INVESTIGATION OF METHODS ADOPTED BY SMALLHOLDER BROILER FARMERS IN ADAPTING TO CLIMATE CHANGE

By

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DECLARATION

I Khuguvhila Shumani, hereby declare that this dissertation for Masters in Rural Development (AGMARD) submitted to the Institute of Rural Development at the University of Venda has not been submitted for any degree at this or another university. It is original in design and in execution, and all reference material contained therein has been duly acknowledged.

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ABSTRACT

Broiler farming is one of the fastest businesses with a short production cycle and low initial capital. This practice helps alleviate poverty, ensures food security, and improves people's nutritional status by providing immeasurable employment opportunities for communities. Even though broiler farming is of great benefit, smallholder farmers face challenges, climate change being one of them. The aim of the study was to investigate methods that smallholder broiler farmers have adopted to adapt to climate change. The study was conducted in the Thulamela and Musina municipalities of the Vhembe district. For this study, 124 small-scale broiler farmers were purposively selected (those farming with less than 2000 broilers per cycle) to represent 57 for Thulamela and 67 for Musina municipalities. Data were collected through face-to-face interviews using open and closed ended questions. IBM SPSS statistics version 29 was used to determine frequencies using descriptive statistics and mean scores. The results from the study reflected that the age of most farmers who are involved in broiler farming is 36-45 (40.3%). About 79.9% of female farmers are involved in broiler farming compared to 21% of male farmers. The results show that most broiler farmers (96%) sell their live chickens locally. The results reflected that 54% of the farmers strongly disagree with changing from closed housing systems to an open-sided one during summer. Furthermore, 66.1% of the farmers strongly agree that during the summer season, they are challenged with high mortality rates due to heat stressed. On perceptions of farmers, the mean score reflected that the farmers ranked decrease in sales volume in summer ($\bar{x}$=2.39) as more important, followed by an increase in water intake in winter ($\bar{x}$=2.54) and changing the housing system ($\bar{x}$=2.63). It emerged that farmers (49,2%) have developed their strategies for adapting, which include use of *Aloe vera*, Munzere (*Bridelia micrantha*), salt and sugar and dipping chickens in water as a measure of cooling the broilers; with the cooling system being expensive. About 98.4% prefer to use open-sided housing as ventilation compared to the cooling system. In conclusion, because of change in climate and expensive conventional adaptation methods, the farmers have developed their own indigenous and cheaper ways of adapting to climate change. I recommend that further studies need to be conducted on the effectiveness of indigenous methods adopted by smallholder broiler farmers.

Key Words: Adapting, broiler chicken, climate change, smallholder farmers

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ABBREVIATIONS AND ACRONYMS

DALRRD - Department of Agriculture, Land Reform and Rural Development

DFID - The Department for International Development

SAPA - South African Poultry Association

SMAT - The Smallholder Market Access Tracker

STATS SA - Statistics South Africa

UNDRR - United Nations Office for Disaster Risk Reduction

UNFCCC - United Nations Framework Convention on Climate Change

VDM Vhembe District Municipality

WHO - World Health Organization

Chapter 1: Introduction

1.1 Background

Livestock plays an important socio-economic role in developing countries (Mulaudzi, 2015; Koirala & Bhandari, 2019). Humans rely on animals for products such as eggs, meat, wool, and milk as essential animal protein sources. Some farmers use livestock for draught power in farming and transportation. Crop farmers use livestock manure as fertilizer. Families living under poor conditions and landless people, mostly in rural areas, keep chickens for consumption and income generation. These socio-economic roles are visible in rural areas where little or no technology is needed in production.

More than 1.1 million households are active in poultry production in South Africa (Davids *et al*., 2017). Broiler farming is one of the speediest businesses with a short production cycle and requires less start-up capital. This practice contributes to poverty alleviation, ensures food security, and improves people's nutritional status, providing immeasurable employment opportunities for communities, especially youth and women (Bounds & Zinyemba, 2018). Broiler farming directly employs approximately 49 887 and indirectly employs 111 822 in South Africa (Vhembe District Municipality (VDM), 2020; SMAT, 2020). The VDM (2020) reported an estimated weekly production of 51 719 broilers with a total Poultry monetary value of R107, 6 million per year. Smallholder farmers often use this practice as a means of self-employment, which could be the primary source of a family's income (Ngongolo *et al*., 2020). Broiler farming plays a significant role in providing meat to overcome malnutrition because broiler meat is a healthy source of protein and other micronutrients fundamental to human health (Mozumdar *et al*., 2010). The practice is, however, faced with hindrances, even though it has excellent benefits.

One of the challenges that the farmers are facing is climate change. Climate change has been a global challenge affecting livestock productivity widely. Throughout the year, the rainfall pattern affects the broiler production system through its effects on cereal development and the outbreak of diseases and parasites (Ali & Amogne, 2018). High temperatures are becoming more common because of climate change, causing heat stress in broiler chickens. Homoeothermic animals prefer to increase heat loss and reduce heat production in response to high temperatures to avoid increased body temperature. Heat stress causes weakness, dizziness, easy sickness, inability to breathe, and rapid death without warning (Ahiwe *et al*., 2018). Furthermore, high temperature reduces feed intake of broiler chicken because more energy is needed to conserve the heat caused by high temperature, hence, a decrease in the rate of feed intake (Adesiji *et al*., 2013). The cold climate produces metabolic acclimation during the winter, resulting in lower broiler performance and efficiency (Koirala & Bhandari,

2019). High rainfall and relative humidity provide a conducive environment for breeding parasites that cause diseases outbreaks that invariably reduce egg production and broiler growth.

With these continuous effects of climate change on broiler chickens, farmers have adopted different methods to ensure broiler chickens are adapted to climate change. The methods they use include air ventilation that uses fans or air conditioning. This helps reduce the chicken housing's temperature and removes the smell caused by broiler waste (Linden, 2014). Smallholder broiler farmers use breeds that can adapt to extreme temperatures. Due to high disease breakout, farmers have adopted biosecurity measures on the farm, which prevents diseases from entering the farm. The biosecurity measures include using a footbath when entering the broiler house.

Most studies have focused on methods that are associated with commercial farming and not smallholder farming. This study investigated methods that smallholder broiler farmers adopt in adapting broiler production to climate change. The study aimed to outline some methods that smallholder broiler farmers have adopted in adapting to climate change. In the Thulamela and Musina Municipalities, there is little information on methods that broiler farmers use in adapting broiler production to climate change, as most studies have focused on backyard or village chickens instead of broilers.

1.2 Problem statement

Climate change has become one of the global challenges which has posed an increasingly large number of climate-related events. Both livestock and crop farming have been affected by climatic conditions, which are constantly changing (Koirala & Bhandari, 2019). Environmental factors affecting broiler farming include sunlight, humidity, and relative humidity. Broiler meat production has decreased from 2015 to 2017, though there was an increase overall during the last decade (SAPA, 2019). The mortality rate of broilers increases as the ambient temperature increases, especially when it reaches 34°C (Ahaotu *et al*., 2019). Furthermore, the ambient temperature strongly influences survivability and performance in broiler production.

