per province in 2016.

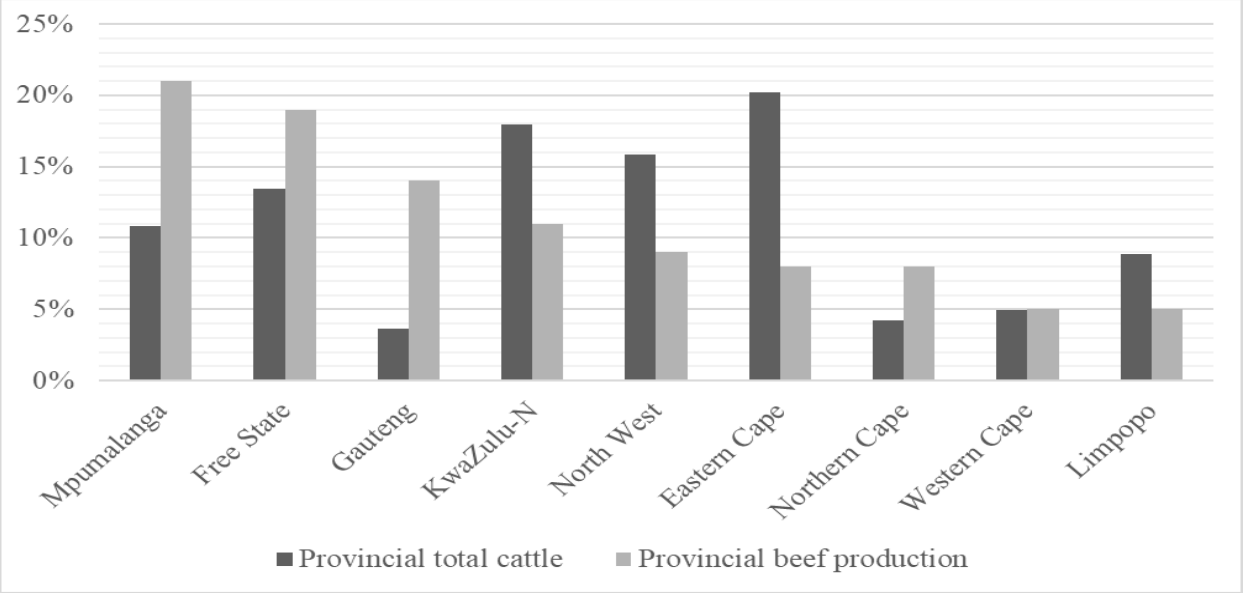

Figure 2.3: Total cattle and beef production per province, 2016

Note: The total number of cattle and amount of beef produced in 2016 were 13 934 125 head and 792 095 tons, respectively.

Source:Statistics South Africa (Stats SA) (2016); Department Of Agriculture Forestry And Fisheries (DAFF) (2016)

As indicated in Figure 2.3 above, beef production takes place in all provinces, with the largest producer being Mpumalanga, with 21% of the total beef produced in 2016. The amounts of beef produced by the Free State, Gauteng, and Kwazulu-Natal amounted to 18%, 16%, and 11% of beef produced in the same year, respectively. The North West, Northern Cape, and Eastern Cape provinces produced 8% each, while the Western Cape and Limpopo produced the least, at 5% each. The Mpumalanga, Free State, and Gauteng provinces produced more beef, relative to the other provinces, because the prime product markets are favorably situated in these three provinces. These provinces import numbers of cattle from other

provinces,which cattle are then marketed in the former because of their better infrastructure and market conditions. Therefore, despite cattle production occurring in all the provinces of South Africa, beef production and cattle sales are not merely dependent on the number of cattle owned in a particular area. Various categories of infrastructure, such as feedlots and abattoirs, play a pivotal role in determining the number of cattle sold and slaughtered, as well as the amount of beef produced.

The beef industry in South Africa is critical, not only to the livestock sector, but also to the agriculture sector, as it is the primary source of income for most households. Around 13.3 million cattle are owned by commercial farmers, while 5.69 million are owned by smallholder farmers (DAFF, 2018). Beef cattle account for about 80% of the total number of cattle herds, while dairy cattle account for just about 20% (DAFF, 2018). Figure 2.4 below shows the production and consumption of beef and veal from 1971 to 2017, as well as the import pattern for the same period.

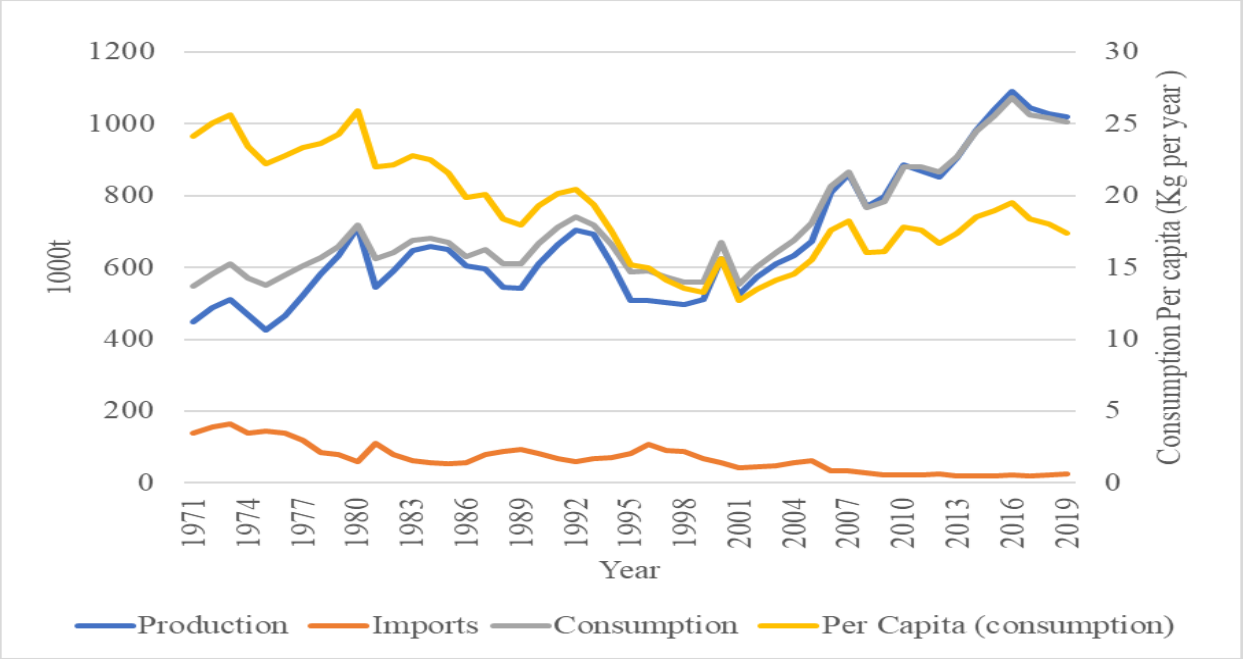

Figure 2.4: Production and consumption of beef and veal, 1971 to 2017

Source: Quantec (2021)

Figure 2.4 shows that, on average, both the production and the total consumption remained steady in the 1970s through to the 1990s, as not much change occurred in this period.

However, the overall trajectory after 2001 shows a growth in both beef production and consumption, indicating growth in the beef industry. There was a 24 percent increase in the per capita income between 2000 and 2007, which impacted on the per capita consumption to increase from 12.3 kg per year to 18.1 kg per year in the same period (Department of Agriculture Forestry and Fisheries (DAFF), 2010). An increase in disposable income is directly related to per capita consumption. Thus, as individuals earn higher incomes, they tend to switch from a high carbohydrate diet to a more protein-based diet by including meat and dairy products. This is consistent with Bennett's law, which states that people eat fewer calorie-dense starchy staple foods and more nutrient-dense meats, oils, sweets, fruits, and vegetables as their incomes increase (Wickizerand Bennett, 1941).

Figure 2.4 above shows that, for the most part, beef consumption was higher than production, which implies that the deficit was covered by imports. Beef production was only sufficient in the period between 2014 and 2017, when production was higher than consumption. In 2016, both production and consumption had increased by 36% and 34%, respectively, relative to the previous decade (Bureau for Food and Agricultural Policy (BFAP), 2018). The feed grain prices have been continually low, and this is expected to support a projected 15% growth of meat production by 2027, relative to the base period of 2015–2017 (BFAP, 2018).

However, there was a decline in both production and consumption in the period of 2016/2017, relative to 2015/16, as depicted in Figure 2.4 above. The decline in the consumption of beef observed in the figure can partly be explained by shifts in consumer preferences that lead them to demand healthier choices, thus resulting in a shift from red meat to poultry (BFAP, 2018). There is an increasing demand for diets containing less cholesterol, which leads to increased demand for chicken and fish, and a decline in the demand for beef. The rise in per capita income may have a dual effect on demand, that is, it raises overall meat demand because people can now afford to buy more, while an increase in per capita income is also correlated with more numbers of housewives participating in labour markets. As such, these housewives would demand options that are more convenient and take less time to prepare, such as poultry options (Anderson and Shugan, 1991; Grunert, 2006). For the period between 1970 and 1999, these reasons were seen to cause the same effect of declining per capita consumption, as seen in the United States (Davis and Stewart, 2002). Related causes of a decline in beef consumption are changes in relative prices, which lead to substitution demand.

In this case, Figure 2.4 above also shows that, at the points at which beef imports were high, the per capita consumption declined. However, as soon as the local production of beef increased and the imports declined, the per capita beef consumption increased. During the period from 2013 to 2016, the value and quantity of beef imports from Namibia and Botswana reduced to 41% and 37%, respectively, at the same time that the per capita consumption of beef in this period was rising (DAFF, 2018). However, the per capita consumption of beef declined in 2017, which correlated with a decline in beef production and an increase of total imports from Namibia and Botswana, which accounted for 65.8% and 33.8% of the beef imports, respectively. The amount of beef imported in 2017 by South Africa was 819 tons, valuing approximately USD 2 713/unit (DAFF, 2018).

Therefore, a decline in domestic beef production results in more imports, which leads to beef being more expensive, relative to the prices of alternative commodities such as chicken and pork. According to (Taljaard, Jooste and Asfaha, 2006),the key drivers of change in beef consumption between 1970 and 1988 were prices and income per capita changes, while taste factors were vital for the period between 1958 and 2003. Therefore, the factors influencing the changes in consumption patterns include changes in dietary choices to include more healthy foods and foods that adhere to food safety requirements. Also important are the changing demographic patterns, such as urbanisation and the earning of higher incomes by individuals. Although the purchasing power of the consumer is expected to remain constrained, the growth in incomes is expected to support the expected increase in consumption (BFAP, 2018).

In the period between 2007 and 2017, the average gross value of beef produced was R21 billion. The prevailing prices affect the gross value of beef production, and the beef prices significantly increased in the period between 2007 and 2017. The increase was attributable to a growth in the population, and greater numbers of people including meat in their diet (DAFF, 2018). The market in effect determines the prices because there are no price settings, mandatory carcass auctioning, or restrictions in establishing abattoirs. Cattle numbers and the number of slaughters also affect the gross value of beef production. Figure 2.5 below shows how these factors have varied over the period between 1971 and 2017.

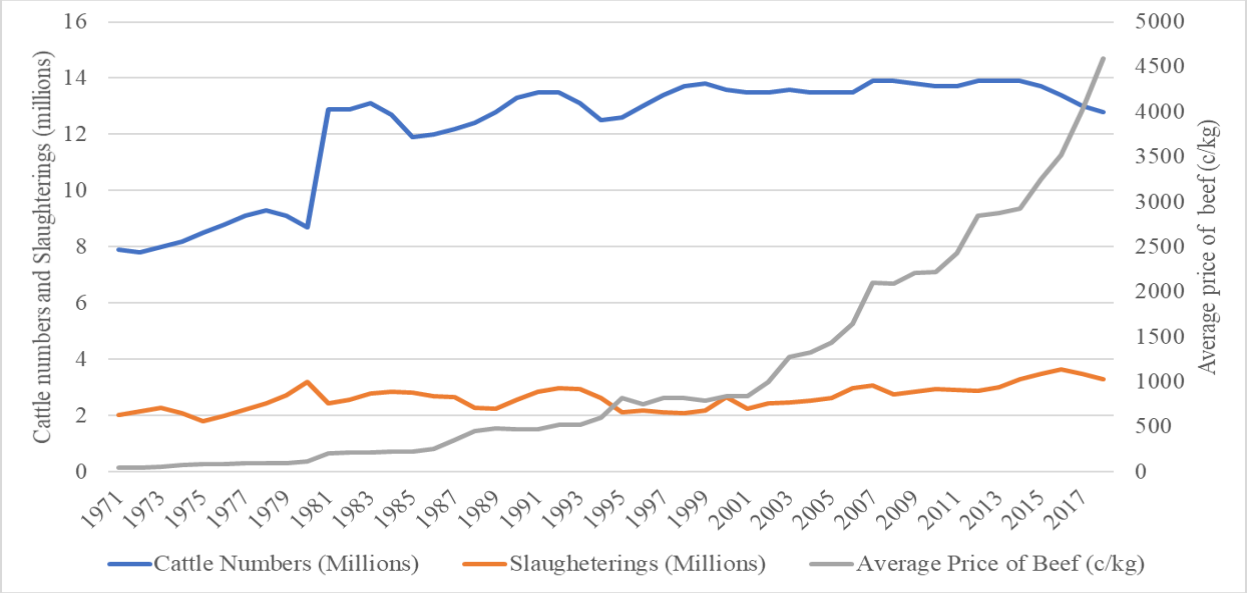

Figure 2.5: Cattle numbers, number slaughtered &the average price of beef, 1971 to 2017

Source: Quantec (2021)

Figure 2.5 above shows that beef prices had significantly risen in the period between 2007 and 2017. As established in the previous section, this period was associated with an increase in per capita income. High per capita income operates to increase the demand for protein-based diets. On the other hand, the cattle numbers remained somewhat constant, between 13 and 14 million cattle, after the sharp increase in 1980, which was brought about by the national statistics then including the informal sector. Therefore, as the law of demand and supply predicts, an increase in demand, while the supply remains constant, acts to drive the prices up. The continued rise in beef prices is also related to the constant growth in the national population, which also has a positive impact on the demand for beef and beef products (DAFF, 2018).

The number of cattle slaughtered shows the most variation over this period due to factors such as changes in real per capita income, the consumer perception of beef affordability, the availability of beef substitutes, and factor prices such as the price for labour. Lastly, the trend of cattle numbers and numbers slaughtered declined after the most recent severe drought in 2015, as beef prices continued to rise after this period. The increase in prices after a drought period is attributable to supply shortages, as the beef producers would have lost cattle and would still be trying to rebuild their stock after the drought (DAFF, 2018).

Therefore, the increasing beef prices should serve as an incentive for smallholder cattle producers, encouraging them to increase their participation in livestock markets due to the availability of higher profits that are attributable to the sales that will be made when prices are high. On the other hand, for the smallholder farmers to increase the volume of their cattle sales on the market, they should also be prompted to adopt technologically efficient means of production to meet the growing beef demand and changing consumer preferences. The next section considers the aspects related to the marketing of livestock.

2.3 LIVESTOCK AND BEEF MARKETING IN SOUTH AFRICA

The livestock producers in South Africa have the choice to supply the domestic market or the international market, or both, with meat and meat products. The domestic market has grown over the years because the upward shift of demand for meat and meat products that resulted from higher consumption levels (BFAP, 2018). As shown in the previous section, the growth in domestic beef demand levels is actuated by factors such as rising incomes, urbanisation, and migration. Livestock marketing is vital, as it potentially uplifts the living standards of rural households and the country at large. The smallholder farmers in South Africa own about 40% of the national cattle herd, yet, they engage sparingly in livestock marketing. The smallholder farmers sell less than 10% of the herd size they own, while commercial farmers sell between 25% and 30% of their herd size (Gwiriri et al., 2019).

Increased market participation by the smallholder farmers could raise their food security levels and also increase beef exports. Typically, smallholder farmers sell their cattle during festivities and when they need cash for emergencies or immediate needs (DAFF, 2018). The beef produced and supplied through formal market channels can be traced through the chain due to the registered market brands that are used, which then allows the consumers to confidently obtain their meat preferences. However, most of the transactions that occur in the informal market channels are not accounted for. The beef value chain includes producers, feedlots, abattoirs, processors, distributors, wholesalers, and retailers, as depicted in Figure 2.6 below.

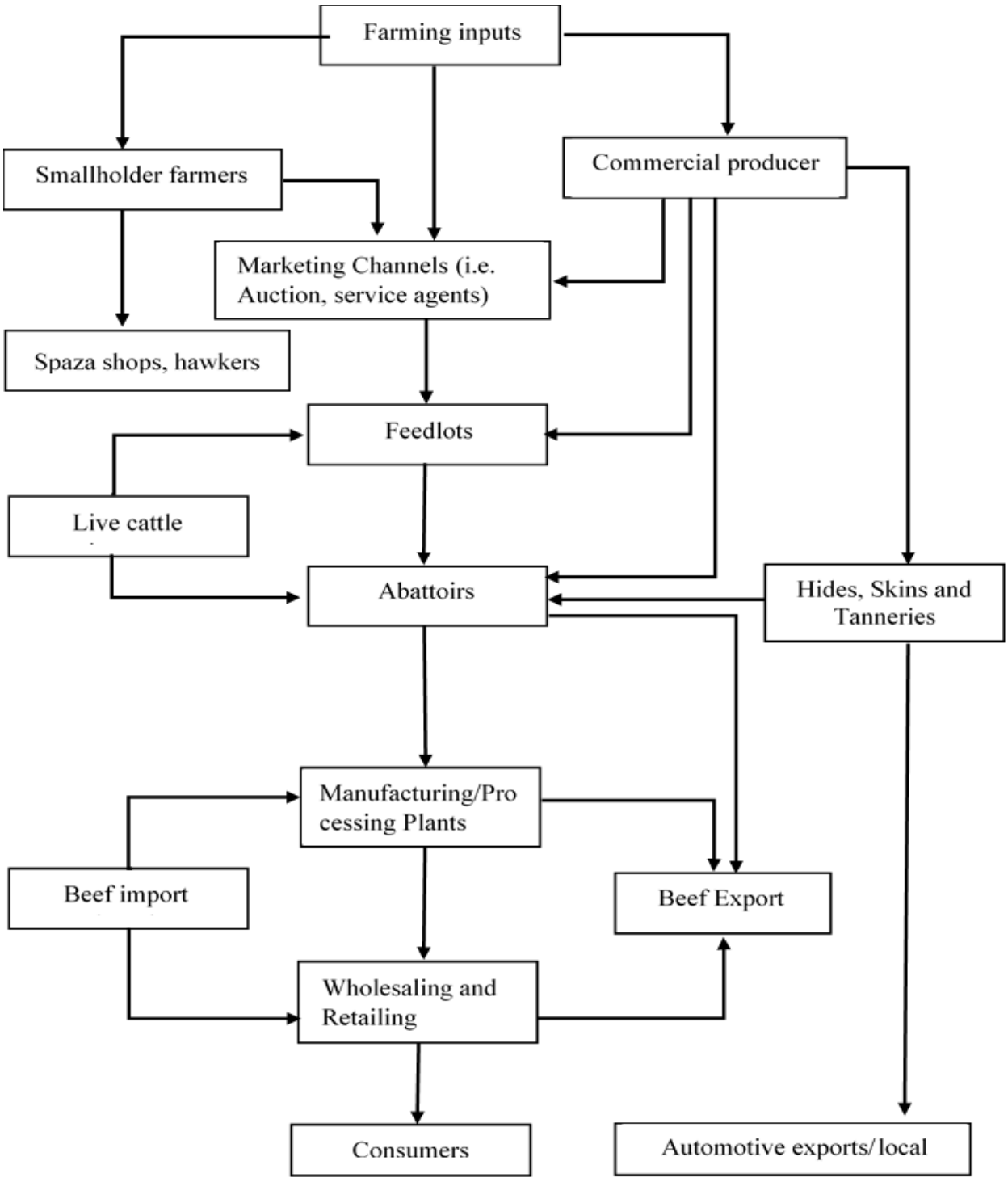

Figure 2.6: Beef Value Chain

Source: Department of Rural Development and Land Reform (DRDLR) (2016)

The beef value chain, illustrated in Figure 2.6 above, shows that the smallholder farmers are missing out on opportunities that are available in the export market by sparingly participating in the market. However, the devising of trade agreements and policies, globalisation, and its

exports of high-quality beef have combined to increase access to the global market for the South African beef industry. The beef exported by South Africa has low cholesterol and fat levels that are acceptable for most international standards.

The major countries that South Africa exports to are Mozambique, Eswatini, Angola, Lesotho, Kuwait, China, Namibia, and Vietnam (DAFF, 2018). The expansion of exports is vital in enhancing economic growth in South Africa by promoting trade and the international competitiveness of the beef sector, thus, increasing the share of GDP it contributes (Bulagi, Hlongwane and Belete, 2016). In 2017, the major importer of South African beef was Asia, while one hundred metric tons were exported to countries in Africa, with the highest exports being commanded by Mozambique and the lowest by Tanzania (DAFF, 2018). There were more exports than imports in the period from 2014 to 2016 due to the World Organisation for Animal Health (OIE) giving South Africa a foot and mouth disease-free status. Relative to 2007, the export quantity of beef in 2016 was valued at R2 billion (39 000 tons), indicating an increase of 36 000 tons, while the imports increased by 707 tons (DAFF, 2017). Therefore, the benefits that might be realised through exploiting available beef export opportunities to Asia and Africa by the smallholder farmers are being forgone as a result of their lack of participation in livestock markets, to any degree.