The negative impact of climate change on animal health and welfare can be caused by changes in temperature, precipitation, and the frequency and intensity of extreme weather events, which can be direct or indirect (Lacetera, 2019). Heavy rains can cause flooding and increase atmospheric humidity, providing favorable conditions for reproducing pathogens, ticks, flies, and mosquitoes (Sejian *et al*., 2021). Pathogens and vector-borne diseases' rate of development are increased by high temperatures, which increases the transmission between the broilers and pathogens. Smallholder broiler farmers continue to produce under

these hostile climatic conditions, but the method they use to adapt their production are not known. There is, however, limited information on methods adopted by smallholder broiler farmers in rural communities. Most studies focus on large scale commercial broiler production. The objective of this study was, therefore, to establish the methods used by smallholder broiler farmers in adapting production to climate change.

1.3 Justification of the study

Climate change is a daily challenge as fossil fuels are still being used. It has a direct and indirect impact on human beings, animals, and the environment. This study helps farmers know which climate change adaptation methods improve broiler survival and growth performance. This study has assisted in producing information which will help in improving the knowledge of smallholder broiler farmers on climate change. This could increase employment in rural areas and contribute to rural development and local economies. The study addressed global sustainable development goals: no 1, 'i.e., end poverty in all its forms everywhere.

1.4 Research objectives

1.4.1 Main Objective

The objective of the study was to investigate the methods used by smallholder broiler farmers to adapt production to climate change.

1.4.2 Specific objectives

1. To characterize the demographic factors of the broiler farmers in the Thulamela and Musina Local Municipalities;
2. To determine the perceptions of farmers on the extent to which climate change affects broiler chickens; and
3. To identify and describe methods that smallholder farmers use to ensure that broiler chickens adapt to changes in climate.

1.5 Research questions

Which are the methods used by smallholder broiler farmers to adapt production to climate change

1.6 Operational definitions of key terms and concepts

Adaptation: refers to modifying natural or human systems to mitigate harm or capitalize on possibilities (UNFCCC, 2012).

Climate change: occurs due to fuel combustion, cutting down of trees, urbanization, and industrialization, which causes variation in solar energy, temperature, and precipitation (Koirala & Bhandari, 2019).

Smallholder farmers- are farmers who farm on a relatively small portion of land; their focus of production is on survival with little access to big markets (Kamara *et al*., 2019).

Broiler chickens- are chickens raised specifically for meat (Harrison, 2013).

Mortality rates- are demographic measures used to describe the number of deaths that occur in each population relative to the size of that population (Luykx, 2006).

Perceptions - the process to acquire consciousness or knowledge of sensory information (McDonald, 2012).

1.7 Organization of the Dissertation

This dissertation consists of 7 chapters.

Chapter 1, the background of the study, problem statement, justification of the study, and objectives are explained. In this same chapter, the research questions are presented as well as key concepts and terms defined. Chapter 2, literature regarding broiler chicken and climate change is reviewed, providing clarity on the research gap. Chapter 3, the study methodology is explained. In this chapter, the study design, data collection process, sampling procedures, data analyses, and ethical consideration are explained. Chapter 4 consists of results and discussion on description of demographic factors of the broiler farmers in the Thulamela and Musina Local Municipalities. Chapter 5 consists of results and discussion on the perception of farmers about the extent to which climate change affects broiler chickens. Chapter 6 consists of results and discussion on methods that smallholder farmers use to ensure that broiler chickens adapt to changes in climate. In Chapter 7, the general discussion, conclusion, and recommendation are provided. The references that were consulted in compiling this dissertation are duly listed and the appendices that provide the ethical clearance certificate and a sample of the data collection tool(s) used to congregate data for this study are included.

CHAPTER 2: Literature review

2.1 Introduction

In this chapter a detailed literature review was outlined. The literature review focused on three aspects of the study namely, demography of the farmers, impact of climate change on broilers and lastly adaptation methods used by smallholder broiler farmers to adapt production to climate change. The demographics of smallholder farmers includes age, gender, education, experience, occupation, and operational scale of smallholder broiler farmers. This is followed by the impact of climate change on broilers which includes mortality rate, diseases outbreaks, growth performances, meat quality, sales and quantity and availability of feeds. The study further delves into the methods that farmers have adopted which includes ventilation system, biosecurity measures, broiler houses, brooding lights, vaccination of broiler chickens, the use of adapted breed, the use of Aloe vera as medication, and adding ice to the water that chicken drinks. This chapter ends with the conceptual framework.

2.2 Demographics of smallholder livestock farmers of the developing world

2.2.1 Age and gender

Broiler farming is one of the economic ventures which both males and females are currently doing. Ngongolo *et al.* (2020) ascertained that females of age above 21 years dominate broiler farming. Gopala *et al*. (2017), reflected that most dominated broiler farmers were at the young age category 25-35. Ifeoma (2015), findings revealed that females dominate broiler farming in the Vhembe district This could be because small-scale broiler farming is not labor intensive, hence females could do without any challenges (Mulaudzi, 2015). Furthermore, females are more caring as required during broiler rearing than their male counterparts. Most small-scale broiler producers in the Vhembe district were less than 40 years old (Mulaudzi, 2015). Moreover, this could be attributed to the fact that most young people under the age of 40 are unemployed, and as such, they initiate broiler production as a means of survival.

Gopala *et .al* (2017) have found out that most people involved in broiler farming were male. In support, Ojo *et al. (*2021) discovered that most broiler farmers were males compared to females and age distribution of the respondents shows the dominant age falling between ages 40 and 49, followed by the age 29-39. This literature on age and gender of small-scale broiler farmers means that the practice was embarked on by farmers who were physically and mentally fit to face challenges.

2.2.2 Education and experience

Smallholder broiler farmers in the Vhembe district have a tertiary level of education, with secondary education following, then there are farmers with elementary educational level

(Mulaudzi, 2015). Baliyan (2017), had reflected that broiler farmers had a senior secondary education, followed by those with a university education. Sendramampionona *et.al* (2020) reflected that broiler farmers had completed their education at the college level, followed by the primary school level, and the least had the secondary school level. Furthermore, they reported that in most rural communities, the illiterate level for smallholder farmers accounts for 5% (Sendramampionona *et al*., 2020).

Farmers in Madagascar have an experience of 15 years of broiler farming (Sendramampionona *et al*., 2020). The longer the years of practice, the older the household head. Smallholder broiler farmers have 1 to 5 years of experience in broiler poultry farming and have at least 5.1 to 10 years of experience in broiler poultry farming (Gopala *et al*., 2017). Baliyan (2017) showed that most broiler farmers had two years of experience, at most, in poultry farming, while 28.3 percent had two to four years of experience. This review reflected that most broiler farmers have an experience of 1-5 years of experience with secondary and tertiary being the highest level of education.

2.2.3 Marital Status

A study conducted by John et al., (2020) in Nigeria indicated that there were more married broiler farmers than single farmers. This finding concurred with the findings of Oyelami et al., (2022) who indicated that most of the farmers were married as compared to those who were single. Most of the farmers were married because marriage provided mental, physical, and practical assistance, laid a solid foundation for navigating the ups and downs of agriculture (Daghagh et al., 2019). Many rural communities might have had social norms and expectations for marriage and family life (Idang, 2015). Furthermore, farmers might have been more likely to adhere to traditional societal norms, such as marriage and family formation.

2.2.4 Operational scale

Most broiler farmers in Bangladesh focused on small-scale farming, in which they had less than 1000 chickens (Kamruzzaman *et al*., 2021). Smallholder broiler producers had fewer than 2 hectares of land to work with. This was the reality in the rural community, where farms were either small or marginal and were used by farmers without salaried employment who were reliant on other forms of income, such as chicken farming (Sridharan, 2017). A study done by Uchendu *et al*., (2015) in Nigeria reflected that most small holder farmers have 250-1900 broilers for their farming project.

2.3 The extent to which broiler chickens are affected by climate change

2.3.1 Mortality

When the temperature increases, the mortality rate also increases. The mortality of broiler chickens is mostly caused by a rise in temperature (Lara & Rostagno, 2013). The smallholder

farmers cannot afford most of the medication, resulting in a high mortality rate (Phiri *et al*., 2023). The shortage of supply of feed and water due to drought and low rainfall caused by climate change results in mortality (Orimoloye *et al*., 2022). The availability of the parasites and viruses causing broiler diseases, were on the rise thereby mortality if the animals were not vaccinated or treated.

2.3.2 Disease Outbreaks

Climate change leads to variations in temperature and rainfall, which cause outbreaks of livestock diseases (Magiri *et al*., 2021). Temperature and rainfall were the most significant climatic variables affecting broilers. When the temperature increased and rainfall patterns fluctuated, it affected the availability of pathogenic bacteria, viruses, parasites, and fungi (Escarcha *et al*., 2018). High temperatures promoted survivability, shorter development rates, and better transmission than colder temperatures. Insects and parasites that transmit diseases might also benefit from higher temperatures (Kumar *et al*., 2021)

2.3.3 Growth performance/ weight

Growth and feed utilization efficiency are reduced when broilers are exposed to hot or cold stress (Esmail, 2020). During winter, the metabolism of the broiler became acclimatized, which lessened animal performance and production efficiency (Koirala & Bhandari, 2019). When the atmospheric temperature increases, feed consumption lessens to reduce metabolic heat production. The broiler reduced feed consumption by 1.5% per 1˚C increase in temperature, this reduction in feed consumption caused the broilers to lack some essential nutrients (Abioja & Abiona, 2020). The nutrients available in the body were used in heat loss mechanisms instead of muscle mass for profitability. This caused the digestibility of feeds in the gastrointestinal tract of the broilers to be lowered. Therefore, the growth rate of broilers was reduced when the environmental temperature rised because even the little energy obtained from the small feed consumed was expended in panting. The result was that birds would have lower final body weight (Abioja & Abiona, 2020).

2.3.4 Sales and quantity

According to DALRRD (2020), South Africa's meat & edible offal of broiler exports decreased by 2% in value and increased by 5% in quantity between 2012 and 2016. During the same period, exports of meat & edible offal of broiler to Lesotho decreased by 5% in value and 2% in quantity. This was caused by climate change because of scorching heat, which occurred in 2015, together with the drought, which led to a low water supply to chickens and caused many broiler chickens to die (Mukwevho, 2015).

Between 2015 and 2016, South Africa's export value of meat & edible offal of broiler remained the same. During the same period, the export value of meat & edible offal of broiler to Lesotho

decreased by 10%, and Mozambique also experienced a decrease of 5% (SAPA, 2019). DALRRD (2016) reflected that in 2016 drought caused by climate change affected maize crops which are essential to broiler feeds, resulting in high feed costs. SAPA (2019) has reported that in the year 2017 there was an outbreak of the avian influenza disease, which caused high mortality in the broilers, and some broiler farmers were forced to close their businesses.

2.3.5 Availability of Feeds

Indirectly, climate change greatly impacts feed availability for poultry. Low rainfall and heavy rains reduce the quantity and the quality of cereal grains and oil seeds. This triggers an increase in feed prices and increases the competition for feed between humans and animals. Due to droughts, farmers tend to adopt irrigation systems which are mostly expensive, thus increasing the price of the feed (Abioja & Abiona, 2020). Adesiji *et al*. (2013) emphasized the impact of climate change on the production and availability of feed grains. Furthermore, reported that rising temperatures and sharp declines in precipitation is affecting yields, harvests, and grain supplies. This increased poultry production costs, as intensive poultry is heavily dependent on grains.

2.4 Methods that smallholder farmers use to ensure that broiler production adapt to changes in climate

2.4.1 Ventilation system

The ventilation of the poultry house provides lively and fresh air which assist to reduce extreme temperature, humidity, and air pollution to the acceptable limits for caged chickens (Sáenz, 2020). The improved ventilation system had also enabled a dense population of captive livestock and poultry, reducing construction costs per unit housed (Harris, 2012). This was economically important as it reduced excessive heat in the house caused by climate change. In broiler production, birds needed to consume large quantities of high-quality feed to develop the metabolic processes required by its environment and organism. This metabolic process, on the other hand, released a large amount of heat into the environment which increased the temperature (Beckford *et al*., 2020). Other factors such as population density, geographical location, and age of the bird were also involved. Birds drain water by breathing and falling, and water accumulates in the area and therefore, must be removed by ventilation (Alchalabi, 2015). Birds cannot sweat, so breathing, flapping violently and gasping give off excessive heat. Ventilation helps remove excess heat and moisture from the bird pen, ensuring comfort and well-being (Sáenz, 2020).

2.4.2 Biosecurity measures

The first line to combat infectious diseases was to prevent their introduction and further spread through strict biosecurity measures, the establishment and maintenance of immunity, and

vaccination. Biosecurity as a farm management tool will help reduce the risk of disease on the farm. Following the biosecurity guidelines helps to reduce the risk of diseases (Soliman & Abdallah, 2020). Each farm should have a biosecurity checklist posted or maintained on hand (Abouelenien *et al*., 2020). Cleaning and disinfecting are key biosecurity measures in keeping broiler chickens healthy. Cleaning and disinfecting reduce the introduction and spread of diseases on the farm (Sharma *et al*., 2018). Farmers always clean when new stock comes into the house using chemicals that kill bacteria. Bacteria such as Salmonella and E. coli can thrive on equipment surfaces and lead to infections (Yulistiani *et al*., 2019). Diseases can be spread through various things in broiler farms, such as equipment, vehicles, and wild birds. Rodents and birds can act as vectors for various diseases, including avian influenza and other pathogens harmful to broilers (Velkers *et al*., 2017).

2.4.3 Broiler houses

Economical breeding of chickens begins with the accurate and proper design of the building for the relevant breed and environment of the site (Alchalabi, 2013). Poultry house design played an important role in determining environmental conditions in the house to optimize bird health, growth, and production capacity (Oloyo & Ojerinde, 2020). One of the houses that smallholder broiler farmers used was open-sided housing. Open-sided housing provided improved air circulation through natural ventilation. Natural ventilation in open-sided buildings helped to manage the temperature within the facility. This was important especially in hotter areas, where broilers might have been susceptible to heat stress. Furthermore, this contributed to maintaining a comfortable and healthy environment for broilers by a reduced heat stress, lowered ammonia levels, and encouraged fresh air exchange. The free movement of air dissipated heat prevented negative impacts on bird health and performance (Bhadauria, 2017). Open-sided housing, as opposed to fully enclosed buildings with mechanical ventilation systems, can save money on energy. The use of natural ventilation lowers the need for fans or other artificial cooling devices, making the broiler production process more energy efficient and cost effective (Mateus *et al*., 2023). A well-insulated roof reduces the penetration of solar heat into the house on warm days and reduces the heat stress on the birds. In the village environment, many farmers use iron abandoned on the roof, but to insulate the building from extreme heat, straw-covered local foliage material (especially in tropical countries) is preferable (Farrell, 2013). In cold weather, a well-insulated roof reduces the heat loss and energy consumption required to maintain a proper environment for the broiler during the incubation phase (Glatz, 2013).