Again, as depicted in Figure 2.6 above, the smallholder farmers also do not explore the hides, skin, and tanneries market, which is a lucrative market due to the growing demand for hides and skin by car industries, both locally and internationally (Labuschagne et al., 2010). However, the manner in which cattle are reared and slaughtered by the smallholder farmers impacts negatively on the quality of the hides obtained. The smallholder farmers use more extensive livestock rearing methods, and as such, do not obtain hides of a marketable standard. The smallholder farmers still have an opportunity to increase their participation in hide markets due to available demand for products for use in the manufacture of shoes, furniture, and car interior finishes (Spies, 2011). Most of the hides in the informal sector are wasted, without any value addition, and accordingly, smallholder farmers should be taught value addition skills and enabled to participate in hides markets.

The marketing of livestock by the livestock producers, from the farm level to the retail market, follows four marketing channels, as presented in Figure 2.6 above. These channels differ in the manner in which prices are determined, which then causes variations in profit margins. The marketing channels used in the livestock markets are discussed below.

2.3.1 Direct sales

The smallholder farmers make direct sales by engaging in transactions in the informal sector, which include sales to spaza shops and hawkers (Labuschagne et al., 2010). The smallholder farmer and the buyer negotiate a selling price for the animal that is suitable to both parties involved in the transaction. Such transactions commonly occur when the animal purchased is sold or bought for religious celebrations or festivals such as circumcision ceremonies, weddings, andfunerals (DAFF,2018). Low transaction costs are incurred during such transactions, as they occur amongst people who are usually in very close proximity, thus, marketing costs and transport costs are low (Dercon, Hill and Zeitin, 2009). The negotiation costs are also low due to the lack of middlemen in the transaction; therefore, the smallholder farmers maximisetheir profit margins insuch transactions.

The smallholder farmers also make direct sales to butcheries. However, the kinds and numbers of livestock demanded by the butcheries are highly determined by the preferences of the end consumers. This is because the animal purchases by the butcheries are primarily required for retail purposes, and as such, the consumer preferences need tobe met. Smallholder farmers sell their animals to butchers because such transactions offer a good platform for negotiation, which would potentially result in the farmer being satisfied with the transaction (Nkhori, 2006).The smallholder farmers may sometimes not sell live cattle, but instead slaughter the animals to be sold and supply the meat in bulk to butcheries. The smallholder farmers typically increase direct sales to meet demands, such as for purchases of farming inputs right before the start of the rain season. Smallholder farmers may also engage in barter systems, especially in drought periods when they are facing adverse shocks.

2.3.2 The auction market

Unlike direct sales, which mostly occur among members of the same community and usually on the farmer’s premises, auction markets are conducted at regular intervals at designated places. The commercial farmers also make use of this formal market channel. In this case, many buyers are present at the place where the animals are being sold, and the buyers offer the amounts they are willing to pay for the animal being sold, and the animal is then sold to the highest bidder (Nkhori, 2006). The auction markets have no restrictions and can be

accessed by any willing buyer or seller. However, smallholder farmers sparingly engage in such markets for fear of obtaining low prices for their animals. Low-quality animals atttractfew bidders, who typically offer low amounts, which then will reduce the profit margins obtained by the smallholder farmers.

The animals placed on auctions are bought for several reasons, including consumption, retail sales in butcheries, and mere speculation that the price of animals bought today might be higher tomorrow, and thus resold at a higher price (Suon, Hol, Siek, McLean and Copeman, 2006). In speculative buying, the buyers aim to offer aminimum price,which allows them to resell their purchases at a profit,and this leads to opportunistic behavior. The information asymmetry that exists between the buyers and the sellers at auctions works to disadvantage smallholder farmers through their lack of a full understanding of how the auction markets operate. Thus, the smallholder farmers may chose to not participate in auction markets, as they may not fully comprehend the price-setting mechanisms that prevail during auctions (Nkhori, 2006). On the other hand, the smallholder farmers would also have a low engagement in auctions because of the absence of this channel in some parts of the country. The animals of smallholder farmers are also usually of a lesser quality,with the result that their sales are disadvantaged during the auctions. The smallholder farmers typically receive very low prices, which discourage their engagement in such markets. The auction market prices fluctuate due to the effects of the demand and supply forces, and supply is higher when most farmers are faced with a crisis such as drought, and consequently chose to dispose of their animals to obtain cash for immediate relief (Musemwa et al., 2010).

The auction market channel is vital for the sale of live animals, as it allows the buyers to have a wide range of options of animals they would want to buy. The auction market may offer bulls, cows and calves, of varying sizes, ages, breeds and quality, to meet the verious requirements of various buyers. The auctioneer ensures that the animals brought in by the producers are sold at the highest price offered, and all auctions are carried out in an appropriate manner, taking various factors into consideration, including the laws that guide the sale of live animals (Gollin and Rogerson, 2009). The auctioneers receive a commission for facilitating the transaction between the buyer and the seller.

2.3.3 Feedlots

The South African feedlot industry employs about 2500 people, with about 97 commercial feedlots in operation (Ford, 2016). The combined standing capacity of the feedlots is 620 000 cattle, with a throughput of about 1.8 million cattle per year (Ford, 2016). Figure 2.7 below shows the provincial numbers of cattle in feedlots associated with SAFA in 2016.

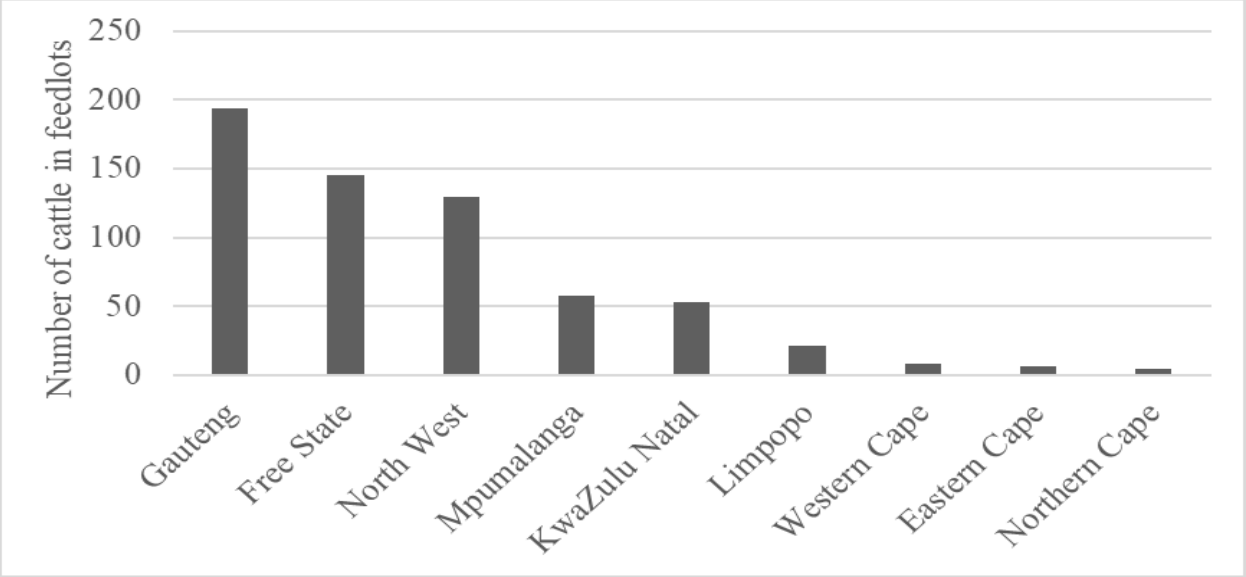

Figure 2.7:Provincial numbers of cattle in feedlots associated with SAFA in 2016

Source:Pienaar et al. (2019)

Most cattle in South Africa are being finished in, and marketed through, feedlots (DAFF, 2018). Feedlots vary in the sizes, indicated by their standing capacities, which ranges from 40 000 animals to 110 000 animals (Spies, 2011). Figure 2.7 above shows that the Gauteng province had the highest number of cattle in feedlots, while the Northern Cape had the lowest. This is because most of the feedlots with relatively high standing capacities are located close to large cities in the Gauteng province; Johannesburg, on the Witwatersrand, and Pretoria that tend to have better infrastructure (Spies, 2011). The cities have advanced transport systems that facilitate the transportation of cattle and calves (DAFF, 2018). Furthermore, feedlots have direct linkages with consumers through supplying beef to wholesalers and retail outlets, which are present in large numbersin Gauteng. The province also has a high demand for beef as a result of the high population in the province (DAFF, 2018).

Therefore, the sale of animals to feedlots provides another marketing channel that is used by livestock producers. In this case, established feedlots buy animals from the farmers and placethe animals in feedlots, where they are fed until when they reach the desired state of quality. However, a number of the well-established feedlots,which could offer premium prices for animals sold by the smallholder farmers, are usually integrated with commercial farms, thereby disadvantaging the smallholder farmers (Spies, 2011). This integration is mainly driven by feedlots that own abattoirs and wholesalers. The high-throughput feedlots are concentrated in specific regions of the country, and as such, transactions by smallholder farmers with such feedlots require paying high transport costs, which reduce their profit margins.

The feedlots are strict regarding the weight, sex, quality, and breed of the feeder cattle that they purchase, and most smallholder farmers may not be able to offer the best quality animals, and as a result, they receive low prices on the sales made. Rather than the majority of breeds reared by smallholder farmers, the feedlots instead prefer the Afrikander, Nguni, and Bonsmara breeds due to their high average daily gain and to the facts that they are easier to process and are less labor-intensive when finally processed (Pienaar et al., 2019). If a feedlot owner expects to obtain higher returns from particular animals at the end of the feedlot period, then a higher price might be offered for suchfeeder cattle (Stür and Varney, 2007). The live weight of new feeder cattle is usually about 250 kg,and by the end of the feedlot period, steers have an average weight of about 400 kg (Pienaar et al., 2019). However, most smallholder farmers fail to meet some of the standards required for supplying animals to the feedlots, such as those that require that ananimal be healthy anddisease-free, and must not have any parasites. The smallholder farmers are more willing to sell off their old oxen, with the result that most of these oxen are excluded from this market channel.

2.3.4 Abattoirs

There about 430 abattoirs in South Africa, varying in sizes and locality, with some being owned by municipalities or by farmers, while some are integrated into feedlot companies and wholesalers (DAFF, 2018). The average slaughter capacity of the abattoirs is 16 500 units per day, where a ‘unit’ is equivalent to a single large animal or 15 small ruminants (Mazibuko, 2013). South African abattoirs are classified as high-throughput or low-throughput abattoirs,

with averages of 21to 100 units/day and 1 to 20 units/day, respectively (Spies, 2011). Figure 2.8 below shows the distribution of a total of 120 high-throughput abattoirs in South Africa.

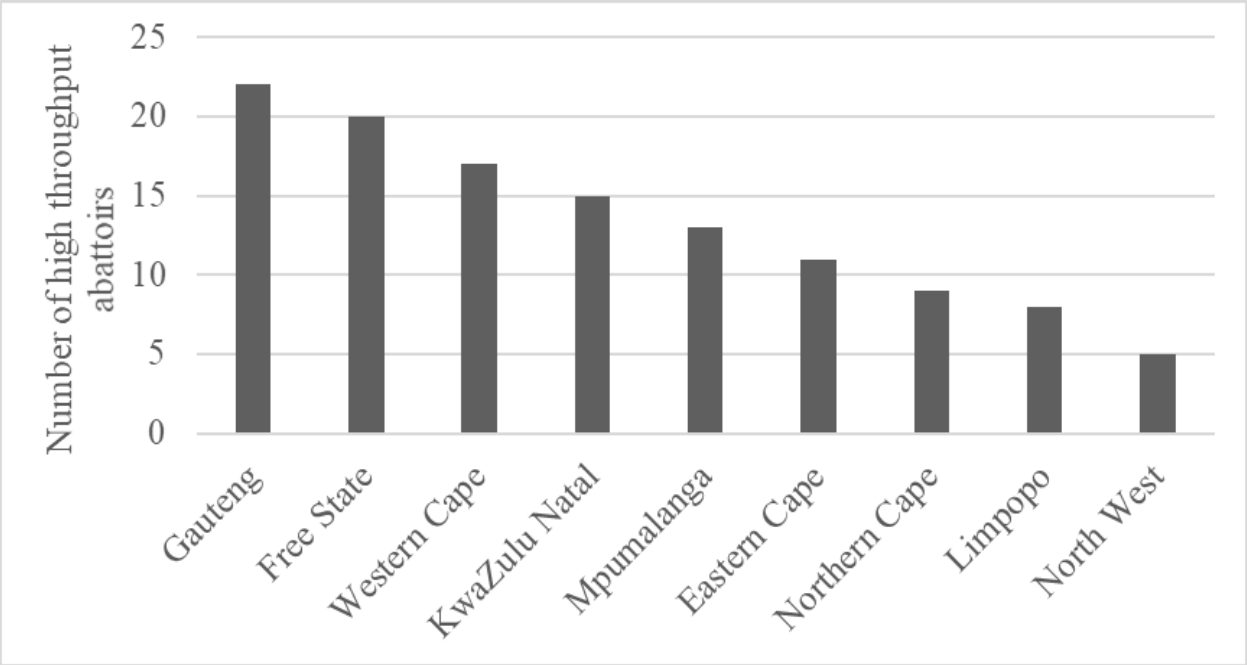

Figure 2.8: Number of high throughput abattoirs per province

Source:Red Meat Abattoir Association (RMAA) (2009)

Figure 2.8 above shows that the Gauteng province has the highest number of abattoirs, relative to other provinces, which has an impact on the provincial amounts of beef produced. The number of high-throughput abattoirs in Gauteng is 22, followed by Free State with 20, and the Western Cape with 17 (RMAA, 2009). The North West province has the lowest number of high-throughput abattoirs. The abattoirs sell beef to butchers, processors, and meat traders, as guided by the Meat and Safety Act. The Act provides for the safety and quality of meat products and stipulates the responsibility for each step in such transactions.

Refrigerated trucks comprise the common mode of transporting beef between the abattoirs and processors,as well as directly to retailers and butcheries. Refrigerated trucks have varying capacities, ranging from 60 to 100 cattle carcasses for trucks rated between 13 and 24 tons (Pienaar et al., 2019). The volume transacted is typically reduced, as the distance covered increases, due to the higher transportation costs incurred by the farmer (Shiferaw et al., 2006). Vertical integration exists between abattoirs and wholesalers which purchase carcasses from abattoirs, as well as cattle that is ready to be slaughtered. The consumers make their meat purchases from retail stores, such as Woolworths and Pick n Pay, or from butcheries.

Therefore, there is a great opportunity for smallholder farmers to both increase their sales and arrange for the slaughter of their livestock at abattoirs because the full capacity of the abattoirs is hardly ever reached. The abattoirs provide a good linkage to the wholesalers and butcheries that buy bulk meat at the abattoirs for retail purposes. However, the transport cost per head is highwhen transporting only one animal, but relatively cheaper when taking two or more animals to the abattoir.Nevertheless, the transport costs discourage smallholder farmers from using this marketing channel because of their small herd sizes. The smallholder farmers who sell their livestock to abattoirs are also subjected to delayed payments, charged levies, and incur losses if the meat quality is condemned after slaughter (Mazibuko, 2013). The price of an animal is determined by the weight, quality, and age of the animal, rather than the type of breed of an animal or how the animal was reared (Nkhori, 2006). Therefore, this is not the most preferred channel for most smallholder farmers who face a high risk of obtaining quite low-profit margins.

Abattoirs are usually a very good option in periods when cross-border trade restrictions are in place due to diseases such as Foot and Mouth Disease (FMD) in a particular region (Lubungu, Sitko and Hichaambwa, 2015). In this case, the smallholder farmers sell their live animals to abattoirs because the live animal trade across regions is restricted. Abattoirs buy the animals because they are vertically integrated with the wholesalers or retailers. Smallholder farmers would then decide which abattoir to sell to, depending on the extent to which they trust the weighing scales and the price offered per kg forthe animal being sold. The classification of the carcasses is conducted with regard to age and fatness, which indicate meat tenderness and fat level, respectively (Pienaar et al., 2019). Thus, the money values of meat will vary according to the designations prescribed by the South African Carcass Classification System.

Accordingly, the discussion above shows that the most preferred and commonly used market channel that is utilised by the smallholder farmers is the direct sales channel, and this is because it is associated with the lowest transaction costs. In this case, farm-gate sales do not include brokerage fees or commission for a marketing agent, and the farmer does not incur any transport costs (Shiferaw, Obare and Muricho, 2006; Musemwa, Mushunje, Chimonyo, Fraser, Mapiye and Muchenje, 2008). However, increased market participation by the smallholder farmers would have the effect of increasing exports, and, perhaps more significantly, would also enable them to explore the hides, skins, and tanneries market. This would then enhance the commercialisation of the smallholder farmer segment.

2.4 SUMMARY

The chapter has discussed an overview of livestock production and marketing in South Africa. The chapter has demonstrated the importance of the livestock sector, as it contributes much to the agricultural sector's GDP. Livestock production occurs in all the provinces of South Africa, but the production levels in each province are influenced by factors such as environmental conditions, biomes, population density, and infrastructure. This was signified by the low number of households engaged in livestock production in the Northern Cape province, despite the province having a large portion of the grazing land in South Africa. Therefore, one of the ways in which livestock production can be enhanced in the provinces where it is low, such as the Northern Cape, is to help the smallholder farmers to gain access to better pastures during dry winters, as well as improved access to major input and product markets.

Livestock marketing is linked to several factors that enhance beef production, such as the favorable location of aprovince, an improved transport system, a proper network of abattoirs, and feedlots thatboost the number of slaughters. Although the Gauteng province has the smallest area of land and has a small number of cattle in the province, it is among high beef-producing provinces in South Africa. This indicates that the rich beef-producing provinces have better infrastructure, such as more feedlots and abattoirs in Gauteng, despite sometimes having low livestock numbers. Therefore, this creates an opportunity for smallholder farmers to acquire market linkages and become engaged in contracts with feedlots and abattoirs in such provinces, thereby increasing their offtake rates and market participation. However, there is also a great need for improved transport systems that are needed to enhance the access to input and product markets by the smallholders, and for better infrastructure such as abattoirs and feedlots. These aspects are vital for increasing livestock production and marketing among the smallholder farmers, which will would then provide great potential for them to reduce poverty, enhance food security, and improve livelihoods.

The discussion also showed that the increase in beef consumption levels is consistent with Bennett's law, which states that "as incomes rise, people eat relatively fewer calorie-dense starchy staple foods and relatively more nutrient-dense meats, oils, sweeteners, fruits, and vegetables (Wickizerand Bennett, 1941)." As such, it can be expected that, as the per capita income continues to rise in South Africa, the beef consumption levels will also rise.

Accordingly, this will provide greater opportunities for smallholder farmers to increase their market participation so as to meet the growing demand for meat and meat products. The discussion also demonstrated that there has been a rise in beef prices, which could incentivise the smallholder farmers to increase their participation in the beef markets. This could be achieved through concerted efforts by both the government and the private sector tohelp the smallholder farmers to sell their livestock in profitable market channels. The more profitable market channels include selling to auctions, feedlots and abattoirs, rather than the commonly used market channel utilised by smallholder farmers to conduct direct sales at farm-gate prices, which results in low-profit margins. The use of improved market channels by the smallholder farmers would enable them to take advantage of opportunities that are available in livestock markets, such as increased export markets and the hides market for the automotive and clothing industries.

CHAPTER 3: LITERATURE REVIEW

3.1 INTRODUCTION

The previous chapter provided a comprehensive analysis of livestock production and marketing in South Africa. The chapter analysed the beef value chain to identify some of the constraints that smallholders face, and highlighted the opportunities that they could potentially exploit through increased participation in livestock markets. Apart from the constraints related to marketing channels and infrastructure, as elaborated on in the previous chapter, smallholder farmers are also affected by other factors, such as climate variability effects seen in the regularity of drought and animal diseases.

Primarily, this study investigates the effects of drought and animal diseases on the participation by smallholder farmers in livestock markets. As such, the study enhances the comprehension and understanding of the market participation dynamics of smallholder farmers. This will provide a way for informing the formulation of policies, and enhancing the growth and development of the livestock sector in South Africa. The smallholder livestock farmers are faced with low economic returns due to low participation in markets caused by factors elaborated in this chapter including the effects of drought and animal diseases. Some concepts and phrases will be used several times in this chapter that require explanations from the onset. The definitions adopted for concepts used in this study include:

- **Smallholder farmer**: a person engaged in farming, owns a small piece of land, consumes most of the products, and keeps about 3 to 5 large ruminants (Herrero, Thornton, Bernués, Baltenweck, Vervoort, van de Steeg, Makokha, van Wijk, Karanja and Rufino, 2014b).
- **Market participation**: the buying and selling of livestock in the market (Barrett, Bellemare and Osterloh, 2004a).
- **Climate variability**: the change in weather patterns due to rising temperatures and increased carbon in the atmosphere (Singh and Singh, 2012).
- **Drought**: a condition of low rainfall received in a particular area, relative to its average that, over time, is considered ‘normal’(Wilhite and Glantz, 1985).
- **Animal disease**: a condition that causes an animal not to perform its normal bodily functions (William BurrowsDante G. ScarpelliCharles E. Cornelius, 2018).