2.4.5 Brooding lights

Studies have shown that chicks exposed to low temperatures endanger the immune and digestive systems (Abo-Al-Ela *et al*., 2021; Hofmann *et al*., 2020). As a result, chicks under

cold stress grow slower and are more susceptible to illness Artificial light boosts growth and manages day-and-night cycles. However, light utilization is not limited to growth stimulation; it also serves a functional purpose by regulating the circadian rhythms of broilers, altering their sleep-wake cycles and activity patterns (Abo-Al-Ela *et al*., 2021). Light becomes a key instrument for maintaining buildings to the greatest possible standards, as chickens demand quality conditions to thrive. Chicken keepers can properly inspect their flock for probable ailments or diseases that could spread with the right amount of light. It also assists them in completely cleaning buildings to prevent the spread of infections. The appropriate light exposure can help broilers grow faster and generate more consistent broilers. Light also impacts feeding because it helps chicks identify feeders and, as a result, get the proper amount of nourishment to help them grow (Johnson, 2018).

2.4.6 Vaccination of broiler chickens

Climate change can alter disease patterns and the frequency of specific infections (WHO, 2023). Effective vaccination programs can assist chicken farmers adjust to changing environmental conditions by reducing disease onset and transmission (Delabouglise *et al*., 2020). Healthy broiler flocks help farmers maintain economic resiliency. Farmers who reduce the impact of illnesses on productivity are better equipped to endure economic problems, especially those related to climate change. Vaccinating broilers helps to prevent disease transmission within flocks (Ravikumar *et al*., 2022). Healthy birds are more productive, requiring less drugs. Reduced antibiotic use can help to prevent the emergence of antibiotic-resistant bacteria, which is a global health concern (WHO, 2022). Sustainable chicken farming practices, including vaccination, can help to make better use of resources including water, feed, and energy. This may be significant in the context of climate change, when resource scarcity and environmental damage are major considerations (UNDRR, 2019).

2.4.7 The use of adapted breed

Adapted breeds are often more suited to the region's climate, whether it is hot and humid, cold and dry, or another type of climate pattern (Hoffmann, 2013). These breeds had developed features that allowed them to endure weather extremes, resist diseases common in the area, or use local feed supplies more efficiently. Furthermore, some adapted breeds had evolved essential tolerance or resilience to diseases prevalent in specific places (Colditz & Hine, 2016). This lessened the need for significant medical interventions and antibiotics, hence promoting more sustainable and environmentally friendly farming practices. Breeds that had been acclimated to certain locations might be more efficient at converting locally available feed resources into body mass (Manyelo *et al*., 2020). This enhanced feed conversion rates, lower production costs, and made broiler farming more economically viable (Ramukhithi *et al*., 2023). Adapted breeds are frequently more compatible with local feeding techniques, relying

on region-specific feed resources. This might involve adding traditional crops or forages that were well-suited to the local climate (Grace *et al*., 2020). Farmers that raise adapted breeds frequently had traditional understanding of their breed's special demands and traits. Integrating this knowledge in broiler farming operations improved the overall management and efficiency.

2.4.8 The use of *Aloe vera* as medication

Climate change can create stressful conditions for broilers, compromising their health and growth. *Aloe vera* is known for its anti-stress characteristics, which may assist birds deal with environmental challenges (Jaiswal *et al*., 2021). Aloe vera contains chemicals that have been shown to have immunomodulatory properties. These properties play a role in improving broiler immune systems and are critical in illness prevention and management, especially when changing climates affect the incidence of specific infections (Quaye *et al*., 2023). Climate change can cause oxidative stress in birds due to changes in environmental factors. Aloe vera contains antioxidants that may help neutralise free radicals and prevent oxidative stress (Hęś *et al*., 2019). Aloe vera has been shown to have a good impact on digestive health (Darabighane *et al*., 2011). Maintaining a healthy gut is critical for optimal food absorption and overall well-being in broilers (Khan *et al*., 2022).

2.4.9 Adding ice to the water that chickens drink

Broilers are sensitive to temperature changes, and too much heat might stress them, reducing their growth, and overall well-being. Cool water with ice or ice-cold water helps broilers keep their body temperature stable and reduces heat stress (Johnson, 2020; Park *et al*., 2015). Furthermore, cold water is generally more enticing to birds, and adding ice to the water to reduce temperature, might encourage them to drink more, keeping them hydrated. Hydrated broilers have higher feed conversion rates, which means they convert feed to body weight more efficiently (Ravindran & Abdollahi, 2021).

2.5 Conceptual Frameworks

The conceptual framework serves as a guide for the study. In this study, the conceptual framework was adopted from the The Department for International Development (DFID) livelihood 2000, as shown in Figure 2.1. The framework consisted of climate change, the impact of climate change on the broilers and the methods that broiler farmers have adopted to ensure that broiler chickens adapt to climate change.

Climate change refers to any change in climate over time, whether due to natural variability or because of human activity (Riedy, 2016). Oke *et al*. (2024) indicated that the change in climate affects the broiler chickens in two different ways, the direct and indirect ways. The direct impacts included heat stress. Environmental temperature and humidity play a role in heat stress, a phenomenon which occurred when the bird's core temperatures increased to fatal levels because of poor heat loss and limited coping means; (Noll, 2018). During cold seasons, lower temperatures consistently showed a higher risk of disease occurrence because this condition stimulated viral activity, while lower minimum temperatures supported virus survival (Wasti *et al*., 2020). Moreover, lower temperatures resulted in poor growth performance and poor meat quality. The indirect impact of climate change included the availability of feeds and prices of the feeds. When the feed is limited, its price tends to increase significantly. Higher temperatures affected the growth of cereal grains which were vital feeds of the broilers, which reduces the quantity and sales of broilers.

As a means for sustainability, farmers have opted to adopt methods to ensure that broiler chickens adapt to climate change. Adaptation is a change in natural or human systems in response to present or expected climatic stimuli or their effects, which mitigates harm or exploits potential benefits (UNFCCC, 2012). Various types of adaptation can be distinguished, including anticipatory and reactive adaptation, private and public adaptation, and autonomous and planned adaptation (McCarthy *et al*., 2001). There are demographic factors that influence farmers to adapt methods that ensure broiler chickens adapt to climate change. Hayes (2021) reflected that demography is the study of a population-based on factors such as age, race, and gender, and it is the socio-economic information expressed statistically, including income and employment.

Smallholder broiler farmers use different methods in adapting to climate change, such as ventilation, biosecurity, housing, brooding, and lightning in the houses. Ventilation is an important consideration for controlling heat and humidity (Saran *et al*., 2020). Kriel (2018) defined biosecurity as the first line of defense in the fight against broiler disease as it entails various measures to prevent birds from getting into contact with disease-carrying organisms. These organisms can be from people, other animals, feed, and even farm equipment. Housing

differs from one farm to the other; its function is to protect broilers from predators and easily control temperatures. The brooding and lighting in the houses provide favorable climatic conditions for the broilers. All this leads to good outcomes, which were reduced mortality rate, increased growth performance, and good meat quality. As such, the farmers continued to benefit from their broilers.

2.6 Conclusion

The literature review reflected that most broiler farmers were males and between the age of 30-49. Moreover, most of them were married. The review reflected that most farmers had tertiary qualification with experience ranging between 1-5 years. Farmers had less than 2 hectors of land. The review also reflected on the impacts of climate change which included mortality disease outbreaks growth performance/ weight sales and quantity and availability of feeds. This impact causes high mortality rates through diseases outbreaks which causes declines in growth performance. Lastly the literature review reflects on the adapted methods by broiler farmers which ensures that broiler chickens adapt to climate change. The methods includes ventilation for reducing heat and aloe vera for medication.

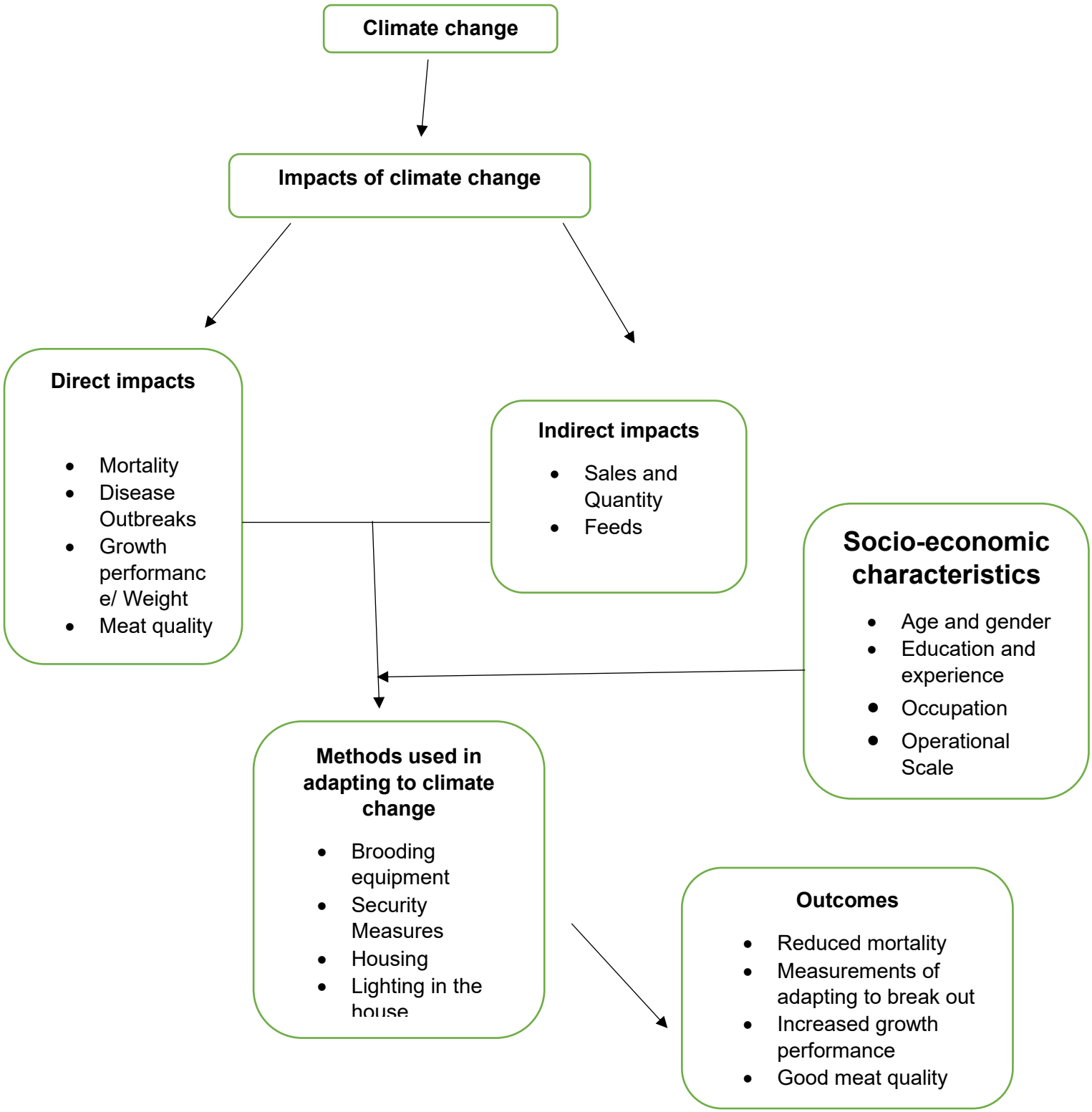


Figure 2.1 Conceptual framework: Source; Adapted from DFID Livelihood (2000)

3. Methodology

3.1 Introduction

In this chapter, the methodology was outlined. Furthermore, a detailed study area was outlined. The research design used in this study together with the population and sampling was explained. A detailed information on the community entry was also outlined. Data collection techniques which include data collection instruments, pre-test; world café method including the data collection method were explained. How the measurement of reliability and validity was conducted has also been detailed. Lastly the data analysis and ethical considerations for this study was also outlined.

3.2 Study area

The study was conducted in Thulamela and Musina Local Municipalities under Vhembe District which is in the Northern part of the Limpopo Province. The Vhembe District shares borders with Capricorn and Mopani Districts in the eastern and western directions, respectively. Thulamela Local Municipality had an estimated population of 497 237 people whereas Musina has an estimated population of 32 009 people (COGTA, 2020). This study focused on 9 service centers namely Tshixwadza, Khumbe, Thohoyandou, Matangari, Tshishivhe, Mapani, Nwanedi, Tshipise and Masia as shown in Figure 3.1. According to the extension officers these service centres have different weather conditions with Tshixwadza being the coldest and Mapani being the hottest. The population size of smallholder broiler farmers in both Thulamela and Musina municipalities was about 350 (DALRRD, 2023). These farmers have ventured in broiler farming to diversify their income streams, because broiler farming can provide an extra economic source for farmers, reducing their reliance on a particular crop or livestock. In 2022, the maximum daily temperature recorded in Thulamela was 37.0˚C and the minimum was 6.9˚C, whereas in Musina they were 40,8˚C and 4.4˚C, respectively (DALRRD, 2023).