This chapter provides an overview of how livestock marketing among smallholder farmers is affected by various factors, including the effects of drought and animal diseases. Livestock markets continue to be viewed as a way by which smallholder farmers could be enabled to commercialise their business operations. As such, this chapter gives an overview of the status of drought and animal disease in South Africa and of how these impact upon the participation by smallholder farmers in livestock markets. A clear elaboration of how drought and animal diseases affect the smallholder farmers' participation in livestock markets is reflected in the conceptual framework. The next section starts by elaborating on the various factors that affect market participation, as shown in the literature.

3.2 FACTORS INFLUENCING MARKET PARTICIPATION

Market participation comprises the buying and selling of livestock in the markets (Barrett et al., 2004a). However, smallholder farmers rarely participate in livestock markets (Zuwarimwe and Mbaai, 2015). The participation by smallholder farmers in livestock markets is vital for enhancing much-needed agricultural transformation in developing countries (Alene, Manyong, Omanya, Mignouna, Bokanga and Odhiambo, 2008). The increased participation by smallholder farmers in output markets significantly reduces poverty, increases food security, and increases foreign currency gains (Heltberg and Tarp, 2002; Sotsha et al., 2017). Therefore, improving market participation among smallholder farmers is a priority for most developing nations, including South Africa.

There are many factors that influence the participation by smallholder farmers in livestock markets, including human factors, financial factors, physical factors and transaction costs such as distance to the market and the main roads, the availability of transport, and population density; and physical factors such as the number of livestock owned and the farm size or amount of land owned (Delgado, Catelo, Lapar, Tiongco, Ehui and Bautista, 2007). The following discussions will demonstrate how these factors influence the participation by smallholder farmers in livestock markets.

3.2.1 Human factors

The human factors that affect the participation by smallholder farmers in livestock markets include the smallholder farmer's age, gender, and level of education (Mafimisebiand Ikuerowo, 2018). Other human factors are household size and the death of a household member (Lubungu, Chapoto and Tembo, 2012). As smallholder farmers get older, they take

on more responsibilities, such as paying their children's school fees or meeting other financial obligations, which prompts them to become more involved in livestock markets. Likewise, as the household size increases, it is expected that the smallholder farmer would increase his or her participation in livestock markets to supplement his or her income on order to meet the increased household needs. However, household size might also reduce market participation because, as the number of dependents increases, smallholder farmers would be less likely to sell their livestock, but rather use it for their consumption (Ehui, Benin and Paulos, 2003). The death of a household member also influences a smallholder farmers' participation in the livestock market (Lubungu et al., 2012). When a household member dies, the smallholder farmer is confronted with an emergency that necessitates obtaining financial assistance to cover funeral expenses; as a result, the buffer or safety net typically used by smallholder farmers in such times is represented by the sale of livestock, which increases their participation in markets.

Most smallholder farmers rear livestock in cultural settings that favour male livestock ownership over female livestock ownership. As a result, male-headed households usually own more livestock than female-headed households do; thus, male-headed households are more likely to participate in livestock markets. Males are also generally regarded as being more easily inclined to make decisions about selling livestock than females are. Furthermore, education improves the skill and ability for using market information effectively, potentially lowering marketing costs and increasing market participation efficiency (Mafimisebi and Ikuerowo, 2018). This is crucial, given farmers' general belief that market conditions are unfavourable. As a result, education is expected to increase market participation because smallholder farmers would be able to deduce the conditions in livestock markets at any given time.

3.2.2 Financial factors

Financial factors, such as the smallholder farmers' income levels, are important determinants of their participation in livestock markets. The hurdle to participating in the livestock markets is higher for poorer smallholder farmers, relative to those who are wealthier (Ngqangweni and Delgado, 2002). Their on-farm and off-farm activities, and their level of crop commercialisation, contribute to a smallholder farmer's total income gains; thus, they also influence their market participation (Lubungu et al., 2012). Smallholder farmers want to maximise their profits in the livestock markets. As a result, if smallholder farmers earn more

money from participating in livestock markets, they are more likely to increase their participation, and vice versa. However, if a smallholder farmer has a high off-farm income, he or she is less likely to participate in livestock markets because their financial needs are being met largelyby the income generated by their off-farm activities.

Chipasha, Ariyawardana and Mortlock (2017) highlighted the fact that access to credit is a significant financial factor that affects market participation. Increased credit access is expected to increase the adoption of improved technologies and, as a result, market participation (Ehui et al., 2003). Smallholder farmers may obtain credit for livestock activities, such as restocking depleted herds and fattening, which benefits their participation in markets. Credit obtained for purposes other than livestock production, on the other hand, results in lower participation by smallholder farmers in livestock markets.

3.2.3 Physical factors

The number of livestock that a smallholder farmer owns also influences their participation in livestock markets (Lubungu et al., 2012). The well-established buyers typically prefer to use contracts that provide them with a consistent supply of livestock; as a result, smallholder farmers with lower numbers of livestock suffer. When a smallholder farmer's livestock herd increases, it implies that the farmer would have more livestock to sell in the market, even after own consumption. The smallholder farmers with higher numbers oflivestock are expected to engage more in markets. However, livestock numbers are usually low for each smallholder farmer, which impacts negatively on his or her participation in livestock markets. The proper marketing of livestock requires infrastructure such as feedlots, abattoirs, and animal holding facilities (Pienaar et al., 2019). The amount of land owned by asmallholder farmer could alsohave a positive effect on his or her market participation. Smallholder farmers typically engage in extensive livestock rearing; as a result, the more land they own, the more animals they can rear, and more areas of pasture will beavailable to feed their livestock. Having greater areas of pasture implies that the livestock they produce would be of higher quality, which enhances their market participation (Gesese, Woldeamanueal and Legesse, 2019). The smallholder farmers, at times, struggle with attracting buyers because of the poor body conditions of their animals. The prices offered to them during transactions, such as during auctions, are quite low, which discourages their participation in livestock markets. Thus, improved body conditions of livestock results in higher prices and demand, encouraging smallholder farmers to increase their participation in livestock markets.

3.2.4 Transaction costs

Transaction costs also influence the smallholder farmers' participation in markets. The conditions of infrastructure, such as roads, and the distance to the main markets impact on the transaction costs incurred by the smallholder farmers (Nkonde, 2008). Infrastructure is important for facilitating the flow of market transactions. The smallholder farmer needs to transport the animals to the buyers, and if the roads are poor, the movement of animals is impeded, which constrains market transactions (Gabre-Madhin, 2009). Thus, the farmers incur higher transport costs,which reduce the incentive of the smallholder farmers to participate in the markets. Smallholder farmers who encounterlower transaction costs are more likely to participate in livestock markets because their profits can be maximised. Thus, smallholder farmers who are located closer to main roads can more easily access well-developed markets in large cities at better product prices, and with lower transportation costs.

The failure to gain access to market information by the smallholder farmers also increases their transaction costs (Gabre-Madhin, 2009). The lack of readily available market information makes it difficult for sellers to know where to find buyers, and vice-versa. Thus, both buyers and sellers are forced to engage the servies of marketing agents, which increases the transaction costs. There may also be a state of information asymmetry between the buyer and the seller, which leads to opportunism or self-interest combined with guile (Eisenhardt, 1989).The availability of market information reduces the market risks and increases the chances of a transaction occurring at the minimum transaction costs. Using the available market information, the smallholder farmers are able to become aware of the opportunities prevailing in the market, and thus can take advantage of the opportuniities by increasing their livestock supply in markets. The availability of market information allows smallholder farmers to incur lowercosts relating to searching, negotiation, and concluding contract agreements, thereby resulting in their increased market participation. Smallholder farmers participate in the market only when it is profitable for them to do so, and they then decide how much to sell. As a result, the aforementioned factors have an impact on profit margins by influencing the costs of livestock marketing.

This section has shown that the participation by smallholder farmers in livestock markets is influenced by a variety of factors. Moreover, there is a clear link between the effects of

climate variability, such as droughts and animal diseases, and the smallholder farmers' decisions to engage in livestock activities (Kabubo-Mariara, 2008). Despite the obvious link between climate variability and smallholder farmers' decisions to participate in livestock markets, it is only briefly mentioned in the literature. This study, therefore, assesses the impacts of drought and animal diseases on smallholder farmers' participation in livestock markets. As such, the following section further contextualises this study by highlighting the climate variability effects of drought and animal diseases on livestock marketing.

3.3 EFFECTS OF DROUGHTAND ANIMAL DISEASES ON LIVESTOCK MARKETING

Climate variability directly affects the agriculture sector, globally, and its effects are more adverse in regions with arid or semi-arid climates (Alabdulkader et al., 2016; Ochieng, Kirimi and Makau, 2017). Climate variability, as observed by rainfall and temperature irregularities, has a negative and significant impact on agricultural productivity increase in the Southern African Customs Union (SACU) region which includes South Africa (Ajetomobi, Dlamini, Dlamini, Ogunniyi and Dlamini, 2020). Climate variability largely affects the smallholder farmers and pastoralists by depleting their livelihood assets and undermining their ventures, such as farming and other off-farm income-generating activities (Intergovernmental Panel On Climate Change (IPCC), 2007; Goldman and Riosmena, 2013). Climate variability also causes a reduction in the production of fodder due to a fall in rainfall amounts, unsustainability in the irrigation of pastures, and a decrease in grain production, which result in a rise in feed prices (Thornton, van de Steeg, Notenbaert and Herrero, 2009). The negative effects of climate variability are expected to be high in areas where the smallholder farmers conduct farming under pastoral grazing, and where temperatures are rising and rainfall levels are declining (Rust and Rust, 2013).The climate variability effects cause livestock production rates to fall, and increase livestock losses because of poor pastures caused by droughts. Moreover, increased outbreaks of animal disease result in a decline in the quality of animal being reared.

The adaptive capacity of smallholder farmers to deal with drought and animal disease determines the extent to which their livelihoods will be impacted upon (Ortiz-Bobea, 2013; Ajetomobi et al., 2020). Adaptive capacity is defined as an "adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates

harm or exploits beneficial opportunities" (Intergovernmental Panel On Climate Change (IPCC), 2001). Some of the factors that increase afarmer's adaptive capacity include the farmer's asset value, income level, his or hersocial capital, and the extent to which the farmer is knowledgeable about the use of mitigation strategies, such as water harvesting (Ngqangweni and Delgado, 2002; Scheffran et al., 2012; Noelle et al., 2018). Smallholder farmers are more vulnerable to effects of climate variability because of their high reliance on agriculture and their food insecurity status (Reinman, 2012). Thus, to adapt, they may be forced to sell off their household assets and livestock to cover their consumption gaps and to meet other financial demands. Therefore, households with higher and more diverse incomes are more resilient to climate variability shocks (Muricho, Otieno, Oluoch-Kosura and Jirström, 2019). The poverty-stricken and marginalised smallholder farmers are the most severely affected by climate variability effects.

The major climate variability shocks in Sub-Saharan Africa (SSA) are in the form of droughts and resulting animal diseases (Thornton et al., 2009; Muricho et al., 2019). Livestock farmers have faced an increased risk of drought and animal diseases over the past three decades (Opiyo, Wasonga and Nyangito, 2014; Mwanyumba, Wahome, MacOpiyo and Kanyari, 2015). The smallholder farmers are vulnerable to droughts and animal diseases because they lack diversified livelihoods (Thornton et al., 2009; Sala, Otieno, Nzuma and Mureithi, 2019). Most of the smallholder farmers in developing countries are highly dependent on agriculture; however, smallholder agriculture relies on rainfall, and as such, it is highly linked to climate variability (Gadgil and Kumar, 2006; Olarinde, Adepoju and Jabaru, 2014). Therefore, drought and resulting animal diseases have environmental, social, and economic impacts, including effects on the smallholder farmers' participation in livestock markets.

Livestock marketing in developing nations is a vital element in eradicating poverty in rural areas, improving household resilience, and improving food security and productivity (Girma and Abebaw, 2012; Herrero et al., 2014a). The most important type of livestock reared by the smallholder farmers is cattle. As highlighted above, smallholder farmers rear livestock for various reasons, which will affect their decisions to either participate in livestock markets or not. Smallholder farmers rear livestock for prestige, for security against emergencies, as a store of wealth, and for the mere satisfaction that is derived from livestock rearing (Motiang, 2017). Livestock is also used to pay customary bride prices and to pay a form of compensation when disputes arise (Chimonyo, Kusina, Hamudikuwanda and Nyoni, 1999). In other instances, livestock is used for festivals like circumcision and wedding ceremonies,

and for funerals (Musemwa et al., 2008). However, some smallholder farmers only rear livestock as a hedge against the extreme effects of climate variability.

Livestock rearing is viewed by most rural agricultural households as being a better hedge against such conditions as drought and animal disease outbreaks than growing crops is (Rötter and Van de Geijn, 1999). The major reason that smallholder farmers rear livestock is to provide reserves (in the form of livestock) for food and cash. However, the marketing of livestock among smallholder farmers is influenced not only by factors such as profitability of market channels and availability of infrastructure, or the factors that relate to human, financial, physical and transaction costs, but also by droughts and animal diseases, as described in the following subsections.

3.3.1 Droughts effects

Southern Africa has experienced recurrent droughts with greater intensity that affect many countries, including South Africa (Ortiz-Bobea, 2013; Baudoin, Vogel, Nortje and Naik, 2017). Drought occurs when there is a persistently low amount of rainfall received, relative to the mean rainfall in a specific area (Wilhite and Glantz, 1985). Effects of drought include causing poor grazing lands, unavailability of water, and the death of animals (Muricho et al., 2019). Droughts also degrade the livelihoods of the affected households by reducing both on-farm and non-farm incomes (Fafchamps, Udry and Czukas, 1998). The reduction in the amount of rainfall in a region due to drought causes water scarcity, which has direct implications for the food security status of smallholder farmers (Opiyo et al., 2014). Drought also affects the capacity of a region to respond to other impacts of climate variability that rely on the availability of water to be curbed (Marshall, Aillery, Williams, Malcolm and Heisey, 2013). Figure 3.1 below shows the mean austral spring and summer (September–February) rainfall (shaded; mm) across southern Africa, based on material from Climate Hazards Group InfraRed Precipitation with Station data (CHIRPS) from 1981 to 2018.

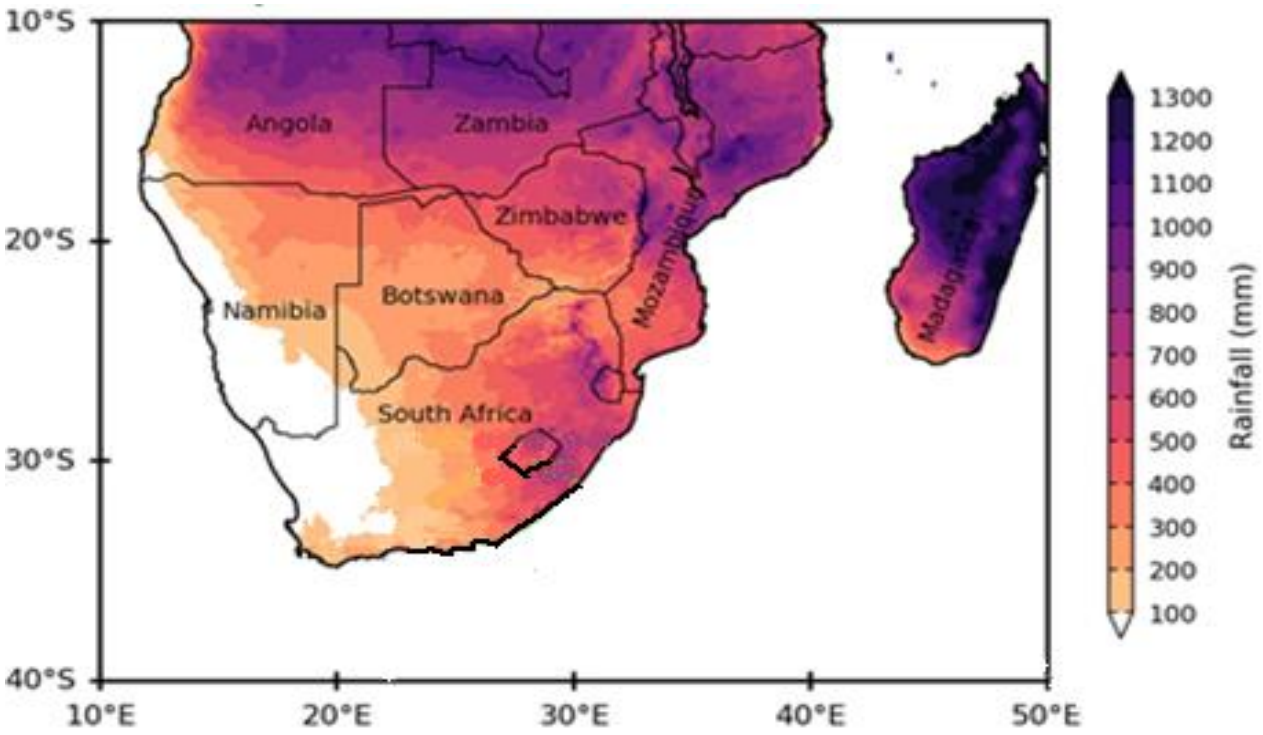

Figure 3.1: The mean austral spring and summer (September–February) rainfall

Notes: Rainfall shown shaded, in mm, across southern Africa, based on CHIRPS data for 1981 to 2018

Source: Mahlalela, Blamey, Hart and Reason (2020)

Figure 3.1 above indicates that South Africa's location, topography, and below-average rainfall combine to render it prone to drought(Water Research Commission, 2015). The extreme droughts in South Africa are associated with the El Niño Southern Oscillation (ENSO), a quasi-periodic invasion of warm sea surface waters into the central and eastern tropical Pacific Ocean that reoccurs at least once in every ten years (Rouault and Richard, 2003). Droughts exacerbate water resource constraints and are a recurring feature attributed to climate variability, which leads to severe weather change. Droughts in South Africa strain the country's agro-economic system, leading to increased unemployment and negative effects on economic activities such as livestock rearing and marketing. Figure 3.2 below shows the amounts of rainfall over the years from 1970 to 2020 in South Africa.

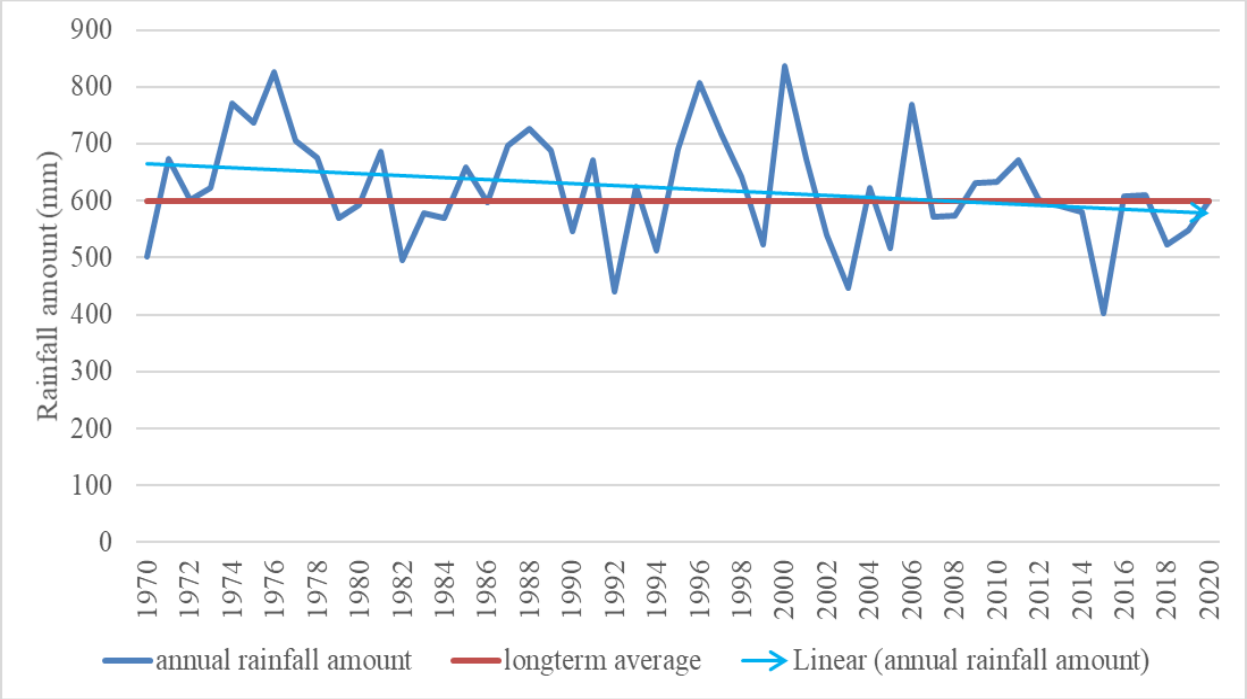

Figure 3.2: Annual average rainfall

Source: Weather South Africa (2021)

The long-term average plot in Figure 3.2 above shows that the average rainfall amount in South Africa is 600 mm. As a result, all years with less than 600 mm of rainfall are classified as drought years. At least twenty of the forty-seven years shown above had rainfall levels that were below normal. Drought frequency increased after 1990,when compared with the previous years. The slope of the linear plot of annual rainfall amounts decreases between 1970 and 2020, meaning that, if the line continues in this direction, less rainfall will be expected in the future. Droughts in South Africa are linked to climate variability, which triggers rising temperatures and shifting rainfall patterns. South Africa was hit by a heavy drought in 2015, caused by a powerful El Nino occurrence. The effects of this El Nino-related drought continued for several months, resulting in serious effects similar to those that resulted from a drought that hit the entire region from 1992 to 1995. South African authorities now classify it as the worst experienced in 23 years (Vogel and van Zyl, 2016; Botai, Botai, Dlamini, Zwane and Phaduli, 2016). Droughts affect the agriculture sector, reducing the viability of water supplies, and, as a result, food production declines. In addition, there has been a fall in fodder production, as well as occurrences of disturbances in certain economic activities, such as livestock rearing, thereby increasing unemployment rates (Baudoin et al., 2017).

Accordingly, smallholder farmers in South Africa have been negatively impacted upon by the effects of drought due to their low adaptive capacity for dealing with climatic variability effects (Sotsha et al., 2017). Drought occurrences result in a reduction of the per capita capacity of smallholder farmers to supply quality livestock, which negatively affects their participation in livestock markets (Makhura, 2002; Baluka, Mugisha and Ocaido, 2014). The smallholder farmers receive low prices for their livestock sales due to the decline in the quality of the livestock they produce. Droughts have also led to extensively high livestock mortality rates, especially among smallholder farmers (Stroebel, Swanepoel, Nthakheni, Nesamvuni and Taylor, 2008). In Kenyan arid and semi-arid lands, it was observed that more than twenty-five percent of cattle deaths occurred during droughts due to the lack of pasture and the unavailability of water (Ogutu, Piepho, Said, Ojwang, Njino, Kifugo and Wargute, 2016).

As such, when the herd sizes owned by the smallholder farmers reduce even further due to mortality caused by droughts, the transaction costs they incur also increase. The transport cost incurred by a farmer is lower per animal when they are transported in bulk than when only one animal is being transported to the market. According to a case study in Kenya, which was conducted to evaluate beef marketing efficiency, it was found that cattle marketing was constrained by high cattle mortality rates attributed to drought (Mbogoh, Munei, Komen and Mohammed, 2016). Moreover, animal birth rates decline significantly in prolonged drought periods due to the longer birth intervals experienced during droughts (Stroebel, Swanepoel and Pell, 2011). Bellemare and Barrett (2006) conducted studies in Kenya and Ethiopia that showed that cattle birth rates influence market participation. The same effect has also been observed in South Africa (Bahta and Bauer, 2007). As such, prolonged droughts also impact upon livestock marketing negatively due to a significant increase in cattle mortality rates.

However, livestock marketing among smallholder farmers has also been seen to increase during drought periods (Mbogoh et al., 2016). Livestock sales have risen during drought periods, causing an increase in offtake rates (Kinsey et al., 1998). A study conducted by Barrett et al. (2004a) found that smallholder farmers sell their animals in response to droughts, with high initial sales that then decline overtime. The authors also state that those smallholder farmers who own more numbers of livestock participate more in markets after droughts. The smallholder farmers with lower numbers of livestock may only participate in the livestock markets after the shock to cover their consumption gaps. However, other studies

that have evaluated the effects of the drought conditions in West Africa and Kenya indicated that drought did not affect the cattle offtake rates (Barrett, McPeak, Luseno, Little, Osterloh, Mahmoud and Gebru, 2004b; Fafchamps et al., 1998).

As a result, given the recent pattern of decreasing rainfall amounts and the projection for a similar trend to continue in the future, the factors described above that link droughts to smallholder farmer participation should be critically examined. Such research would improve the government's ability to react quickly and mitigate the catastrophic effects of droughts. Without a thorough understanding of the drought factors that affect the participation by smallholder farmers in livestock markets, the governments' efforts to enable the commercialisation of the operations of smallholder farmers would be in vain. Similarly, as seen in the following subsection, animal disease outbreaks have an effect on livestock marketing.

3.3.2 Animal disease effects

Animal diseases have a strongly negative impact in developing countries, and are estimated to kill 20% of ruminants and more than 50% of poultry, per year, resulting in a loss of USD 300 billion per year (Grace, Bett, Lindahl and Robinson, 2015). Climate variability can worsen diseases in livestock, and certain diseases are particularly strengthened by changes in climate. Climate variability is linked to 58 percent of the 65 animal diseases listed as being the most important to smallholder farmers (Grace et al., 2015). Thus, the diseases that are most critical for smallholder farmers are the climate-sensitive diseases that are most likely to have the greatest effect. Climate variability may have indirect effects on animal diseases that are more important than the direct effects are.

The climatic variability impacts negatively upon the livestock sector, causing the emergence of new livestock diseases (Baylis and Githeko, 2006). The change in temperature and the rainfall patterns attribute able to climate variability impacts favourably on the survival and occurrence of disease vectors, parasites, and pathogens (Thornton et al., 2009; Kebede, Zinabu, Ferede and Dugassa, 2018). The depletion of the ozone layer as a result of greenhouse gasses also affects disease distribution and occurrences (Baylis and Githeko, 2006).Therefore, climate variability increases animal diseases and pathogens, and intensifies animal methane emissions, creating a potentially vicious climate–disease loop, as depicted in Figure 3.3below.

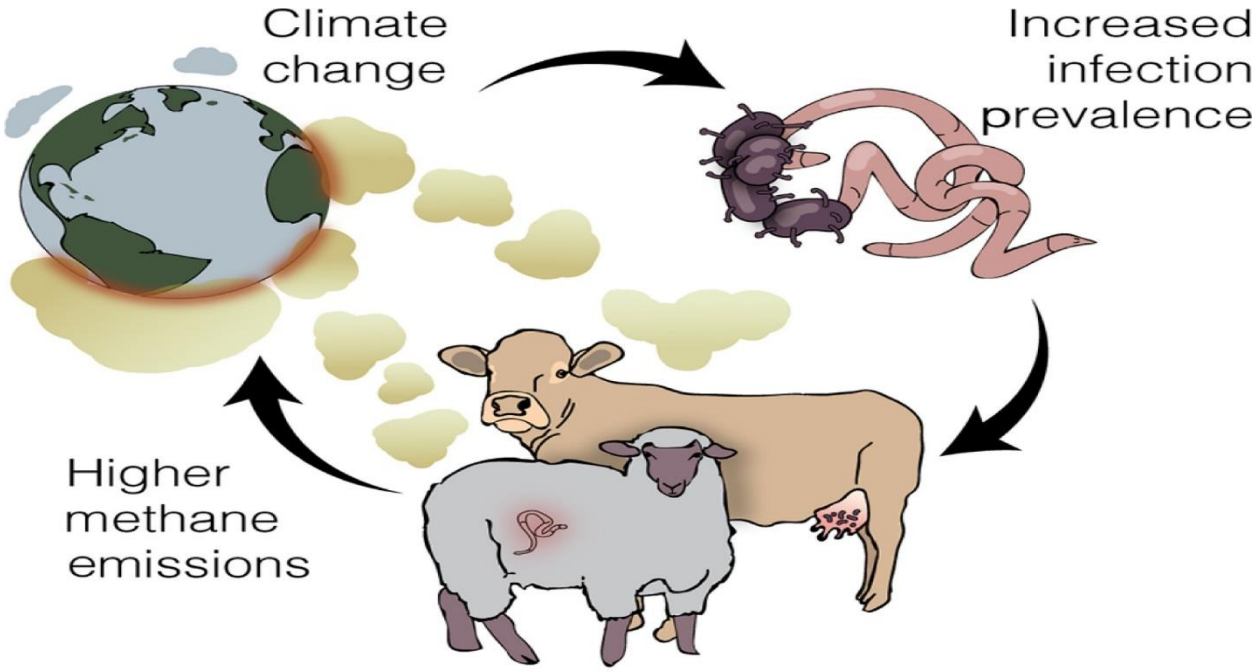

Figure 3.3:Potential positive feedback loop arising from interactions among climate, animal diseases, and methane emissions

Source: Ezenwa, Civitello, Barton, Becker, Brenn-White, Classen, Deem, Johnson, Kutz and Malishev (2020)

Livestock accounts for sixty percent of all mammal biomass on the planet. As such, Ezenwa et al. (2020) state that climate change not only increases the prevalence of animal disease, but infections can also exacerbate animal methane generation, potentially resulting in a vicious climate–disease loop. Methane is a greenhouse gas, also produced by livestock, notably ruminant cattle, and has a global deleterious warming effect that is about 28 to 36 times stronger than that of carbon dioxide (Ezenwa et al., 2020). Climate variability has been linked to an increase in pathogen infections. However, pathogens such as gastrointestinal worms and bacteria can increase methane yield, reduce production efficiency, and extend the time it takes for animals to attain production targets (Ezenwa et al., 2020). For example, an infected animal's gained weight is lower than that of an uninfected animal, and as such, it takes longer to achieve the target slaughter weight, resulting in higher lifetime methane generation (Fox, Smith, Houdijk, Athanasiadou and Hutchings, 2018). Parasites can also lead to maternal weight loss and delayed weaning, implying greater methane output per weaned animal.

The high animal disease incidences resulting from the variability in climate also cause higher livestock mortalities, a rise in poverty, and increased malnutrition and hunger levels (Mutibvu, Maburutse, Mbiriri and Kashangura, 2012; Noelle et al., 2018). Disease outbreaks

also result in a decline in animal productivity and, as a result, a decrease in livestock marketing, leading to scarcity of meat and other animal products (Pritchett, Thilmany and Johnson, 2005). Twelve of the world's sixteen most deadly animal diseases are found on the African continent, with eight of them wreaking havoc mostly in Sub-Saharan Africa (Wallace, Mather, Chetty, Goga and Babluk, 2014). South Africa is among the regions that are most susceptible to animal diseases associated with climate variability, such as tick-borne diseases (Olwoch, Reyers, Engelbrecht and Erasmus, 2008). The common animal diseases in South Africa are caused by internal parasites (roundworms, tapeworms, flukes) and external parasites (ticks, lice, mites, flies, midges). Figure 3.4 below shows a summary of animal disease outbreaks, as reported by municipalities in South Africa.

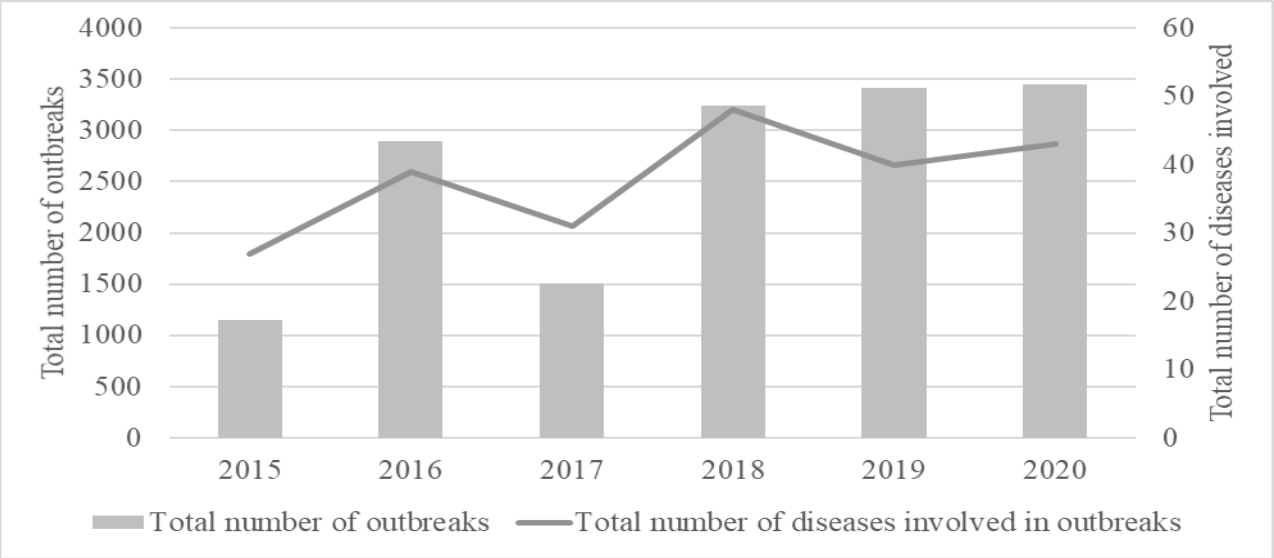

Figure 3.4: Animal disease outbreaks as reported by municipalities in South Africa, 2015-2020

Source: Department of agriculture Forestry and Fisheries (DAFF) (2020))

Figure 3.4 above shows that the number of animal disease outbreaks in South Africa increased between 2015 and 2020. Over the same period, the actual number of diseases affecting smallholder farmers also increased. The livestock of smallholder farmers need to be vaccinated to prevent an increase in the number of animal disease outbreaks. In South Africa, the state is responsible for providing veterinary services to livestock farmers through the Department of Agriculture and Food Security (DAFF). Veterinary facilities are critical in ensuring that sanitary standards for livestock processing, health, and trade are met, as well as

ensuring that the meat supply chain is kept hygienic and that other animal products are safe to consume (Habiyaremye, Maziya, Chaminuka and Mdlulwa, 2017). South Africa furthermore has a Disaster Management Act in place that promotes integrated multisectoral and multidisciplinary administrative, organisational, and operational preparation systems and capacities that are aimed at mitigating the effects of natural disasters and associated biological, technical, and environmental disasters, such as drought and animal disease outbreaks (Louw and Van Wyk, 2011). As a result, when faced with the devastating effects of drought and animal diseases, smallholder farmers may be eligible for compensation.

Animal diseases affect livestock marketing due to the various restrictions that are put in place because of disease outbreaks. Usually, no cross-border trade is permitted, and inland trade is subject to restrictions that aim to combat animal disease outbreaks (Baluka et al., 2014). Local markets become oversupplied as a result of low exports and low inter-provincial trade in live animals when cross-border trade is limited. As a result, smallholder farmers receive extremely low prices for their livestock `because their livestock, even in good times, is lower in quality than the livestock of commercial farmers, and oversupply discourages them from participating in livestock markets. Because of the increased local supply, smallholder farmers are forced to sell their livestock only to local butcheries and to communities directly (Lubungu, Sitko and Hichaambwa, 2016).When the movement of livestock is prohibited, the situation is made worse for traders in districts without abattoirs, as they must comply with regulatory disease inspections before any transactions can occur.

During animal disease outbreaks, livestock are liable be subjected to additional inspections before being released. As a result, livestock is quarantined for a specified period, resulting in considerably higher transaction costs. As transaction costs rise, the profitability and therefore the income of smallholder farmers decrease, which has been shown to serve as a disincentive for smallholder participation in the livestock industry. Quarantine conditions, as a result, have a negative effect the participation by smallholder farmers in livestock markets (Shiimi, Taljaard and Jordaan, 2012). In a study of the factors the restrict the efficiency of cattle marketing in Kenya, animal disease occurrence was established as one of the major constraints to cattle marketing (Onono, Amimo and Rushton, 2015). Animal diseases, like drought, result in poor-quality animals, which are not demanded by buyers on the market. As a result, and despite their willingness to sell their livestock, smallholder farmers are unable to do so due to the poor quality of the animals when affected by diseases (Düvel and Stephanus, 2000; Seleka, 2011; Shiferaw, Tesfaye, Kassie, Abate, Prasanna and Menkir, 2014).

However, livestock may be reared as a buffer against extreme climate variability risks and to assist smallholder farmers in meeting their immediate needs. As a result, smallholder farmers can still sell their animals as a coping strategy, disregarding the low prices that prevail during animal disease cycles (Motiang, 2017). In this scenario, smallholder farmers use their livestock to cover their consumption gaps in the face of climate variability and the risk of animal disease (Stroebel et al., 2011). As a result, the prevalence of animal diseases negatively affects smallholder farmers' livestock offtake rates or the ratio of sold livestock to the herd size owned.

Therefore, the low participation by smallholder farmers in South African livestock markets may be attributed to animal diseases, which have increased in recent years, negatively impacting on the cross-border trade of live animals, as well as causing rises in market transaction costs. Smallholder farmers are vulnerable to the consequences of animal diseases because they are unable to control them on their own, without government interference. As a result, increasing investment in research and development, as well as the deployment of early warning systems, are required to reduce the impact of climate variability (Ajetomobi et al., 2020). The cyclic relationship between climate variability, animal diseases, and carbon emissions, the marketing of smallholder farmers' livestock could become constantly under stress from animal disease. The conceptual framework outlined in the following section assists in consolidating and clarifying, primarily, the relationship between drought and animal diseases and the market participation by smallholder farmers, which is the aim of this study.

3.4 CONCEPTUAL FRAMEWORK

The importance of the participation by smallholder farmers in livestock markets has been stressed in previous sections. Many factors, however, influence a farmer's decision to engage in the market or not. As a result, the farmer makes a rational decision on whether or not to participate in the market. Rationality implies "some consistent maximization of a well-ordered function, such as a utility or profit function" (Becker, 1962). The farmer tries to maximise his or her utility by participating in the market and maximising profitability or minimising the costs incurred during the transaction. The farmer may also choose not to engage in the market, allowing him or her to focus on other aspects of livestock rearing. Such aspects may include rearing livestock as a sign of wealth or as a coping strategy for buffering against climate variability shocks such as droughts and livestock diseases.

As such, the decisions made by farmers may sometimes be inconsistent with the classical theory of economics. The rational reasons for profit maximisation may not always be the only reasons that farmers consider when deciding whether or not to participate in livestock markets. Farmers and other market actors are bounded by rationality, which raises transaction costs due to unforeseen circumstances. The farmers may not have all the information needed to optimise the decisions they make to participate or not to participate in the livestock markets. Agency problems also arise when bounded rational decision makers, with conflicting interests, transact under conditions of asymmetric information (Eisenhardt, 1989). This implies that the seller and the buyer have conflicting goals. The information asymmetry that exists among the actors gives rise to opportunism. Opportunism, as defined by Williamson (1975), is "self-interest seeking with guile" and it leads to lying and swindling (Kang and Jindal, 2015).

Therefore, the market environment affects the decision to engage in the market or not. Smallholder farmers can choose to maximise utility by rearing cattle for reasons other than profit, such as personal consumption, rather than simply participating in markets to maximise profit. Therefore, various factors affect the smallholder farmers' decisions to engage in markets. As elaborated in the previous chapter, market participation is a dichotomous response variable that is influenced by several factors, including human factors such as age, gender, household size, education level, and amount of land owned; financial factors such as income from livestock and off-farm income; physical factors such as distance to markets or main roads and infrastructure; and factors that directly affect transaction costs, such as the access to market information and animal transportation costs.

Moreover, the previous sections have shown the links that exist between the effects of drought and animal disease, and the participation by smallholder farmers in livestock markets. These associations are further elaborated at the bottom of the conceptual framework, as this is the primary focus of this study. Figure 3.5 below depicts how these variables are conceptualised to influence market participation, and how they are related to one another.