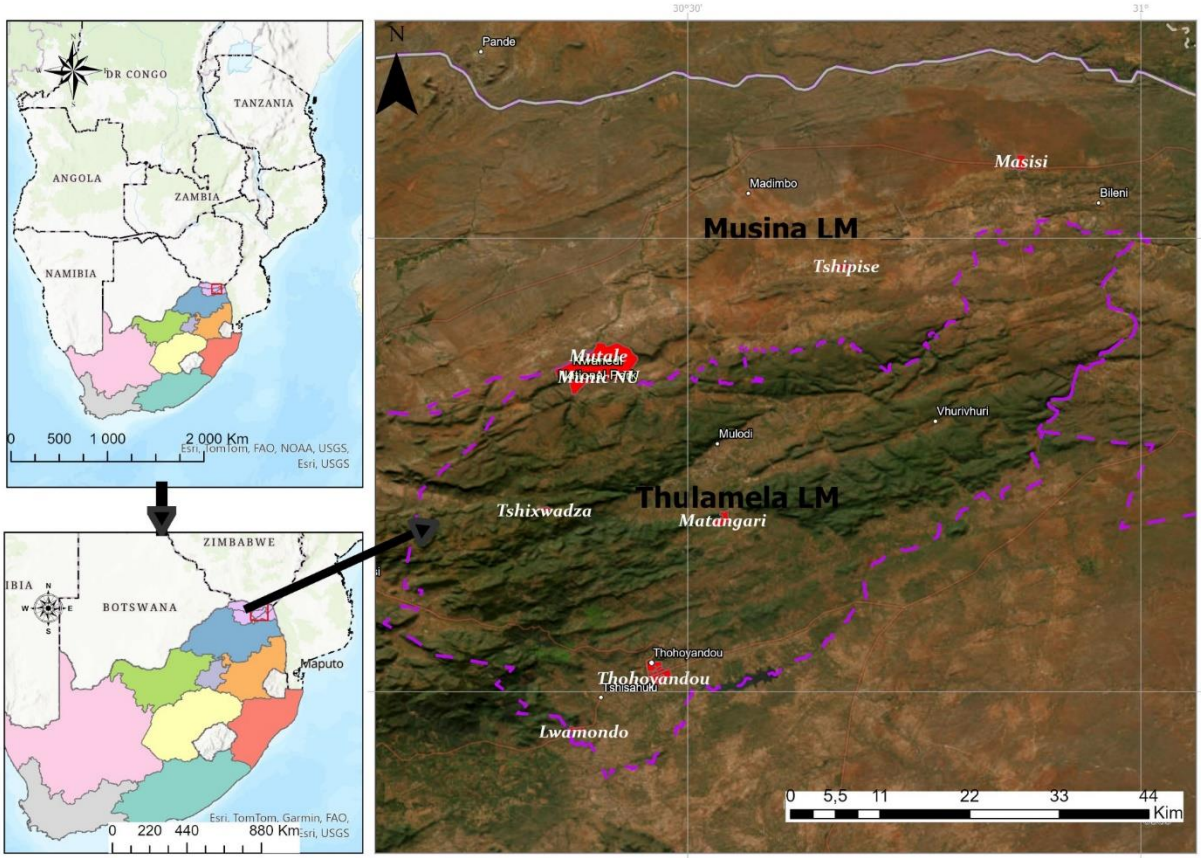


Figure 3.1: Map of Vhembe district showing Service centres in Thulamela and Musina municipalities

3.3 Research design

The mixed research design was used. Shorten & Smith (2017) defined mixed research method as ‘a technique which uses both quantitative and qualitative data within the same study’. ‘Leveraging the potential strengths of both qualitative and quantitative methods, mixed-method research allows researchers to explore different perspectives and relationships that exist between the intricate layers of complex research questions’ (Almeida, 2018). This study was descriptive, because it focused on observing and describing the characteristics or behaviours of an adaptive strategies on climate change. Qualitative research is used by researchers in seeking general meaning and insights in specific situations (Mohajan, 2018). The qualitative data were used in covering some aspects of describing the broiler farmers such as sustainability of the business. Quantitative research design was defined as an organized study of phenomena by collecting numerical data and applying statistical, mathematical, or computational techniques (Mohajan, 2020). The quantitative data collected for objective 1 were age, gender, educational level of the farmers. Quantitative data were also used in objective 2 which covered the Likert scale on the extent to which climate change affects the broiler production. Lastly, quantitative data which was collected on objective 3 which covered the methods adopted by broiler farmers in adapting broiler production to climate change.

3.4 Population and Sampling

The population size of smallholder broiler farmers in Thulamela was about 250 and in Musina was about 100 (DALRRD, 2023). Farmers with a producing capacity of 100-2000 broilers per carrying capacity of the farm and who have been farming for at least six months were purposively targeted. Of the 350 broiler farmers, 124 (available and willing to participate in this study) were interviewed, 57 for Thulamela and 67 for Musina municipalities. Targeting farmers with at least six months of experience ensured they had sufficient information on broiler farming and climate change.

3.5 Community Entry

The first step for community entry was to apply for permission to conduct research at the Department of Agriculture and Rural Development. After the permission was granted (Appendix A), the second step was meeting with the extension officers. The extension officers were met to request assistance with arranging meetings with the farmers. The research study was discussed with the extension officers and its importance in the region explained. The extension officers then assisted in introducing the research team to farmers. A meeting with the farmers was convened, to brief them about the research objectives. Amongst the farmers were traditional leaders and their representatives. During these meetings, the study focus, and

goals were presented to the extension officers, farmers and traditional leaders, with the information sheet provided to support the verbal explanation of the study. The research team sleeked permissions from the traditional leaders to build respectful and better trusting partnerships during the study. The traditional leaders gave us permission to conduct the research with the help of extension officers. The extension officers helped with organising meetings between the researchers and the farmers.

3.6 Data collection techniques

3.6.1 Data collection instrument

The letter of informed consent and questionnaire and (see Appendix B and C) was used to collect information on the description of broiler farmers, perception of farmers on the extent to which climate change affects broiler production and methods adopted by smallholder broiler farmers to ensure that broiler chickens adapt to changes in climate. The questionnaire consists of both open and closed ended questions based on objectives. Objective 1 used open and closed ended type of questions, objective 2 used Likert scale questions and objective 3 used closed ended questions. Open-ended questions empower respondents to share their ideas, opinions, and experiences in their own words. The use of open-ended questions results in richer, and more thorough information than closed-ended questions with predetermined response possibilities (Weller *et al*., 2018).

3.6.2 Pre-test

The questionnaire was pretested to verify the suitability to gather quality and reliable data. The pre-test of the questionnaire assisted in structuring the questionnaire in a simpler and understandable way, thus removing unnecessary questions which were not addressing the objectives of this study. The questionnaire was tested amongst 5 farmers from one of the service centres who were sampled based on their experience on broiler farming. Sampled farmers had more than 5 years of experience in farming and their responses were not used in the study but only to improve on the tool.

3.6.3 World café method

The World café method was applied after pre-test. It allows the participants to share their thoughts, experiences, and perspectives on a given topic (Löhr *et al*., 2020). This has assisted in creating a friendly environment where farmers gave more insight into the problem and solutions freely and discussed were the other factors that the researcher must include in the questionnaire. This has assisted in understanding the complexity of the research problem that was being investigated.

3.6.4 Data collection

Data were collected through face-to-face interviews. Face-to-face interviews enable researchers to acquire extensive and thorough information. In person, researchers may obtain additional information or clarity on ambiguous responses. Face-to-face interviews offer researchers the chance to study participants in their natural environment. The researcher explained the questions to the farmers for easy understanding. A questionnaire was used to collected data, which farmers had to fill in. The data were also collected through observation of the broiler housing, equipment used and feeds. This assisted in giving more insight on broiler production.