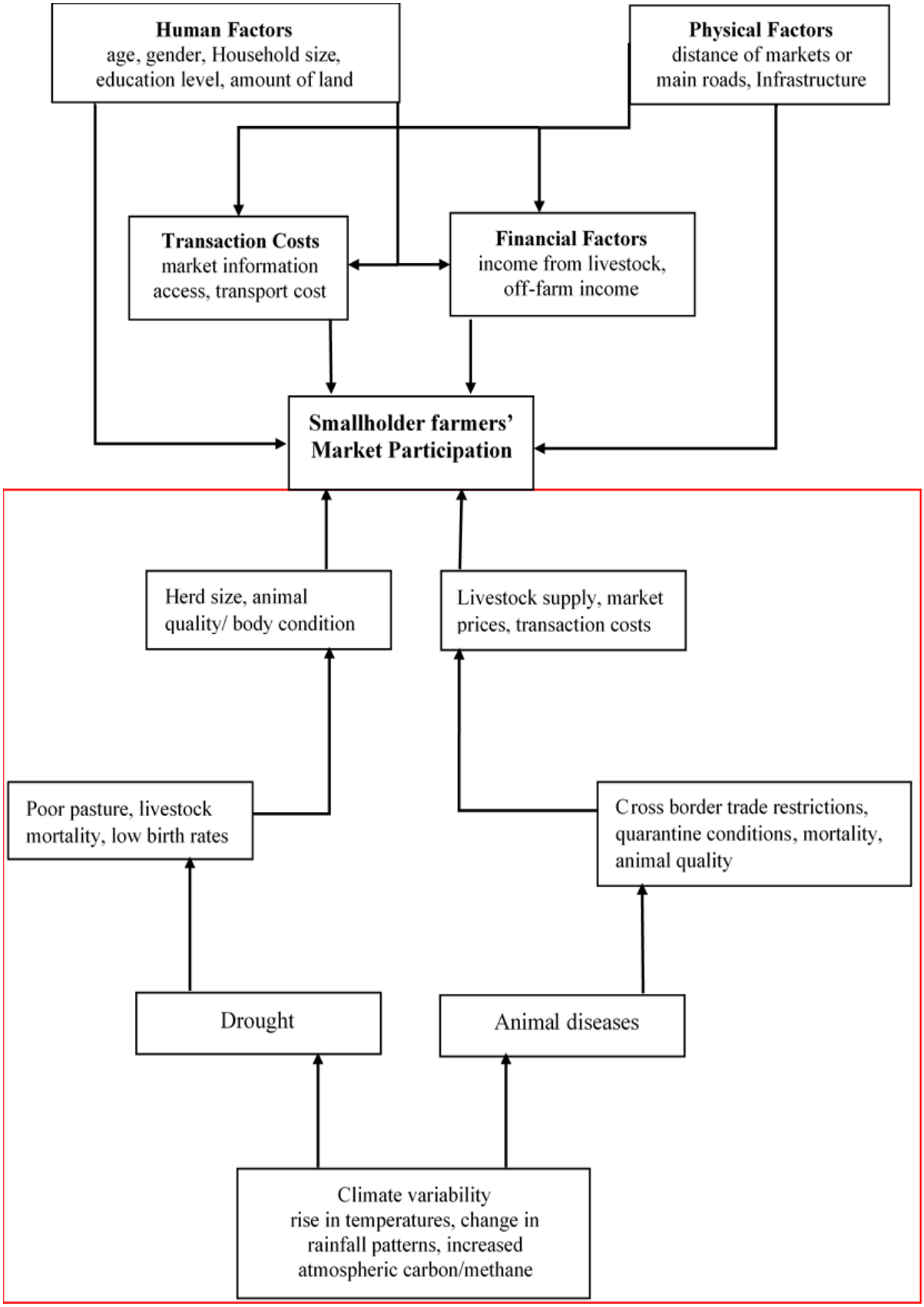

Figure 3.5: Conceptual framework

Source: Author's analysis

Focusing on the bottom part (enclosed in the red box) of the conceptual framework presented in Figure 3.5 above, there is a clear conception given of the drought and animal diseases effects on smallholder farmers' participation in livestock markets. Figure 3.5 above shows that the increasing effects of climate variability, such as changes in rainfall patterns, increased carbon emissions, and rising temperatures, directly affect the prevalence of droughts and animal diseases. This demonstrates that smallholder farmers are in a precarious situation, in which the negative effects of drought and animal diseases will intensify, as the predicted poor climate patterns take hold. The adaptive capacity of smallholder farmers for dealing with such conditions must be increased through government measures that create coping assets and social capital.

Drought is highly associated with increased animal mortality rates, which cause a reduction in the herd size. The reductions in herd sizes imply that feedlots would receive even lower supplies of livestock from smallholder farmers. Drought also leads to a decline in the quality of pastures, resulting in lower birth rates and poor quality of animals. The supply of poor-quality animals by smallholder farmers discourages buyers during auctions. However, the heads of livestock that survive the droughts will regain and have better body conditions due to reduced pressure on pasture, as other livestock will have died during droughts. The improved body condition or quality increases the income gains derived from livestock sales made after the drought (Fafchamps et al., 1998).

On the other hand, the effects of animal diseases, as depicted in Figure 3.5 above, lead to the imposition of cross-border trade restrictions and quarantine conditions that negatively affect livestock supply, market prices, and transaction costs. Then, the smallholder farmers supply livestock to congested local markets and receive low prices, which dis-incentivises their participation in livestock markets. The decline in exports and inter-regional trade restrictions imply that the smallholder farmers miss out on livestock marketing opportunities in other regions.

Both droughts and animal diseases undermine the supply of livestock to the market, which leads to increased demand pressure, thus raising consumer prices. The consumer prices are then kept high, as increasing imports from other countries to meet the supply deficit in local demand is a costly option. Thus, consumers switch to more affordable sources of proteins, which affect the growth of the livestock sector at large. The drought and animal disease

effects negatively impact on the participation by smallholder farmers in livestock markets, which has a bearing on their ability to commercialise their business operations.

Therefore, drought and animal diseases are among the major constraints to livestock marketing. The dynamic effects of both drought and animal diseases on market participation comprise an initial increase in livestock sales to close consumption gaps, and a reduction in market participation due to low livestock supply. As a result, during the post-drought and post-animal disease periods, the numbers of livestock sold can rise at first, and then fall as farmers try to rebuild their stock numbers. Therefore, the projected increase in climate variability could imply that the smallholder farmers will be trapped in a vicious circle of reduced market participation, low-profit margins, and declining adaptive capacity to mitigate the effects of drought and animal diseases.

3.5 SUMMARY

This chapter has shown that the participation by smallholder farmers in livestock markets is critical for agricultural transformation. Increased market participation by smallholder farmers would significantly reduce poverty, increase food security, and give foreign currency gains. Market participation, which is defined as the buying and selling of livestock in the markets, was shown to depend on various factors, such as human factors, financial factors, physical factors, and transaction costs. These factors are important in influencing the smallholder farmers' participation in the market because they determine the income levels obtained by the smallholder farmers, the transaction costs they incur, the financial obligations they have, and the availability of credit. These factors also affect the ability of smallholder farmers to access and use market information. Effectively, the chapter has shown that these factors have impacts on the marketing costs and marketing efficiency, thereby affecting their participation in livestock markets.

The chapter also showed that most of the smallholder farmers in developing countries are highly dependent on rain-fed agriculture. It was also noted that there have been declining rainfall patterns and future projections are expected to follow a similar trend of recurrent droughts with greater intensity. Thus, droughts negatively affect livestock marketing, as they lead to poor pasture, which causes poor animal quality, reduced livestock birth rates, and higher livestock mortality rates. These conditions ultimately lead to an inconsistent supply of

livestock and constrained livestock marketing by the smallholder farmers due to their low adaptive capacity to deal with drought effects. Despite this, other studies reviewed have reported that drought did not affect the cattle offtake rates in the regions that were studied, and that the smallholder farmers examined could increase the sales of their livestock under such shocks to cover their consumption gaps, thereby increasing their offtake rates. As such, drought effects impact upon the marketing of livestock, which therefore could have potential effects on the low livestock market participation that characterises the smallholder farmers in South Africa.

The chapter also showed that climate variability fosters the emergence of pathogens and parasites that cause animal diseases. The increased prevalence of animal disease results in the marketing constraints that impede the movement of animals. It was also shown that animal diseases negatively affect the demand and supply forces in livestock markets, which has a bearing on the smallholder farmers' market participation. Buyers reduce their demands due to the poor body condition of the animals of smallholder farmers, while the sales of smallholder farmers' animals may also be affected by declines in animal productivity and reduced market access. Thus, to enable the farmers to break loose from the vicious cycle in which they are trapped, the government needs to put in place research-based policies to boost the smallholder farmers' participation, despite the projected increase in climate variability effects. The government could build animal holding infrastructure to facilitate transactions when various trade restrictions are in place due to animal diseases. The government could also facilitate increased livestock vaccinations among the smallholder farmers by providing improved veterinary services. The government intervention could also be in the form of compensation paid to smallholder farmers for the losses incurred due to animal diseases.

Lastly, the discussion on the conceptual framework showed that smallholder farmers are rational decision makers who desire to maximise their profits and minimise costs incurred during transactions, subject to the factors highlighted above. However, the smallholder farmers are bounded rational beings, who might engage in unbalanced contracts due to information asymmetry that leads to opportunism. The conceptual framework also showed the associations through which the potential effects of droughts and animal diseases could result in an initial increase in livestock sales to close consumption gaps or a decline in sales as the smallholder farmers are faced with low livestock supply due to high mortality rates and poor animal quality. Thus, drought and animal diseases have a potentially negative effect on the market participation by smallholder farmers in the South African livestock markets.

CHAPTER 4: METHODS AND PROCEDURES

4.1 INTRODUCTION

The effects of drought and animal diseases were addressed in the previous chapter, together with other factors that affect the participation by smallholder farmer in the market. This chapter describes the data and the variables used in this study to determine the market participation of smallholder livestock owners. The methods and the procedures followed to achieve the study objectives are also outlined. The description of the data elaborates on the kinds of data, the data sources, and the techniques that were implemented to acquire a final dataset used in the analysis. The chapter also elaborates on the theory that underlines the model used in the study. Lastly, the empirical model and the variables used for the analysis are presented.

4.2 DATA AND DATA SOURCES

The primary objective of this study was to assess the impacts of droughts and animal diseases on smallholder farmers' participation in livestock markets. The specific objectives of this study were to determine the effect of drought on smallholder farmers' market participation and to evaluate the effect of animal diseases on smallholder farmers' market participation. Finally, the study estimated the combined impact of drought and animal diseases on the participation by smallholder farmers in livestock markets. The data used in the analysis were collected from the National Income Dynamics Study (NIDS), covering the years 2008, 2012, 2014, and 2017 in South Africa (Southern Africa Labour and Development Research Unit (SALDRU), 2018).

Primarily, NIDS records five waves of data at the moment, but this study only uses four, and does not use data from 2010 because data on some key variables (market participation and livestock income) used in this study was not captured in 2010.The NIDS followed a two-stage cluster sampling design, where the first stage resulted in a sample of 400 Primary Sampling Units (PSUs) from a total of 3000 PSUs in the master sample indicated by Statistics South Africa in 2003 (Woolard, Leibbrandt and Villiers, 2010). A nationwide representative sample of 28 000 individuals in 7 300 households was obtained in 2008, and

the survey was repeated every two years with the same individuals, providing a panel of individuals called Continuing Sample Member (CSMs). The individuals added in the succeeding waves, called Temporary Sample Members (TSMs), are not tracked in the waves that follow. The panel survey is carried out by the Southern Africa Labour and Development Research Unit at the University of Cape Town's School of Economics.

The survey is conducted by the Department of Planning, Monitoring and Evaluation (DPME) on elements of individual and household livelihoods such as household shocks, vulnerability, education, labour market participation, and economic activities (Brophy, Branson, Daniels, Leibbrandt, Mlatsheni and Woolard, 2018). The survey has information on various economic activities carried out; however, to evaluate the effects of drought and animal diseases on market participation, this study focused on individuals who were specifically engaged in cattle rearing and only CSMs. Selecting the appropriate variables and individuals relevant for this study produced an unbalanced panel dataset. Therefore, the Multiple Imputation (MI) technique was used for missing observations due to attrition and nonresponse. MI produced a balanced panel, giving a sample of 2 534 individuals to be used in the analysis.

Several authors have recommended the use of multiple imputations over the traditional methods of handling missing data, such as listwise or pairwise deletion, which leads to biased results (Enders, 2010; Newman, 2014). The South African long-term annual average rainfall data was sourced from Weather South Africa(Weather South Africa, 2018). The annual rainfall amount below 600 mm was considered to signify a drought period. Therefore, a drought dummy variable (*Drought (=1, 0 otherwise))* was generated from the rainfall data.

4.3 MODELLING THE EFFECTS OF DROUGHT AND ANIMAL DISEASES ON MARKET PARTICIPATION

Qualitative response models are usually used to evaluate many behavioural responses, such as decisions related to labour force participation (Maddala and Flores-Lagunes, 2001). To evaluate a farmer's choice of whether to participate in the market or not, one must consider the relative level of utility derived by taking either of the two courses of action. The equations set out below show the utility maximisation.

$$y^*_{ijt} = \beta_0 + \beta_i x_{ijt} + \varepsilon_{ijt} \quad (1)$$

where y^*_{ijt} is a latent variable representing the behaviour demonstrated by the i^{th} individual in the j^{th} (j=1, 2, …,9) province of South Africa in period t. The vector of independent factors that affect market participation is denoted by X_{ijt}. The error term, ε_{ijt}, is made up of two parts, as indicated in Equation Two (2) below.

$$\varepsilon_{ijt} = \alpha_{ij} + v_{ijt} \tag{2}$$

The term α_{ij} denotes the individual-specific effects, while the term v_{ijt} is the idiosyncratic error. Therefore, taking into account Equation Two (2), Equation One (1) could be rewritten in a manner that decomposes the error term in its two components, as shown in Equation Three (3) below.

$$y^*_{ijt} = \beta_0 + \beta_i x_{ijt} + \alpha_{ij} + v_{ijt} \tag{3}$$

The latent y^*_{ijt} affects the observed outcome variable (y), such that y is one if $y^* > 0$, and y is zero if $y^* \leq 0$. However, the probability of taking one course of action over another is influenced by independent variables. The logit model is the standard model used to understand the relationship between independent factors and a binary dependent variable (Garforth, Angell, Archer and Green, 2003).The discrete choice logit model is characterised by a binary dependent variable that assumes only the values of zero and one.

The specification of the logit model is as follows:

$$P(y = 1|x) = f(\beta_{1it} x_{1ijt} + \beta_{2it} x_{2ijt} + \ldots + \beta_{nijt} x_{1ijt} + \mu_{ij} + \varepsilon_{ijt}) \tag{4}$$

$$P(y = 1|x) = \begin{cases} 1 \; if \; i \; particpates \; in \; the \; market \\ 0 \; otherwise \end{cases}$$

Where the parameter *p* represents the response probability, and only assumes values of zero and one denoted as $p \in (0,1)$). *Y* is the outcome variable, market participation indicator, which is 1 when an individual participates in the market, and zero otherwise. The probability functional form is given in Equation Five (5) below.

$$f(z) = \exp(z)/(1 + \exp(z)) \tag{5}$$

where f represents the function that also assumes values between zero and one for all real numbers with the notation: $0 < f(z) < 1$, for all real numbers z. The function f has a logistic distribution or probability density function.

4.4 METHODOLOGICAL REVIEW

Varying methodologies have been followed in a number of studies to evaluate behavioral responses such as labor force participation, choice of adoption technologies and market participation. Zuwarimwe and Mbaai, 2015 used the transaction cost theory to evaluated the factors affecting participation and applied the factor analysis to isolate the primary factors that influenced market participation. The technique used enhances a detailed interpretation as the model reduces the data set to a few linear combinations. The transaction cost theory states that high transaction costs reduce participation in livestock markets. Alene, Manyong, Omanya, Mignouna, Bokanga and Odhiambo, 2008 also used a selectivity model in order to evaluate the influence of transactions costs promoting market participation. The study found that institutional innovations and market participation were negatively affected by transactions costs.

A study that analysed constraints and opportunities in cattle marketing used both primary and secondary sources of data, and the study showed that drought and animal diseases constrain cattle marketing (Togarepi et al., 2016). Similarly, qualitative and quantitative data was used in a study conducted in Zambia to evaluate the market participation of the smallholder goat farmers (Chipasha et al., 2017). The authors state that high transaction costs affected the market participation of smallholder farmers. High transaction costs involved in the livestock markets will reduce the income obtained from sales which is a disincentive to market participation.

Another study used a logistic regression model in the analysis of secondary data in order to determine factors that influenced farmers' market participation (Sotsha et al., 2017). The factors that were found to significantly influence market participation are distance to markets, herd size, and the fattening period. The binary logistic model is more appropriate for non-linear distributions and categorical responses which cannot be evaluated appropriately using the ordinary least squares (OLS) method (Seleka, 2011). In his study, Seleka, 2011 showed

that drought and cattle diseases affect the cattle herd-size owned by the farmers which in-turn impacts their participation in markets.

Lubungu et al. (2012) identified some of the financial factors that affect market participation. The study used the probit regression model, a binary response model, to evaluate the factors influencing the participation of smallholder farmers in the livestock markets in Zambia. The author stated that the probit regression model is superior to the logistic regression when the appropriate sample size is limited. A probit regression model was used to analyse primary data and it was found that the market participation of the Nigerian smallholder rice farmers was affected by age, years of education, and the level of income of the household head (Mafimisebi and Ikuerowo, 2018). Similarly, the probit model was used to analyse data from both primary and secondary data sources which evaluated the factors that influence market participation and supply of beef cattle (Gesese et al. 2019). The other techniques employed in the study include the use of STATA software to analyse the descriptive statistics, the use of the Variance Inflation Factors (VIFs) to test for multicollinearity, and the use of the Wald test on the likelihood function to determine the explanatory power of model variables. The study results also showed that household size, age, and gender of the household head determine market participation.

Therefore, qualitative response models are appropriate when the dependent variable is dichotomous in nature. As discussed, the qualitative response models are useful when assessing many behavioral responses such as decisions related to labor force participation (Maddala and Flores-Lagunes, 2001). This study evaluates the farmer's decision to whether or not participate in livestock markets, therefore, it appropriately makes use of the logistic regression model and other techniques applied in the study such as the Wald test and VIF test for multicollinearity.

4.5 MODEL FOR DETERMINING THE EFFECTS OF DROUGHT AND ANIMAL DISEASES ON MARKET PARTICIPATION

The study used a logit model to evaluate the effect of drought and animal disease on the market participation by the smallholder farmers. A qualitative response model is used because of the dichotomous nature of a farmer's decision. The empirical model includes the

factors that are hypothesised to influence the participation by smallholder farmers in the market as explanatory variables. This model relates to the evaluation of the response probability parameter expressed in Equation Four (4). To account for the variables attributed to an individual as well as account for the provincial characteristic differences, such as the rainfall amount (drought variable), the study used a multilevel model as applied by (Zulvia, Kurnia and Soleh, 2017).The model used is shown below as:

$$Y_{ijt} = \Upsilon_{00} + \sum_{q=1}^{r} \gamma_q R_{qj} + \sum_{p=1}^{K} \beta_p X_{ijt} + T_t + u_{oj} + \varepsilon_{ijt} \quad (6)$$

$$Y = \begin{cases} 1 \; if \; the \; farmer \; particpates \; in \; the \; market \\ 0 \; if \; the \; farmer \; has \; not \; participated \; in \; market \end{cases}$$

X = (gender, age, education, death of HH member, cattle income, number of cattle owned, drought, disease, & drought-disease)

where Y_{ijt} is the dependent variable for household-*i* in province-*j* and time-*t*, Υ_{00} is the intercept, γ_q (q=1,2,…,r) is the parameter model for the province, R_{qj} is an independent variable from province j (level 2 variables e.g. drought dummy created from provincial rainfall amounts). On the hand, β_p is the parameter model for a household, X_{ijt} is an independent variable from household-*i* in province-*j* in time-*t* (level 1 variables e.g. cattle income), T_t is the fixed effect of time, u_{oj} is an error from the province ($u_{oj} \sim N(0,\sigma_u^2)$) and ε_{ijt} an error ($\varepsilon_{ijt} \sim N(0,\sigma_e^2)$).

The independent variables were selected based on the literature reviewed and a priori expectations of the factors that affect market participation. The variables used in this study are summarised in Table 4.1 below.

Table 4.1: **Description of explanatory variables in the logit model**

Variable	Description
Market participation	Dummy, 1=yes if the farmer participates in the market
Gender	Dummy, 1=yes if the individual is male
Age	Age of an individual in Years
Education	Level of education of an individual (categorical)
Death of HH Member	Dummy, 1= yes if a household member died
Cattle Income	Income obtained from the sale of cattle, in Rands
Cattle Owned	Number of cattle owned by the individual
Disease	Dummy, 1=yes if the individual's livestock herd was affected by a disease outbreak
Drought	Dummy, 1=yes if the annual rainfall amount was below 600 mm
Disease-Drought	Dummy, 1=yes if an individual was affected by drought and an animal disease outbreak in the same period

Source: Author's analysis

Market participation is the dependent variable, while the independent variables are gender, age, education, death of a household member, cattle income, number of cattle owned, disease, drought, and an interaction term between drought and disease. The variables gender, death of a household member, disease, and drought were dummy variables. Gender was coded as 0 for females and 1 for males, while the death of a household member was coded as 0 if the smallholder farmer did not have a mortality shock, and 1 if he or she had a mortality shock (a household member had died). The disease variable was coded 0 if the smallholder farmers' cattle had not been attacked by a disease in the previous 12 months, and 1 if there had been a disease occurrence. The drought variable was coded 0 for the year in which the province that the farmer resides in received normal rainfall, and 1 when there was below the annual average rainfall (600 mm) received.

The interaction term between disease and drought indicated the points at which the smallholder farmer was affected by both disease and drought at the same time, and those at

which he or she was not affected. The age of the smallholder farmer was measured in years, while the variable cattle income, signifying the income obtained from the sale of cattle, was measured in Rands. The variable number of cattle owned signifies the herd size of the smallholder farmer. This study defined market participation as the sale of cattle in the market by smallholder farmers. The market participation variable was coded 0 if the smallholder farmer did not participate in the market (does not sell any cattle in the market), and 1 if the smallholder farmer did participate in the market. Therefore, the variables of interest that address the objectives of this study are drought, disease and the interaction term between drought and disease. The other variables are included in the model because, intuitively and as shown in the literature elaborated through the conceptual framework presented in the previous chapter, they help to explain the smallholder farmers' participation in livestock markets.

4.6 SUMMARY

This chapter discussed the theory that relates to binary-response dependent variables. Therefore, the logit model is the appropriate model to use for estimating a probabilistic parameter such as market participation. The dichotomous nature of the outcome variable makes the discrete choice logit model appropriate to use for the analysis. The empirical model used depicts a multilevel model due to the data used in the study relating to an individual, which was disaggregated by province, thereby creating two levels. The data used in this study were collected for four waves, thus allowing for the exploration of the panel structure of the data.

CHAPTER 5: RESULTS AND DISCUSSION

5.1 INTRODUCTION

Smallholder farmers in South Africa experience low participation in livestock markets; hence, increasing their participation to help them to commercialise their business operations is a government priority. However, a variety of factors, including drought and animal diseases, affect the smallholder farmers' access to livestock markets in South Africa. The study's specific objectives were to determine the effects of drought on the market participation by smallholder farmers, as well as to assess the effects of animal diseases on smallholder farmers' market participation. Lastly, the study also evaluated the combined effect of drought and animal diseases on the participation by smallholder farmers in livestock markets.

Drought and animal diseases have the potential to influence whether or not smallholder farmers will participate in South African livestock markets. Due to the binary nature of the dependent variable, the logit model (as discussed in the previous chapter) was a preferred model for this study. The pooled model, the random-effects model, and the fixed-effects model were used to analyse the panel data used in the study. However, as presented in this chapter, the likelihood ratio test evaluated the validity of the random effect parameter, which was significant, and the Hausman test indicated that the fixed-effects model was the more appropriate model between the fixed-effects model and the random-effects model.

The empirical results of the model used to answer the specific objectives of the study are presented and discussed in this chapter. The chapter begins by presenting the descriptive statistics of the study sample, and investigates the model's variables. The results of the tests used to determine the best model fit are presented in the chapter. Finally, the estimated model's results are presented, and the accompanying discussions are elaborated on to ensure that proper conclusions related to the study hypothesis are drawn.

5.2 DESCRIPTIVE STATISTICS

The panel data set was composed of individuals who were surveyed under the National Income Dynamics Study (NIDS), for the years 2008, 2012, 2014, and 2017. The cross-sectional unit was a sample of 2 534 smallholder farmers, which was used in this study.

Therefore, the total number of observations in the panel data was a multiple of the number of cross-sectional units by the number of periods (N × T).Therefore, the total number of observations was 10 136 observations for each variable. The summary statistics of each of the variables are given in the following sub-section.

5.2.1 Summary statistics of variables used in the model

The variables used in the study, as presented in the methods and procedures chapter, are market participation, gender of the household head, age of the household head, education level of household head, death of a household member (family mortality shock), cattle income, number of cattle owned, disease and drought. The summary statistics of these variables are tabulated below in Table 5.1.

Table 5.1: Descriptive statistics of variables used in the model

Variables	Units	Observations	Standard deviation	Mean	Minimum	Maximum	Frequency
Market Participation	1 = Participated	10,136	0.2424625	.2424625	0	1	0=75.75 1=24.25
Gender of HH head	1 = Male	10,136	0.4988826	.4662983	0	1	0=53.3 1=46.6
Age of HH head	Years	10,136	16.12779	23.19806	15	98	
Education	0= No formal education 1=Primary 2=Secondary 3=Tertiary	10,136	0.7643945	1.417127	0	3	0=16.39 1=26.19 2=56.76 3=0.67
Death of HH Member	1= Had a mortality shock	10,136	0.4921432	.4116022	0	1	0=58.84 1=41.16
Cattle Income	Rands	10,136	5191.963	5597.701	0	49000	
Number of Cattle Owned	Number of cattle	10,136	6.267112	9.025615	0	150	
Disease	1=affected animal disease	10,136	0.4889098	.3951855	0	1	0=60.4 1=39.5
Drought	1=affected by drought	10,136	0.5000071	.5035517	0	1	0=49.6 1=50.3

Note: HH refers to household

Source: Author's computations

Table 5.1 above shows that market participation is a binary dependent variable, with a value of 0 if the smallholder farmer did not participate in the market, and a value of 1 if the smallholder farmer participated in the market. The number of cattle sold in the market is used

in this study as an indicator of market participation. Thus, if a smallholder farmer's number of cattle sold in the market was greater than zero, it indicated that the farmer participated in the market; otherwise, the farmer did not participate. Over the survey period, the percentage of smallholder farmers who participated in the market was low, at 24.25 percent, while the percentage of those who did not participate in markets was at 75.75 percent. The percentage of the ratio of the total number of cattle sold by smallholder farmers relative to the total number of cattle sold was 4 percent. Therefore, market participation and cattle off-take rates of 24.25 percent and 4 percent, respectively, show that only a few smallholder farmers participated in the market, selling only a few of their cattle.

The study sample over the study period was comprised of 53.4 percent female-headed, livestock-owning households, and 43.6 percent male-headed households, indicating that female-headed, livestock-owning households outnumbered male-headed households by a small margin. Figure 5.1 below depicts the percentage of households selling cattle, distributed by the gender of the household head.

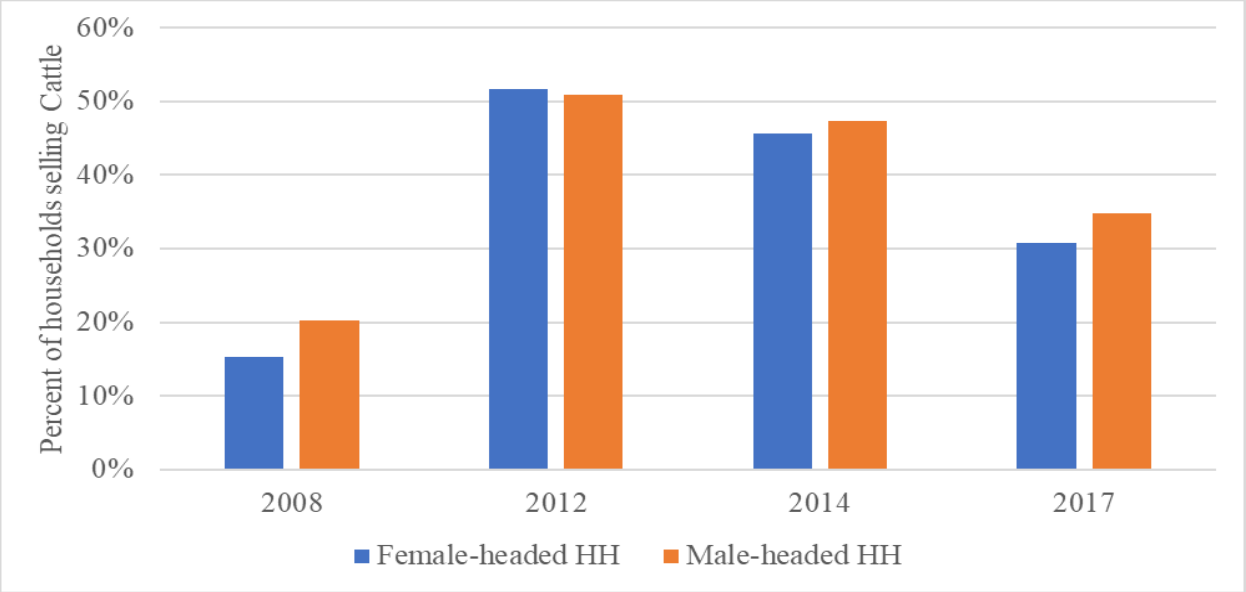

Figure 5.1: Percent of households, by gender, selling cattle, 2008–2017
Source: SALDRU, 2018

Figure 5.1 above shows that, except in a single year, 2012, the percentage of households selling cattle was higher for the male-headed households, relative to the female-headed households. The likelihood of selling cattle in livestock markets is higher for the male-headed households, who are more inclined to make decisions on the management and selling of cattle

than the female-headed households are (Kyeyamwa, Verbeke, Speelman, Opuda-Asibo and Huylenbroeck, 2008). According to Wurzinger, Ndumu, Okeyo and Souml (2008), male-headed households own more cattle, on average, than female-headed households do, which influences their participation in markets.

Table 5.1 above also shows that the age distribution for the smallholder farmers was such that the minimum age was 15 years, while the maximum was 98 years. According to Kawambwa, Hendriksen, Zandonda and Wanga (2014), individuals who fall in the age group between 15 and 65 are more likely to engage in agricultural activities. However, the responsibilities of an individual increase as he or she ages, thereby increasing the need for participating in livestock markets to raise income to meet financial demands. A similar proposition could be made about the level of education of the smallholder farmer, in which case, the individuals with a higher level of education would be expected to participate more in markets.

Table 5.1 shows that 16.39% of smallholder farmers in the study sample, over the survey period, had not received formal education, while 26.19% and 56.76% of the sample indicated their highest level of education as primary level and secondary level, respectively. However, only less than 1% of the sample indicated the tertiary level as their education level, and accordingly, no details of contribution to total cattle sales over the survey period was captured for this group. Figure 5.2 below shows the distribution of the households selling cattle, by the level of education of the household head.

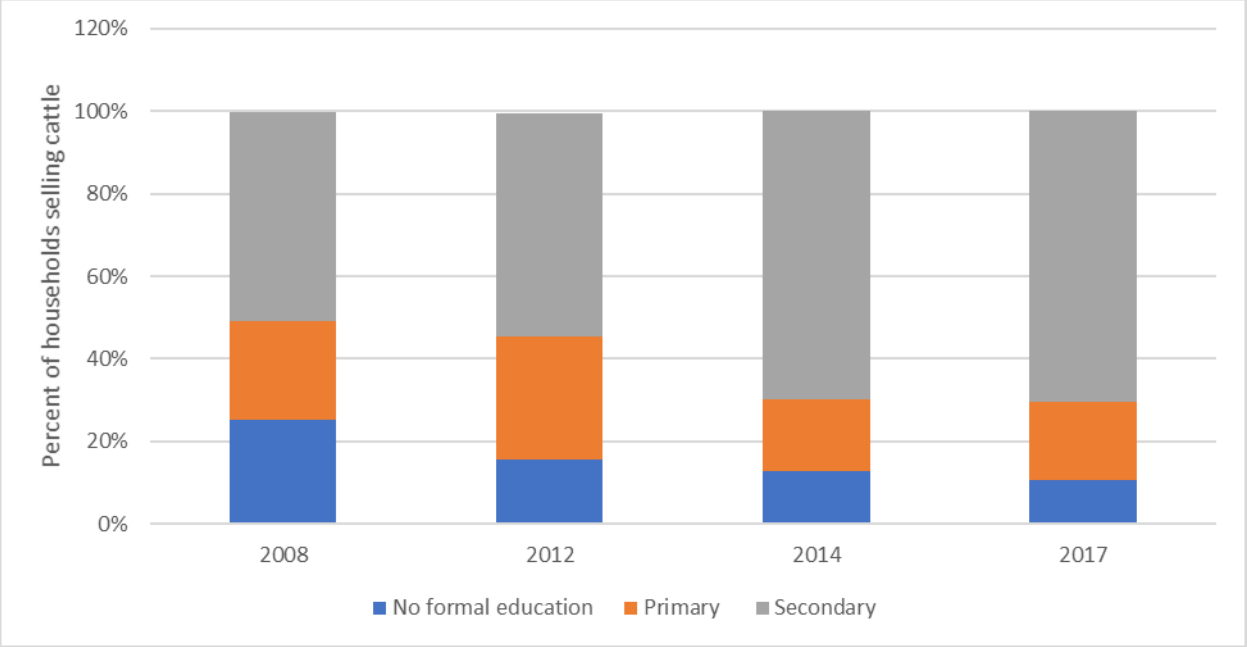

Figure 5.2: Percent of households selling cattle, by level of education, 2008–2017

Source: SALDRU, 2018

Figure 5.2 above shows that most of the households selling cattle over the study period were headed by a smallholder farmer who had attained a secondary level of education. Education is expected to enhance an individual's abilities to search for market information. Thus, a more-educated individual would be better able to make a sound judgment regarding the prevailing market conditions, thereby increasing the likelihood of their participation and sales in markets. Accordingly, Figure 5.2 above substantiates this view, as it can be noted that the proportion of households selling cattle increases with a rise in the level of education attained.

The other explanatory variable in the study, as tabulated in Table 5.1, is the death of a household member, which is one of the human factors affecting market participation, as established in the literature review chapter. This variable shows the households who suffered the loss of a member, such as a brother, uncle, child, parent, wife, husband, or any other family member. The variable distinguishes the households who were affected by a mortality shock and those who were not, thus being dichotomous in nature. Table 5.1 above shows that 41.16% of the individuals were affected by mortality shocks, and the remaining 58.84% had not experienced any mortality shocks or there was no death of a household member in the study period. Figure 5.3 below shows the distribution of the households selling cattle, as affected by the death of a household member (household mortality shock).

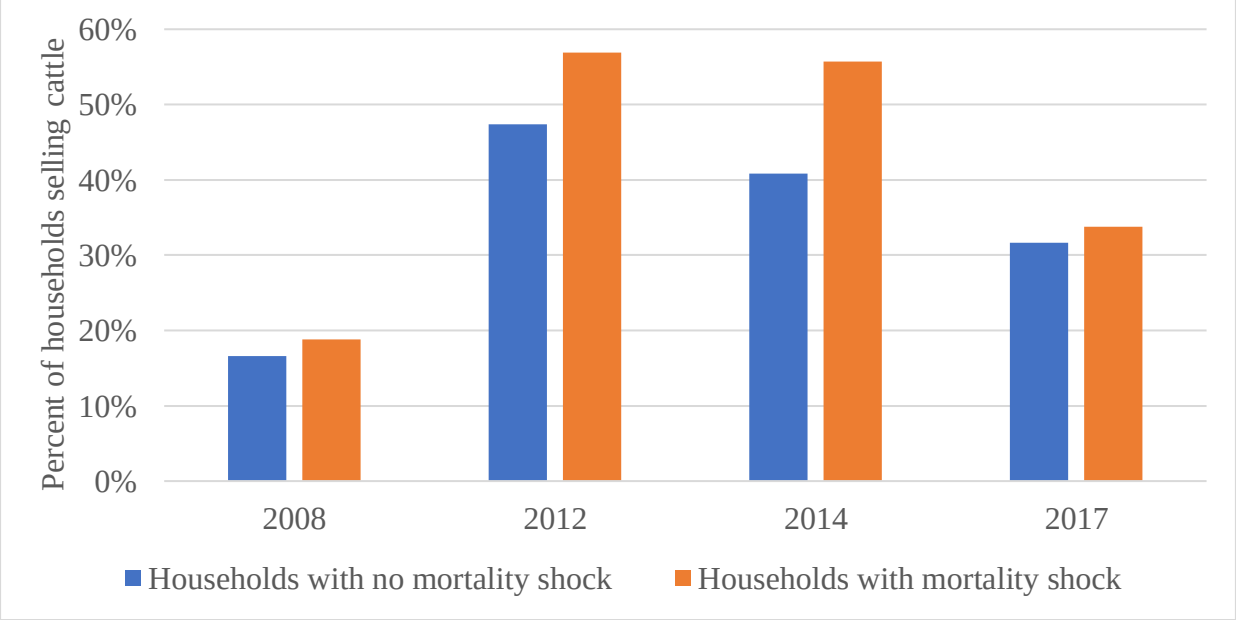

Figure 5.3: Percent of households selling cattle, as affected by the death of a household member, 2008–2017

Source: SALDRU, 2018

Figure 5.3 above shows that the distribution of households selling cattle was such that, in all four waves of the study, although with variations in magnitude, the percentage of households selling cattle was higher for those that had been hit by a mortality shock. This is not surprising because, when people attend funerals, cattle are slaughtered for meat or sold to earn income to meet the financial demands that come with this mortality shock. When the latter is the case, the selling of cattle to gain the income needed to meet funeral expenses leads to an observed rise in cattle sales. However, the death of a household member, like any other negative shock, can also have a constraining effect on livestock marketing by households. The death of a household member may lead to increased own consumption of livestock, due animal slaughters that occur for funerals, which then reduces the livestock available for sale in the market. Livestock may also be shared among relatives when a householder member dies, causing a reduction of the herd size of the giving household, which acts to reduce their sales in livestock markets.

Table 5.1 above also shows that the average income obtained from cattle sales was about five thousand Rands. This low average income derived from cattle sales is as expected for the smallholder farmers, whose participation in livestock markets is quite low. Furthermore, smallholder farmers own small herd sizes, and in this case, the average number of cattle owned by the smallholder farmers in this study was nine, as tabulated in Table 5.1 above. Figure 5.4 below shows the percentage of households selling cattle, as distinguished by the herd size.

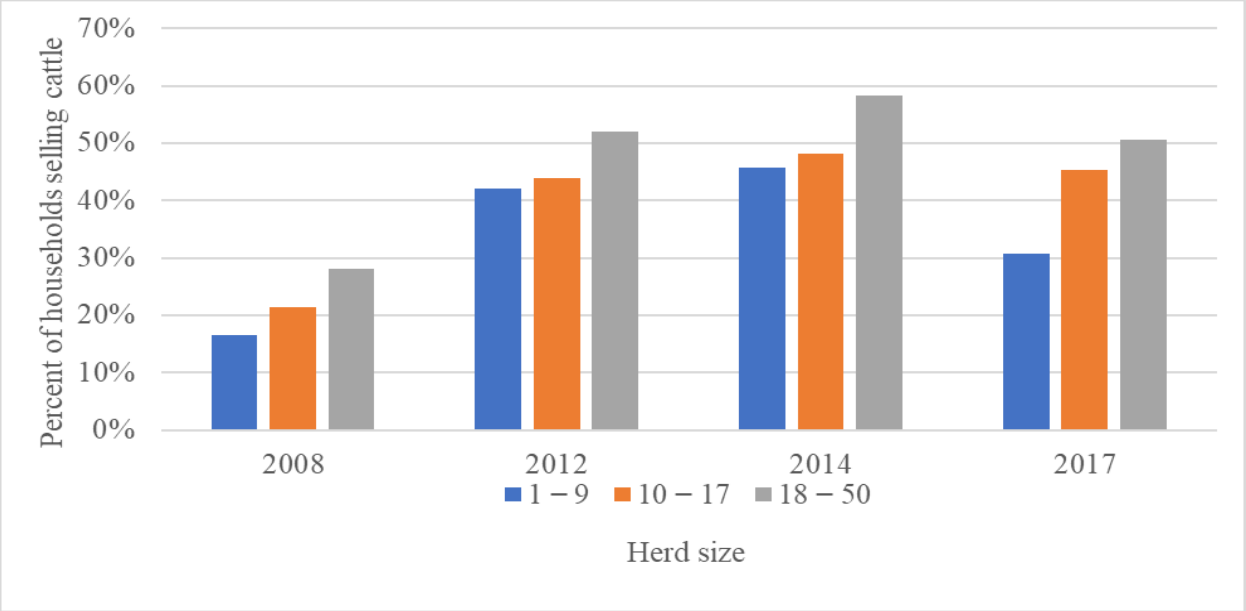

Figure 5.4: Percent of households selling cattle by herd size 2008–2017

Source: SALDRU, 2018

The herd size dynamics can be used to assess the smallholder farmers' ability to market their cattle. When herd size increases, the likelihood of market participation also increases. Figure 5.4 above shows that the percentage of households selling cattle increased with the increase in the herd size owned over the study period. The smallholder farmers with larger herds easily recover after any shock that they may be exposed to. For example, when there is a drought or an animal disease outbreak, the smallholder farmers with large herds take a shorter time to rebuild their stock and restore their participation in livestock markets. The smallholder farmers with larger herds can also offer a more consistent supply of cattle, with a wider quality range, thereby meeting the expectations of buyers.

The animal disease explanatory variable is included in the study, and the summary statistics of the variable, as presented in Figure 5.5 below, show that 39.5 percent of the livestock-owning households had been affected by animal diseases, while 60.5 percent had not been affected. The percentages of households selling cattle, as distinguished by the effect of animal diseases, are given in Figure 5.5 below.