Data collected covered the household, farmer's demography, and broilers' production and marketing. Demography data comprised household type, information about the household head, and information about the ownership and financing of the broiler business. The perception of farmers on the impact of climate change on broiler production covered managerial practice, chicken behaviour, growth performance, and marketing implications. Managerial practices comprised housing system type, stocking density, and rearing period. Chicken behaviour covered wellness (tiredness, fainting, and sickness) and water and feed intake. Growth performance covered mortality, growth rate, and body weight. Marketing implications covered sales volumes, prices of chicks, and feeds. The methods adopted by smallholder farmers to ensure that broiler chickens adapt to climate change are indigenous and conventional. The indigenous methods covered local medicinal plants, common household food additives, and managerial interventions (housing and management of in-house environment and birds), and the use of conventional methods covered disease prevention measures and feed quality manipulation.

3.6.5 Measurement of reliability and validity

Reliability of data refers to ‘the consistency, stability, or reproducibility of measurements or observations’ (Gidron, 2013). It represents the degree to which a measurement or test delivers consistent findings when conducted repeatedly under similar settings (Price *et al*., 2015). Internal consistency reliability was used to measure the reliability of data using the Cronbach's alpha. The alpha value was close to 0.7 which shows that the data is acceptable, this reflects that the data in the scale are highly correlated and measure the same underlying construct. Validity of a data refers to how accurately a measurement or test measures what it is supposed to measure (Thompson, 2013). This indicator is an important part of research because it determines whether the data obtained accurately represents the underlying construct of interest. The validity of the data in this study was achieved through data triangulation. Data triangulation is a research strategy that uses many sources or ways to collect information about the same issue (Flick, 2018). The goal of triangulation is to improve the validity and

dependability of research findings by cross-referencing material from several perspectives or sources. Data triangulation was achieved by doing pre-test World café method and statistics from the weather South Africa (weather SA).

3.7 Data analysis

The Statistical Package for the Social Sciences (IBM SPSS) statistics version 29 was used for data analysis (George & Mallery, 2024). Descriptive statistics was used to analyse the socio-economic characteristics of farmers and the extent to which broiler chickens were affected by climate change. Yellapu (2018) states that descriptive statistics are used to summarize data in an organized way by describing the relationships between variables in a sample or population. The calculations are an important first step in data analysis and should always be performed before making inference statistical comparisons (Guetterman, 2019). Descriptive statistics was used to determine frequencies and mean scores of Linkert scale. With relation to the methods which smallholder farmers use to ensure that broiler chickens acclimatize to climate change, descriptive statistics was used to calculate frequencies.

3.8 Ethical consideration

Ethical clearance (FSEA/22/IRD/04/1707; Appendix D) was obtained from the University of Venda Research Ethics Committee. Permission to conduct research was also obtained from the Limpopo Department of Agriculture and Rural Development (Ref: 12R, see Appendix C). The privacy of the respondents was kept, and their rights were observed. Informed consent and voluntary participation were respectively acquired and adhered to, before and during conducting the research. Consent forms were issued, and both respondents and the researcher signed the consent forms before collection of data. Respondents were informed that the data collected would be used for academic processes only. The laws of Protection of Personal Information (POPI) Act were adhered to.

3.9 Conclusion

The study area was described in the chapter together with the research design. The process of selecting the respondents and collecting data were described including matters of validity, reliability, and ethical considerations. The chapter that follows provides information about the description of the smallholder broiler farmers in Thulamela and Musina Local Municipalities.

Chapter 4: Characterizing demographic factors of the broiler farmers in Thulamela and Musina Local Municipalities

Abstract

The aim of the study was to characterize the demographic factors of the broiler farmers in Thulamela and Musina Local Municipalities. Nine service centers namely Tshixwadza, Khumbe, Thohoyandou, Matangari, Shishivhe, Mapani, Nwanedi, Tshipise and Masisi were considered for the study. Out of the 350 broiler farmers in these centres, 124 were purposively selected to represent 57 for Thulamela and 67 for Musina municipalities. Data were collected through face-to-face interviews using open and closed ended questionnaires. IBM SPSS statistics version 29 was used to determining frequencies using Descriptive statistics. It emerged that there are more (52.4%) adult female-headed households. Most respondents were married (54%). When it comes to educational level, most of the household heads (48.4%) had attained secondary education. The farmers who were involved in broiler farming are aged 36-45 (40.3%). With farming experience, many farmers (52.4%) reported 1-5, followed by 10+ years. One of the reasons that influenced farmers (79%) to start broiler farming was unemployment. Most broiler farmers (96%) sell their chickens locally.

4.1 Introduction

Broiler farming is frequently used as a source of income and sustenance for individuals and families. Broiler farming improves social well-being by providing a source of income, alleviating poverty, and promoting communal development (Birhanu *et al.,* 2023). Broiler farming is increasingly practiced in rural areas contributing to rural development (Wong *et al.,* 2017). Demographic factors contribute to determining the level of employment generated and its impact on local communities (Bhorat *et al*., 2015). These factors influence the adoption of new technology and techniques in the broiler farming business (Dhraief *et al*., 2019). Demographic considerations influence farmer decisions about broiler production, marketing, and distribution (Islam *et al*., 2019). These characteristics include market demand, price structures, and market access, all impacting overall market dynamics. The educational background of broiler farmers influences their ability to implement contemporary and sustainable agricultural practices. The demographic factors play a role in climate change and also adoption of methods to adapt to climate change.

Farmers' comprehension of climate change and its consequences can influence their desire to use ecologically beneficial techniques (Asrat & Simane, 2018). Education and awareness programmes for broiler producers can help to establish a more climate-resilient and sustainable chicken industry. The socioeconomic level of broiler farmers can influence their exposure to climate-related concerns. Farmers with fewer resources may have more difficulty

in adapting to changing climate conditions, potentially resulting to increasing economic losses and lower living security (Ogundeji, 2022). To address the issues faced by climate change, broiler farmers may need to invest in new technologies, infrastructure, and management techniques. These adaptation techniques may incur additional expenditures, which could have an impact on farmers' socioeconomic characteristics (Grigorieva *et al*., 2023).

Understanding demographic features enables the development of customized educational and training programs to improve farm management practices. Comprehension of the farmers' financial capacities is critical for determining their capacity to invest in modern agricultural practices, technology, and infrastructure. Classification of the demographic features of broiler farmers can assist policymakers and development agencies in developing measures to improve rural economies. This study aims to characterize the demographic factors of farmers in Thulamela and Local Musina municipalities.

4.2 Methodology

Kindly refer to chapter 3

4.3 Results

4.3.1 Introduction

The result on demography is categorised into three different aspects. Firstly, the demography of the household which includes type of household, marital status, schooling; occupation of the household head is explained. This information reflects on who, within the household, owns and finances the broiler business. Therefore, who makes the decision within the household regarding the broiler business. Secondly, the demography of the farmer which include age, marital status, education, off farm source of income and farming experience. Lastly, the marketing and production of broiler farming which includes the reason behind farmers starting that business, sustainability of the business and the use of the profit earned.