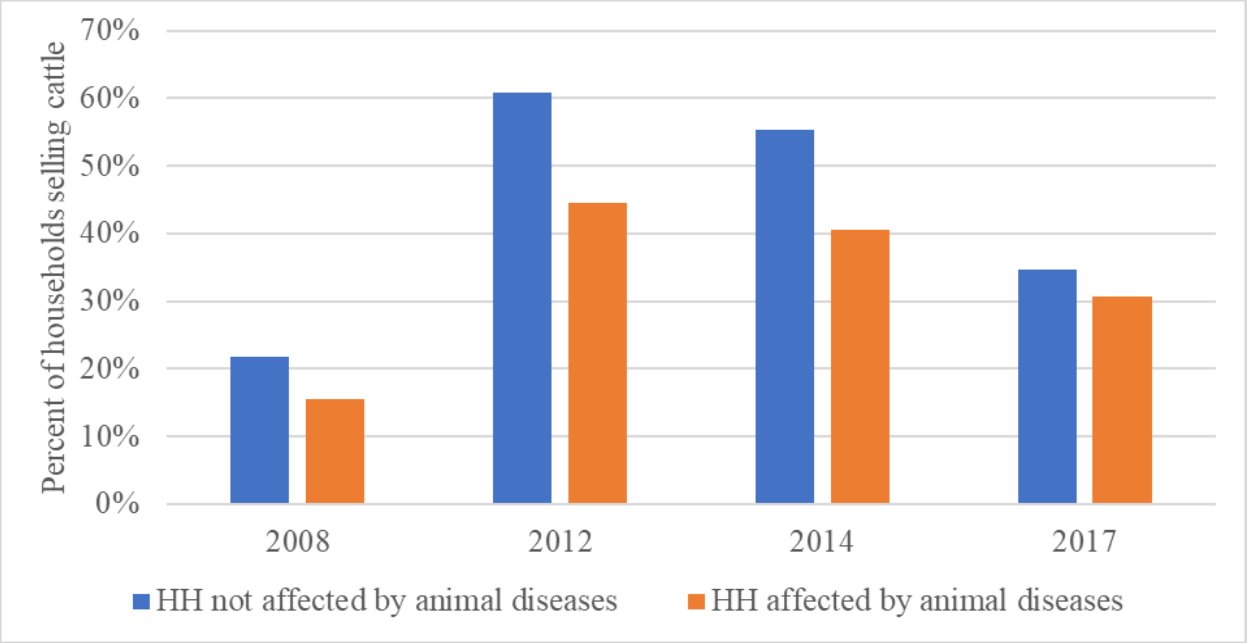

Figure 5.5: Percentages of households selling cattle, as affected by incidences of animal disease, 2008–2017

Source: SALDRU, 2018

Figure 5.5 above shows that incidences of animal diseases reduced the percentages of households who sold cattle over the study period. However, the households who were not affected by animal diseases sold more cattle during this period because they had experienced greater market demand that resulted from the decreased supply from the households affected by animal disease. Animal diseases have similar effects to the effects of drought, being the reduction in the quality and numbers of cattle. The effects of animal diseases usually produce havoc among smallholder farmers due to their lack of access to veterinary services.

Lastly, Table 5.1 above shows that 50.3 percent of the households were affected by drought or had received rain below the South African annual average of 600 mm. For example, the most severely affected provinces in the 2015 drought that occurred in South Africa were KwaZulu-Natal, Mpumalanga, North West, Limpopo, and Free State, with some areas being declared disaster-stricken (Ngoepe, 2015). Therefore, drought causes regional variations in the cattle offtake rates, there by influencing whether households would sell cattle in the markets or not. Figure 5.6 below shows the percentages of households selling cattle, as affected by drought.

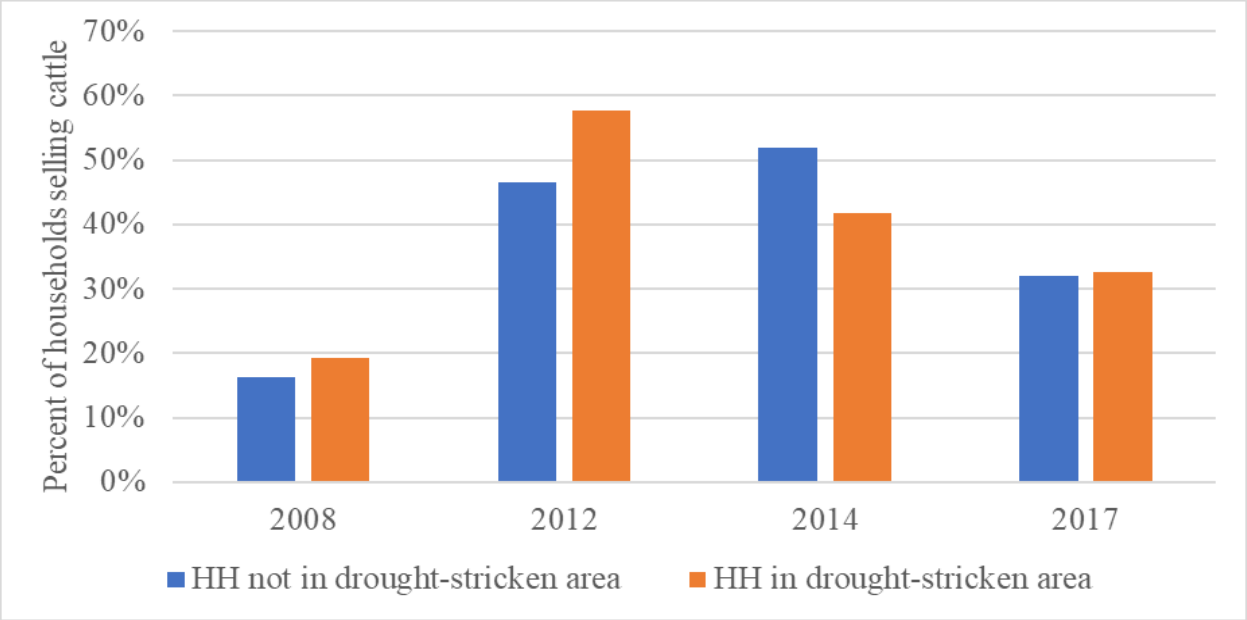

Figure 5.6: Percent of households selling cattle, as affected by drought, 2008–2017

Source: SALDRU, 2018

Figure 5.6. above shows that there was a variation in the effects that drought had on whether households chose to sell their cattle over the study period. For example, in 2012, the households who were drought-stricken sold more cattle in the market, while in 2014, the households that were not drought-stricken sold more. However, in 2012 and 2017, there was not much variation in the percentages of the households selling between those in drought-stricken areas and those who were not in drought-stricken areas. Drought may cause the degradation of pastures, leading to reduced animal quality and greater cattle mortality, which would reduce the percentages of households selling cattle. However, if smallholder farmers could be enabled to mitigate the effects of drought, through the use of supplementary feeding or by moving their cattle to an area with better pastures, the impacts of drought on those households' cattle sales would be minimised.

Therefore, as seen in the discussion of the summary statistics, the effects of the variables used in the model estimation, as presented in the above section, have dynamic effects on a household's ability to sell cattle in the market. As with the drought variable, a variable that had acted to increase a household's cattle sales in the previous year was seen as having the potential to decrease the household's sales the following year. However, certain factors, such as the prevalence of animal diseases, had a consistent impact on the household's cattle sales. As a result, the summary statistics section above was critical for gaining an understanding of

the complex impact of variables on the cattle sales by the households. The next section, on the other hand, moves on to discuss the estimation of the logit model to address the study's objectives.

5.3 ESTIMATING THE LOGIT MODEL

The purpose of this section is to show how the evaluation of the effects of the independent variables (as discussed in the previous section)on the dependent variable (market participation) was achieved by using the logit model. This section describes how the actual model that was used to derive the results to be used for this study was selected. Accordingly, this section shows the tests that were used and presents the results that were obtained. An interpretation of the results to elaborate on how the research objectives were achieved is also given in this section. As stated above, the specific objectives of this study were to determine the effects of drought on smallholder farmers' market participation and to evaluate the effects of animal diseases on participation by smallholder farmers in livestock markets. Finally, this section describes how the study estimated the combined impact of drought and animal diseases on smallholder farmers' participation in livestock markets. The model used to answer the objectives was selected as discussed in the following sub-section.

5.3.1 Model selection

The logit model was used in the study because the dependent variable, market participation, is binary. The dependent variable indicates whether the smallholder farmer participated in the livestock market or not. The pooled, the fixed effects, and the random-effects models were estimated. The pooled model, which does not consider the panel structure of the data by assuming a constant slope and intercept, was the first model used. This model does not account for the individual-specific effects in determining the dependent variable, which is market participation in this case (Baltagi, 2008). The panel data models used were the fixed effects model and the random-effects model, with the basic distinction between the two models being in the assumptions they make.

The fixed-effects model assumes a correlation between the individual-specific effects and the independent variable, while the random effects model assumes independence between the individual-specific effects and the independent variable (Baltagi, 2008). The likelihood ratio test was then used to select between the pooled and random-effects models. The Hausman

test was used to select the appropriate model to use, between the fixed-effects model and the random-effects model. The two tests are discussed below.

5.3.2 The Likelihood Ratio Test (LRT) and The Hausman test

The LRT compares two distinct models in order to indicate which one is a superior model by offering a better fit to the data. LRTs are most generally used to choose if a specific random effect ought to be included in the model by assessing whether that improves the fit of the model, ceteris paribus (Luke, 2017). The null hypothesis for the likelihood ratio test is that there is no significant difference between the pooled and the random-effects models. If Prob>chi2<0.05, then the null hypothesis is rejected, and the conclusion made is that there is a statistically significant difference between the models.

On the other hand, the Hausman test determines if there is a correlation between the unique errors and the regressors in the model. The null hypothesis is that there is no correlation between the unique errors and the regressors. Essentially, the Hausman test determines the better-fit model between the fixed effects (correlated errors) and the random effects (uncorrelated errors) for panel data. Interpreting the result from a Hausman test is such that, when the p-value is less than 0.05, the null hypothesis is rejected. In this case, it would imply that the model has correlated errors and, as such, we fail to reject the alternative hypothesis that the fixed effects model is more consistent. Table 5.2 below shows the results of the likelihood ratio test and the Hausman test.

Table 5.2 Likelihood Ratio Test (LRT) and the Hausman test results

Test	**Statistic**	**P-value**
Likelihood ratio test	121.56	0.000 ***
Hausman test	24.06	0.002 ***

Notes: *** denotes 1% significance, ** denotes 5% significance, * denotes 10% significance

Source: Author's computations

The Likelihood ratio test result, as tabulated in Table 5.2 above, shows that the likelihood ratio test result (121.56) is statistically significant, at a one percent significance level. Therefore, the null hypothesis is rejected, and the conclusion is that the random effects parameter is valid. As such, the random-effects model has a better fit for the data and is more appropriate to use, compared with the pooled model, which did not consider the panel

structure of the data. The random-effects model accounted for the disaggregation of the smallholder farmers by province. The results from the random-effects model showed that the provincial random effects comprised approximately 17.03% of the total residual variance. This result indicates that market participation is slightly correlated within the same province.

However, the Hausman test (24.06), as indicated in Table 5.2 above, was statistically significant, at a one percent significance level. Therefore, the null hypothesis of the Hausman test, that there is no statistical difference between the random effects and the fixed effects models, was rejected. As such, the fixed effects model was more appropriate to use than the random-effects model was. Therefore, the fixed effects model was estimated and its results constituted the point of discussion and the basis for the conclusions made in this study. The robustness of the model was verified, and the test results are presented in the next sub-section.

5.3.3 Robustness of the estimation

To check for overall model fit, the Wald test of linear/non-linear restriction was used. The null hypothesis is that the joint coefficients of the parameter estimate are all zero. Table 5.3 below shows the Wald test statistics.

Table 5.3: Wald test

Test	Statistic	P value
Wald test of coefficient restriction	545.00	[0.000]

Source: own computations

The null hypothesis is dismissed at a one-percent level of significance. The findings show that at least one of the regressors is not zero and contributes to the outcome prediction. The Wald test results show that the logistic regression model is suitable and fits the data well. Distributional assumptions are required when performing a linear regression to determine whether to perform a parametric or non-parametric test. However, since the variables in logistic regression are often categorical, as they are in this analysis, there is no need to determine data normality (Anaba, 2017). Heteroskedasticity is also not a concern when working with panel data, since panel data comprise an intrinsically heteroskedastic solution (Ul Haq, 2012).

This study evaluates the effects that droughts and animal diseases have on market participation, and as such, in this case, the value of the adjusted R^2 is immaterial (Frost, 2018). When understanding the relationships between the variables in the regression model, the interpretation of the significant relationships does not change, regardless of the value of R-squared (Frost, 2018). However, the variables could exhibit linear dependence on each other; therefore, the test for multicollinearity was done. Multicollinearity exists between variables if there is a high correlation between them. A high linear dependence among the predictors increases their standard errors and thereby their variance. The extent to which the variance has been inflated is measured by using the Variance Inflation Factor (VIF). If the VIF is greater than five, the predictors are highly correlated, and multicollinearity exists (Daoud, 2017). Table5.4 below shows the VIFs for the predictors used in this study.

Table 5.4: Variance Inflation Factors (VIF)

Variable	**Variance inflation factor**
Male (=1, 0 otherwise)	3.27
Age (Years)	2.82
Education	2.23
Death of HH Member (=1,0 otherwise)	2.18
Cattle Income (Rands)	1.93
Number of Cattle Owned	1.76
Disease (=1, 0 otherwise)	1.71
Drought (=1, 0 otherwise)	1.70
Disease-Drought (=1, 0 otherwise)	1.63

Source: Author's computations

Table 5.4 above shows that all the predictors used for this study had a variance inflation factor of less than five. This shows that the predictors are not highly correlated, and, therefore, multicollinearity does not exist. Accordingly, this means that the coefficient estimates in the model are not sensitive to small changes and that the statistical power of the regression model is strong: as such, the p-values can be trusted and used to draw reliable conclusions. The results from the fixed-effects model estimation are presented in the next sub-section.

5.3.4 5.3.4 Results from the fixed effects model

The multilevel logit model, presented in Equation Six of Chapter 5,was estimated to answer the objectives and to test the hypothesis. As discussed above, the likelihood ratio test and the Hausman test results support the use of the fixed effects model. Therefore, this sub-section presents the results that were obtained from an estimation of the fixed effects model, as tabulated in Table 5.5 below.

Table 5.5: Results for the fixed effects model

Variable	Marginal Effect	P-value
Male (=1, 0 otherwise)	0.0229	0.083 *
Age (Years)	0.00410	0.000 ***
Education	0.0473	0.000 ***
Death of HH Member (=1,0 otherwise)	-0.0859	0.000 ***
Cattle Income (Rands)	9.84e-06	0.000 ***
Number of Cattle Owned	0.0105	0.000 ***
Disease (=1, 0 otherwise)	-0.0348	0.034 **
Drought (=1, 0 otherwise)	-0.0118	0.393
Disease-Drought (=1, 0 otherwise)	-0.0915	0.000 ***
Number of groups Number of observations		9 10, 136

Note: *** denotes 1% significance, ** denotes 5% significance, * denotes 10% significance

Source: Author's computations

The results show that gender was statistically significant, at a 10% significance level, and it positively affected market participation. This result implies that the likelihood of males participating in livestock markets relative to that of females is higher by 2.29 percent. The finding is consistent with what was observed in Uganda, where males were found to have a higher market participation rate than females among cattle keepers (Ruhangawebare, 2010). To the contrary, a study by Lubungu et al. (2012) and Gesese et al. (2019) showed that gender did not matter in livestock market participation.

The age variable was also statistically significant, at a 10% level of significance, and had a positive relationship with market participation. As such, an increase in the age of the smallholder farmer increases the likelihood of his or her participation in the livestock market by 0.041 percent. This result is consistent with the expectation that the responsibilities and financial demands of individuals increase as they age. As such, the smallholder farmers increase their participation in the cattle markets as they get older, in order to meet their financial demands. Likewise, education was statistically significant and was positively associated with market participation. An increase in the education level of an individual leads to an increase in that individual's ability to access market information (Lubungu et al., 2012).

However, the variable indicating the household mortality shocks, *Death of a Household Member*, was statistically significant, but had a negative effect on market participation. This finding implies that when a family member dies, the effect is a decrease in the likelihood of market participation of smallholder farmers by 8.59 percent. Since the herd sizes of smallholder farmers are so small, when they experience a mortality shock and use their livestock for personal consumption (such as for slaughtering to provide meat for funeral formalities), their involvement in livestock markets is likely to decrease. However, Lubungu et al. (2012), to the contrary, have stated that mortality shocks increase participation in livestock markets. The effect of cattle income on market participation was statistically significant, at a 10% significance level. The result for cattle income was positively related to market participation, which implies that higher incomes lead to 9.84e-04 percent higher likelihood of market participation. High income gains incentivise smallholder farmers, encouraging them to participate in livestock markets. Likewise, the *number of cattle owned* also had a statistically significant and positive effect on the market participation by smallholder farmers. The likelihood of selling cattle increases by 1.05 percent as the size of the herd owned by a smallholder farmer increases which is consistent with the findings by Lubungu et al., 2012.

Therefore, market participation is linked to the factors discussed in the section above, and the literature and prior assumptions used in the variable selection are justified. The death of a family member was the only variable that produced unexpected results. The following three subsections refer to the same table of results (Table 5.5above) used in this subsection. In relation to the specific objectives of the study, an evaluation of the study hypotheses using the results presented in table 5.5 above allows the study to draw the following conclusions:

- The coefficient on the drought variable had a P value of 0.393 which not significant at any of the significant levels evaluated. Therefore, the study rejected the hypothesis that drought negatively affects the market participation of smallholder farmers.
- The coefficient p value (0.034) on the animal disease variable was statistically significant at 5% level of significance. Therefore, the study hypothesis that Animal diseases have a negative effect on the participation of smallholder farmers in livestock markets was accepted at 5% significance level .
- The coefficient of the interaction term between drought and disease had a p value of 0.000 which statistically significant at 1% significance level. Therefore, the study failed to reject or accepted the initial hypotheses which stated that the combined impact of drought and animal diseases on market participation is higher than the individual effects.

In order to expand on the effects of drought and animal diseases, as well as their combined impact, on market participation, thus addressing the study's specific objectives, a detailed elaboration is given the following subsequent sections.

5.3.5 The effect of animal diseases on the smallholder farmers' participation in the market

The coefficient of the *Disease* variable was negative, and its effect was statistically significant, at a one-percent level of significance. The findings imply that the high incidence of animal diseases reduces the likelihood of smallholder farmers to participate in livestock markets by 3.48 percent .Therefore, the findings are consistent with the original study hypothesis, which posited that animal diseases have a negative effect on market participation by smallholder farmers.

Cattle mortality rates rise as a result of animal diseases, thereby reducing the number of cattle available for sale on the market. The probability of smallholder farmers engaging in livestock markets decreases as their cattle herd size decreases. Animal disease outbreaks often reduce birth rates, which has a long-term effect on the size of the cattle herd. Low cattle birth rates make it difficult for smallholder farmers to participate in livestock markets because they prefer to keep their current stock and to invest in restocking, rather than selling. To avoid widespread disease, some disease outbreaks may necessitate government intervention, which

might even involve destroying an entire cattle herd. As a result of the decreased availability of cattle to be sold, disease outbreaks have a significant effect on smallholder farmers' market participation. Animal diseases, on the other hand, may not necessarily result in cattle mortality, but they can also lead to a reduced, poor quality of animals. The animals with a poor body quality do not appeal to buyers, implying a reduction in demand and, as a result, low market participation by smallholder farmers.

Due to certain restrictions being placed on the movement of animals in affected areas, animal disease outbreaks often trigger a decline in smallholder farmers' participation in livestock markets. Such restrictions contribute to the negative effects, observed in this study, of animal diseases on market participation. The restrictions on cross-border animal movement that are sometimes instituted are intended to prevent the widespread of disease across regions. The limited permitted movement of animals during these times normally necessitates livestock quarantining for a set period. Smallholder farmers, on the other hand, maybe unable to wait while their livestock is placed in quarantine camps, resulting in a decline in their market participation. Restricted movement across regional boundaries has the unintended consequence of increasing the cattle supply within those regions that have to keep livestock in place. Because of the excess supply in the local markets in such regions when cross-border trade is restricted, local livestock market prices fall, potentially discouraging smallholder farmers from participating in livestock markets.

Therefore, the occurrences of animal disease in South Africa contribute to the observed low participation by smallholder farmers in livestock markets. These findings effectively imply that the smallholder farmers cannot cope with the devastating effects of animal disease outbreaks. Therefore, they reduce their livestock supplies to abattoirs, auctions, feedlots, and even to direct sales; thus, they fail to take advantage of prevailing marketing opportunities in these channels. Therefore, the contribution of smallholder farmers to exports is low, and furthermore, they do not sell in the hides market due to the poor quality of hides derived from their animals that have been affected by diseases. The decline in participation by the smallholder farmers in such periods reduces consumer surplus attributable to increasing market prices of meat, reduces inflows of foreign currency that might be attained through bulk exports to ready markets, and undermines government efforts to enable the smallholder farmers to commercialise their business operations.

5.3.6 The effects of drought on market participation by smallholder farmers

Drought, according to the study hypothesis, was expected to have a negative effect on the market participation by smallholder farmers. The findings set out in Table 5.5 above, on the other hand, indicate that drought had no substantial effect on the smallholder farmers' likelihood of participating in livestock markets. This result is consistent with the results of Fafchamps et al. (1998), who examined the use of livestock as a buffer stock in West Africa and found that drought conditions had no effect on cattle offtake rates. Similar findings were reported in northern Kenya and southern Ethiopia, where pastoralists' cattle offtake rates remained stable, despite the carrying capacities of drought-stricken grazing lands being reduced (Barrett et al., 2004a).

Smallholder farmers rear cattle for a variety of purposes, including providing animal draught power, providing meat for feasts and festivities, paying the bride price, reimbursement for harm done in the violation of customary law, and prestige, as well as other factors that may or may not be directly related to raising cattle as a source of income (Motiang, 2017). As a result, smallholder farmers will often strive to maintain a certain amount of stock to satisfy other, non-monitored needs, even when they are located in an area that is drought-stricken. Smallholder farmers sometimes also increase the number of cattle they own as a form of insurance against severe climatic threats, which can then be sold to fill consumption gaps during such times (Stroebel et al., 2011). As a result, cattle offtake rates may remain constant, depending on how farmers view the severity of the drought. Smallholder farmers typically only sell cattle as a coping mechanism during extreme drought conditions.

Therefore, the observed low market participation that characterises smallholder farmers in South Africa is not attributable to droughts, which have an insignificant effect on their participation, as described above. As such, these findings effectively imply a lack of significance for the apparent link that seems to exist between drought and livestock marketing, which was shown through the conceptual framework in the literature review chapter. That link suggests that droughts could cause high mortality rates, which would reduce the herd size, and cause poor pastures, which would reduce animal quality. Despite this, however, the smallholder farmers have been shown to have coping strategies that allow them to survive drought periods. This is shown by the fact that, regarding the effect of drought, no changes were observed in livestock offtake rates. Therefore, there is a need to enhance the existing drought coping strategies implemented by the smallholder farmers, so

that their status quo will remain the same, despite the anticipated increase in drought occurrences in the future due to climate variability.

5.3.7 The combined impact of drought and animal diseases on the participation of smallholder farmers in livestock markets

The interaction term between drought and animal disease, shown in Table 5.5above, represents the combined effects of drought and animal diseases. Drought and animal diseases have a combined marginal effect on market participation, resulting in a 9.15 percent decline in the likelihood of smallholder farmers' participation in cattle markets. The value is statistically significant, at a one-percent level of significance. The marginal effect of disease outbreaks, on the other hand, is a 3.48 percent decrease in the likehood of smallholder farmers' participation in livestock markets. Drought has no significant impact on market participation, as stated in the previous subsection. Therefore, these findings are consistent with the third hypothesis, which stated that the combined impact of drought and animal diseases on market participation is higher than the individual effects are.

When smallholder farmers are hit by both drought and outbreaks of animal disease at the same time, the effect is magnified and more catastrophic. During these times, cattle mortality rates are likely to be much higher. Mbogoh et al. (2016) studied the efficiency of beef marketing in Kenya and discovered that cattle mortality during drought cycles did limit cattle marketing. Smallholder farmers then rely on extensive grazing rather than feedlots for their livestock production. Droughts, on the other hand, cause poor pasture, resulting in poor conditions of the animals produced and a reduction in their marketable quality. Because of the low quality, farmers do not receive premium rates for the animals they sell. As such, the smallholder farmers are discouraged from engaging in livestock markets due to the low market prices that are offered. As a result, the combined impact of drought and animal diseases is greater than their individual impacts are.

Therefore, the combined effects of drought and animal diseases contribute to the low market participation by smallholder farmers in South Africa. As previously mentioned, drought has an impact on livestock marketing, although its individual effects are minor or not substantial. However, when drought effects are combined with the effects of animal diseases on smallholder farmers' participation in livestock markets, the combined effect of the two is

significant. The adaptive capacity of smallholder farmers can only alleviate individual drought effects, but not the combined impact of drought and animal diseases. As a result, smallholder farmers should be assisted in building up their resilience, such as by assisting them in acquiring animal breeds that are resistant to drought and disease. They would then be able to overcome the negative effects of drought and animal diseases as a result of their increased resilience, thereby increasing their opportunities to participate in livestock markets.

5.4 SUMMARY

This chapter has presented the descriptive statistics that relate to the study sample as well as the multilevel logit model results. The multilevel logit model was appropriate due to the binary nature of market participation, the dependent variable, and the disaggregation of the data by province. The evaluation showed that there was low market participation by the smallholder farmers, who were also characterised in having low cattle offtake rates. This effectively meant that smallholder farmers are facing marketing constraints that hinder their participation in livestock markets. The status quo, therefore, hinders the commercialisation of the operations of smallholder farmers, and as a result, they are unable to utilise the available market opportunities to maximise their profit margins. The dynamic effects on the ability of households to sell their livestock, as depending on each of the variables used in the analysis, were evaluated. The evaluation showed that the numbers of households selling cattle were higher for the male-headed households than for the female-headed households. This was despite the fact that female-headed households who owned livestock outnumbered the male-headed households. Accordingly, the logit results showed that gender did positively affect market participation. Therefore, greater market participation by smallholder farmers could also be achieved by targeting the increased participation in markets by females.

The chapter has shown that the descriptive analysis, regarding the effects of the independent variables on the households' ability to sell cattle, has indicated that increased sales are experienced for people in the age group between 15 and 65,who are more likely to engage in agricultural activities; with increases in the size of herd owned; and for people with higher educational attainments. Therefore, the implications of the findings are that programmes intended to increase market participation by smallholder should mainly focus on people in the age group between 15 and 65 years, who are less risk-averse and are able to adopt new technologies. Smallholder farmers should be helped to increase their herd size through

government and private sector engagement, because an increase in cattle owned in turn increases cattle sales. The findings also entail that investments in educational facilities would enable most smallholder farmers to attain an education. The consequent higher educational attainments would enhance their access to market information, thereby reducing the transaction costs they incur, such as search and negotiation costs.

Income derived from cattle was positively related to market participation, which implies that higher incomes lead to higher rates of market participation. Thus, the impacts of receiving higher income influence the profit margins gained, and the availability of income acts as an incentive or a disincentive for a smallholder farmer's participation in the market. The numbers of households selling cattle were higher among those who had been hit by a mortality shock, according to the descriptive analysis. On the contrary and unexpectedly, the logit analysis showed that the death of a household member was negatively related to market participation. As such, the households who experienced a mortality shock are more likely to use their livestock for personal consumption during funerals, thus reducing their herd size further, and constraining their participation in livestock markets.

Animal diseases were found to negatively impact upon the smallholder farmers' participation in livestock markets. This was also depicted in the descriptive analysis section by a reduction in the percentage of affected households who sold cattle over the study period. The findings imply that the high incidence of animal diseases makes smallholder farmers less likely to participate in livestock markets. This is associated with the reductions in the livestock reserves of smallholder farmers to supply to the available market channels, which reductions are attributable to trade restrictions and livestock losses resulting from animal diseases. Thus, smallholder farmers are unable to take advantage of prevailing marketing opportunities in these market channels. The implication is that there is a reduction of exports, which then undermines the foreign currency gains derived from exports. Furthermore, the affected smallholders are not able to sell livestock on the hide market because of the poor condition of their cattle that results during outbreaks of drought and animal diseases. The significant effects of animal diseases on the participation by smallholder farmers in the markets imply that the government should take decisive actions to prevent the further spread of animal diseases during outbreaks of those diseases. This would break the vicious animal disease cycle and reduce the disease impacts that are projected to increase due to increased climate variability.

According to the descriptive analysis, drought similarly reduced the number of households who sold cattle, but its effect did not reduce the number of households selling cattle as much as animal diseases did. The finding is acceptable, since it is generally easier to sell a weak animal due to poor pasture than it is to sell a sick animal. Moreover, the logit regression analysis found that drought had no substantial effect on the smallholder farmers' market participation. This meant that the droughts faced by the smallholder farmers did not impact upon their participation in the livestock market, and their cattle offtake rates remained constant. Drought effects largely speak to smallholder farmers' low resilience levels, which should be strengthened. Therefore, the drought effects are most hazardous among the smallholder who cannot cope with the devastating effects of drought occurrences. During droughts, the smallholder farmers could mitigate the effects drought, if they are able to move their animals to a more suitable place with better pasture. As such, the resilience and coping strategies of smallholder farmers should be improved to minimise the drought effects, despite its lower effects associated with livestock marketing, and in view of the expected rise in climate variability effects. Smallholder farmers are rational beings and will enter the market when the prevailing conditions are favourable or when then they intend to fill consumption gaps by selling livestock to raise needed income. As such, the occurrence of drought may not alter the smallholder farmers' cattle offtake rates, unless it is more profitable or cost minimising to do so, relative to other available options like supplementary feeding or moving the animals to a less drought-stricken area with better pasture.

This chapter also showed that the combined impact of drought and animal diseases on market participation is higher than the individual effects are. This is expected, since the ability of the smallholder farmers to cope depends on their resilience, as related to their asset base and social capital. The combined impact of drought and animal diseases leads to higher livestock mortality and poorer pasture, which results in a poor condition of the animals, thereby reducing the marketable quality of the animals. Thus, coping strategies, which allow the smallholder farmers to appropriately mitigate the combined effects of drought and animal diseases, should be enhanced and to increase their participation in livestock markets.

CHAPTER 6: CONCLUSIONS AND POLICY RECOMMENDATIONS

6.1 INTRODUCTION

Climate variability effects have been on the rise, globally, impacting upon most agricultural activities, such as livestock production. Approximately 1.3 billion people are employed in the global livestock sector, contributing about 40 percent of the global agricultural GDP, which makes livestock production a significant economic activity. Livestock production is a major source of income for most rural people, whose primary way of life is founded upon agriculture. Furthermore, livestock production and marketing contribute to food security, poverty reduction, and GDP growth.

South Africa, like other low-income countries in Africa, has a great proportion of its population still living in rural areas, engaged in livestock production. Commercial farmers and smallholder farmers comprise the livestock sector in South Africa, which is separated into two categories: a well-developed commercial formal sector, and a non-commercial informal sector. The development of the smallholder farmers in the informal sector would enable South Africa to meet the growing demand for meat and meat by-products, increase the production of raw materials such as hides and wool, which are used in the automotive and clothing industries, and increase foreign currency earnings due to increased exports. However, livestock production and marketing in South Africa are challenged by pasture degradation, low technical adoption rates, droughts, and animal diseases.

Therefore, this study evaluated the effects of drought and animal diseases on the market participation by smallholder farmers in the South Africa. The study was conducted against the background of global recognition that climate variability and its impacts are affecting livestock production and marketing ,as seen in the increased regularity of incidences of drought and animal disease. These effects, over time, could have potentially influenced the low market participation that characterises the smallholder farmers in South Africa. The study used a four-wave panel dataset comprised of two thousand and thirty-four smallholder farmers in South Africa. The next section provides a summary of the discussions and findings arising from the analysis of the effects of drought and animal diseases on the market participation by smallholder farmers in South Africa. This chapter will also present the overall conclusions and policy recommendations drawn from the findings of the study. Lastly, the opportunities for further research are presented in this chapter.

6.2 SUMMARY

The evaluation of the effects of drought and animal diseases on the smallholder farmers' participation in the livestock market was done with a realisation that smallholder farmers participate sparingly in livestock markets. The low participation in livestock markets among the smallholder farmers is attributable to various determinants, including the effects of drought and animal diseases. The cattle offtake rate among the smallholder farmers in South Africa is only five percent, despite them owning about forty percent of the total herd in South Africa. The increased participation by smallholder farmers in livestock markets is vital for the commercialisation of their business operations and the growth of the South African livestock sector at large.

The livestock sector has global importance, as can be seen from the large number of people it employs and the large amounts it contributes to global agriculture GDP. Livestock production occurs in all provinces in South Africa, as affected by factors such as each province's climatic environment, biomes, population density, and proximity to metropolitan markets. Accordingly, a higher product output in low livestock-producing provinces could be attained by enabling producers to gain access to better pasture during dry winters and improved access to major input and product markets. Livestock marketing was depicted through the beef value chain that goes through four market channels, being direct sales, auction markets, feedlots, and abattoirs, which differ in the profit margins that might be obtained in each channel. However, the smallholder farmers prefer to conduct direct sales, at the farm gate, because it has the lowest transaction costs by excluding brokerage fees and commissions for marketing agents that would be incurred by the use of the other channels.

Changing demographic patterns have been experienced in factors such as urbanisation, and changes in consumption patterns by individuals who earn higher incomes, leading to them to make dietary choices to include more meat protein in their diets. This was shown to be consistent with Bennett's law, which states that "as incomes rise, people eat relatively fewer calorie-dense starchy staple foods and relatively more nutrient-dense meats, oils, sweeteners, fruits, and vegetables". Therefore, the rise in meat consumption calls for a commensurate change in the livestock offtake rates, especially among the smallholder farmers, to meet the growing demand. It was also shown that increasing beef prices would serve as an incentive for smallholder cattle producers to increase participation in beef markets because of the

increased profits obtained when prices are high. The smallholder farmers could also explore the hides, skin, and tanneries market, which has been growing due to high demands from the car and clothing industries.

The participation by smallholder farmers in livestock markets is critical for agricultural transformation. However, their participation in markets is influenced by human factors, financial factors, physical factors, and transaction costs. Climate variability effects, such as those caused by outbreaks of droughts and animal diseases, also cause regional variations in offtake rates, thereby negatively impacting on market participation. South Africa, like the rest of Sub-Saharan Africa (SSA), has been negatively affected by the effects of drought and animal diseases, which greatly challenge the smallholder farmers due to their low adaptive capacity to deal with climatic variability effects.

An overview of the rainfall amounts received in South Africa for the period between 1970 and 2020 showed a decreasing trendline in the rainfall amounts received. The period analysed, 1970–2020, showed that the years in which the amount of rainfall received was below average (600 mm) have increased in the latter part of the time frame. Droughts have increased in South Africa, large due to the Pacific and Indian Oceans warming up from the occurrences of El Niños. Climate variability effects have been on the increase, impacting upon the prevalence of animal diseases. Climate variability impacts upon the distribution and prevalence of pathogens and parasites, such as ticks, and South Africa is highly susceptible to tick-borne diseases. The conceptual framework enhanced the understanding of how droughts and animal diseases could potentially affect the market participation of smallholder farmers by impacting upon their livestock supply through high mortality rates, poor animal quality, and trade restrictions.

The discrete-choice multilevel logit model was used because of the binary nature of the dependent variable and disaggregation of the data used by each province. The study used the Likelihood Ratio Test and the Hausman test to choose the appropriate panel data model to use. The Hausman test result obtained was significant, indicating that the fixed effects model was more appropriate, and it was therefore used to estimate the study results.

The findings obtained showed that the effect of animal diseases on the participation in livestock markets by smallholder farmers is negative, while the effect of drought is insignificant. The study further found that the combined impact of drought and animal diseases on market participation was such that it reduced market participation, and its effect

was greater than the individual effects of drought and animal diseases. Therefore, the findings on the effect of animal diseases, as well as its combined impact with drought, were consistent with the initial study hypothesis. The respective initial study hypotheses for the effect of animal diseases and their combined effect with drought were that animal diseases have a negative effect on the participation of smallholder farmers in livestock markets and the combined impact of drought and animal diseases on market participation is higher than the individual effects, respectively. Therefore, the study failed to reject or accepted the two hypothesis. However, the initial hypothesis that drought negatively affects the market participation of smallholder farmers was rejected due to the study's findings that showed that the effect of drought on market participation was not significant.

6.3 CONCLUSIONS

It can be concluded that livestock marketing is vital among smallholder farmers and is essential for their growth and the commercialisation of their business operations. Among the four livestock marketing channels used – auctions, feedlots, abattoirs, and direct sales – the direct sales channel is the most preferred due to its lower transaction costs. It can also be concluded that smallholder farmers still have the opportunity to increase their participation in livestock markets through sales in the other marketing channels, which would also increase exports. Their participation in these channels and the consequent improved profits would also enable them to add value to their businesses by improving the quality of their animals, and then supply improved-quality skins and hides to the car and clothing sectors.

This study concluded that the gender of the household head, the age of the household head, the death of a household member, cattle income, number of cattle owned (herd size), animal diseases, and the combined impact of drought and animal diseases were significant factors in determining the market participation by smallholder farmers. To the contrary, drought was not a significant factor in determining the market participation by smallholder farmers. These findings allow the study to conclude that the probability of participating in livestock markets is higher for males than females. Aging is associated with increased responsibilities, implying that smallholder farmers increase their participation in livestock markets as they grow older because they then take on greater responsibilities, with greater financial demands. Smallholder farmers who experience a mortality shock are more likely to use their livestock for consumption during funerals, and accordingly the probability of their participation in

livestock markets increases. Smallholders with greater numbers of livestock tend to participate more in livestock markets, as was depicted in the graph of herd sizes and household cattle sales. Higher educational attainments were also shown to enhance market information access, thereby increasing the smallholder farmers' participation in livestock markets. Finally, higher incomes lead to higher market participation rates because higher incomes incentivise rational, profit maximising or cost minimising among smallholder farmers.

It can also be concluded that, in addition to the various transaction costs, and human, financial, and physical factors that affect the participation by smallholder farmers in the livestock market, drought and animal diseases also affect their participation, as was depicted in the conceptual framework. The findings from the logit model estimation allow the study to conclude that the market participation by the smallholder farmers reduces when there are outbreaks of animal disease. The participation in livestock markets by the smallholder farmers is more highly constrained in periods in which droughts and animal diseases occur at the same time, than when farmers are hit by only one of these to shocks. Lastly, market participation by smallholder farmers in South Africa does not depend on whether or not there is a drought, unless it occurs in a period in which there is also an outbreak of disease.

6.4 RECOMMENDATIONS

1. The descriptive statistics showed that the numbers of households selling cattle, or livestock in general, increase as the herd sizes increase. Therefore, this study recommends that the department of agriculture, land reform and rural development, and the private sector should work towards increasing the numbers of livestock owned by the smallholder farmers as a way of boosting their market participation. However, larger herd sizes among smallholder farmers would demand that they should also been powered by the provision of additional amounts of land, which is needed to support the increases in herd size or by allocating additional amounts of communal pastoral land. The government through the department of agriculture would also need to provide supporting infrastructure, such as feedlots, abattoirs, and veterinary centres.
2. Education was shown to increase access to market information, which enhances market participation. Therefore, the study recommends that positive steps should be taken by the government to disseminate market information among smallholder farmers, even to the illiterate, to enhance increased participation in markets.

3. To mitigate the effects of animal diseases, the study recommends that government investments in veterinary services should be increased, together with increased vaccination campaigns, to reduce the negative effects of animal diseases among smallholder farmers. Smallholder farmers in marginalised areas are the most affected, and as such, the government should improve the infrastructure required for transportation systems. This would enable smallholder farmers to easily access veterinary services, as veterinary and extension officers would be more mobile in these areas, leading to increased and timely vaccine delivery during outbreaks of diseases. The government should also decentralise service delivery, such as by increasing the numbers of workstations where smallholder farmers could receive consultations on various diseases.
4. Furthermore, it is recommended that the government should provide increases in disease-combating facilities, like dip tanks. More and better animal-holding facilities should also be built to make animal quarantines easier to manage during disease outbreaks, which would reduce stress on smallholder farmers and encourage their participation in markets, even under animal quarantine conditions. The significant impacts of animal diseases on the smallholders' participation in livestock markets also demands that the government should consider increasing the ratio of the number of service providers to the number of smallholder farmers. In the field of research and development, the government and the private sector should collaborate to better understand the emerging and resurfacing diseases, as well as to find ways to disseminate known information to smallholder farmers and combat the effects of these new diseases and there surfacing diseases.
5. The study also found that the combined impact of drought and animal diseases constrains the smallholder farmers more highly in their participation in livestock markets due to greater livestock mortality rates and poor animal quality. Therefore, the study also recommends that the government's risk reduction policies, which encompass all of the elements needed to reduce vulnerabilities and catastrophic risks across a community, should be enhanced. The key risk reduction concepts of prevention, mitigation, and preparedness are all included. This would enable the smallholder farmers to receive timely support and receive commensurate compensation with regard to the events that have prevailed in the relevant period. Therefore, for a case in which outbreaks of drought and animal disease occur at the same time, a greater constraint on the smallholder farmers' ability to participate in livestock markets should be anticipated. In these situations, their livelihoods are more seriously degraded, and they should be compensated depending on whether they are facing the individual effects of drought and animal

diseases, or the combined effect of both. The government could also encourage the smallholder farmers to obtain insurance cover, as is commonly used by commercial farmers, to cover risks associated with drought and animal diseases. This would allow the insurer to evaluate and quantify the risks and financial effects of outbreaks of drought and animal disease that affect smallholders and necessitate settlement.

6.5 OPPORTUNITIES FOR FUTURE STUDY

This study focused on evaluating the effects of drought and animal diseases on the market participation by smallholder farmers in livestock markets. The study deduced conclusions primarily by evaluating the supply and marketing of cattle in South Africa. However, vital as the beef sector is in South Africa, the livestock sector is not limited to the beef sector. Therefore, this study recommends future research be carried out to focus on analysing the effects of drought and animal diseases by carrying out a comparative analysis that includes other livestock, such as pigs and goats, to draw more comprehensive conclusions.

Lastly, the panel data set used in this study has a short time trend (T), as compared with the cross-sectional units (N), and therefore it could not be used to determine the welfare effects of drought and animal diseases. Drought and animal diseases affect price formation mechanisms in the livestock marketing chain, thereby impacting upon consumer and producer welfare. As such, this study also recommends that future research could focus on determining the welfare effects of drought and animal diseases on smallholder farmers. Market participation dynamics change due to variability in livestock market prices, which is caused by occurrences of drought and animal disease. Knowledge of welfare effects would enhance the formulation of prudent and efficient policies that are directed at ensuring that the coping strategies used by the smallholder farmers are sustainable, and that they receive the necessary and concise support to prevent welfare deterioration. The strategies used by smallholder farmers to prevent welfare losses may vary from one region to another, as such, the government could ensure that sustainable strategies used in one region are implemented in another.

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