4.3.2 Demography of the household

Table 4.1 presents the demography of the households practicing small-scale broiler production in Thulamela and Musina Local Municipalities. The results show that households involved in small-scale broiler production were either headed by females (52.4%) or by males (46%), and those headed by children were only 1.6%.

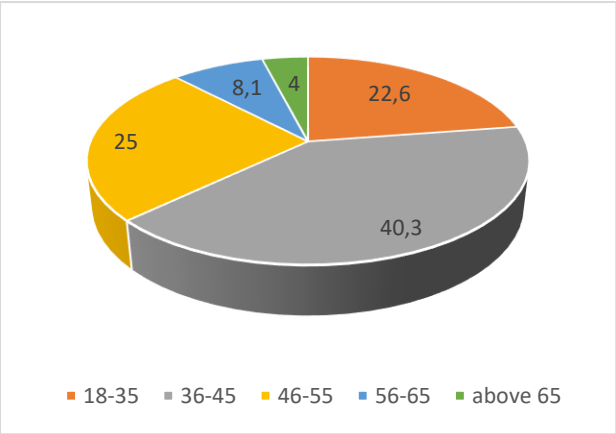
Table 4.1 Demography of the household.

Parameter	Frequency	Percentage
Type of household		
Adult female-headed	65	52.4
Adult male headed	57	46.0
Child-headed	2	1.6
Marital status of the household head		
Single	45	36.3
Married	67	54.0
Widowed	12	9.7
Schooling of household head		
None	7	5.6
Primary	16	12.6
Secondary	60	48.4
Tertiary	39	31.8
Other(specify)	2	1.6
Occupation of household head		
Farmer	89	71.8
None	35	28.2
Who owns the business		
Household head	91	73.4
Wife of the household head	14	11.3
Daughter of the household head	13	10.5
Son of the household head	4	3.2
Sister of the household head	1	0.8
Daughter-in-law of the household head	1	0.8
Who finances the business		
Household head	92	74.2
Wife of the household head	10	8.0
Daughter of the household head	9	7.3
Son of the household head	13	10.5
Off-farm source of income of the household		
None	83	66.9
Nursing	3	2.4
Traditional healer	1	0.8
Chieftaincy	1	0.8
Grant	17	13.8
Business	4	3.2
Pension	3	2.4
Salary	12	9.7

Farmers in female-headed households indicated that they were more independent and took decision regarding broiler production. This was because their husbands worked far away from their homes, which made them less involved in day-to-day household decision making. Regarding marital status, most of the farmers were married (54%) compared to those who were single (36.3%) and widowed (9.7%). When it comes to educational level (Table 4.1), a higher number of the household heads have been to secondary schools (48.4%), followed by those who attended tertiary (31.4%) and 12.9% primary. Most household heads were farmers (71.8%) as compared to the 28.2% who indicated that they were not working. Close to three quarters (73.4%) of the household heads owned the broiler business, followed by their spouses and daughters at 11.3% and 10.5%, respectively). The sons, daughters-in-law and sisters of the household collectively owned less than 5%. Regarding financing of the broiler business (Table 4.1), 74.2% of the household heads did, followed by their sons, the spouses and daughters collectively contributed less than 11%. Other than depending on broiler farming, this study revealed if there were other sources of household income (Table 4.1). It was found that 66.9% of the households depend on broiler farming, whereas 13.7% depend on government grants, 9.7% had salaries, and few (< 4%) relied either on other business ventures or private pension.

4.3.3 Demography of the Farmer

We found that 79.9% of the farmers were female compared to 21% who were male. The most common occupation of the farmers was farming (83.1%), followed by others at 16.9%, which comprised taxi driving, nursing, and even teaching. The results, in Figure 4.1, show that broiler farmers aged 36-45 were dominant (40.3%), followed by those aged 46-55 (25%) and 18-35 (22.6), and the least were those aged 56-65 (8.1%) and aged 65 (4%). Farmers aged 36-45 indicated that they are into broiler farming because they had younger children to feed and those aged 46-55 indicated that they were involved in catering for the needs of their households. Out of 124 farmers, 46% have been married compared 44.4% who are not and 9.7% who were widowed (Figure 4.2). Close to half (46.3%) of the farmers had tertiary qualifications, followed by 37.9% who have been to secondary schooling, and less than 10% of farmer had stopped at primary, never been to school, and others attended levels and abet (Figure 4.3). Results reflected that 72.6% of farmers did not have any off-farm income source (Figure 4.4), whereas 11.3% depend on the salaries, followed by 10.5% who depended on grants, with the least being those who depended on business (3.2%) and pension (2.4%). Regarding farming experience (Figure 4.5), those who had been farming for 1-5 years were dominant (52.4%), followed by those with 10+ years (25%) and 6-9 years (16.9%), and the least being those who had <1 year at 5.6%.



Figer 4.1: Age of the farmer

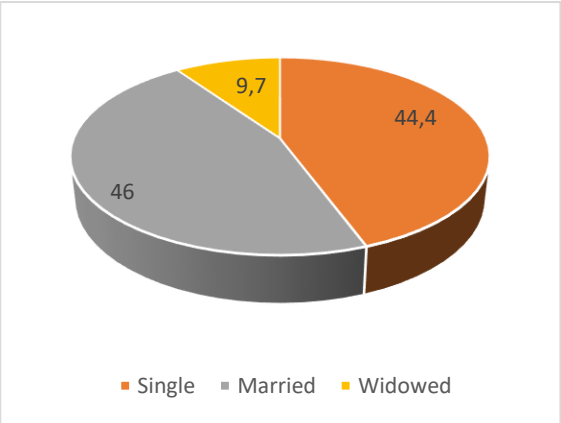
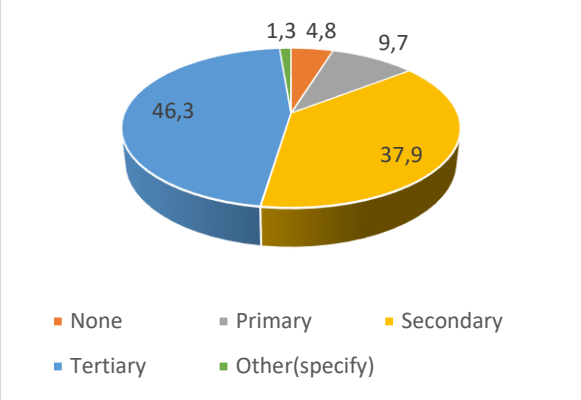


Figure: 4.2 marital status of a farmer



Figer 4.3: Education level

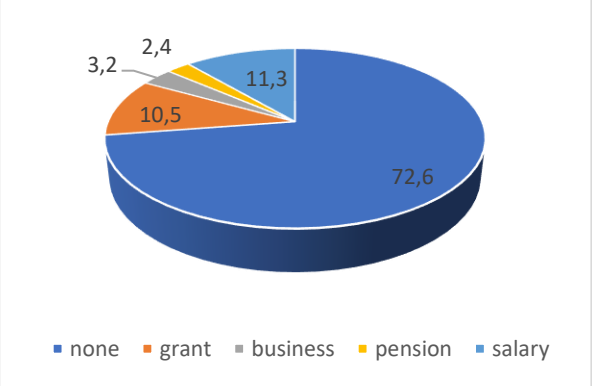
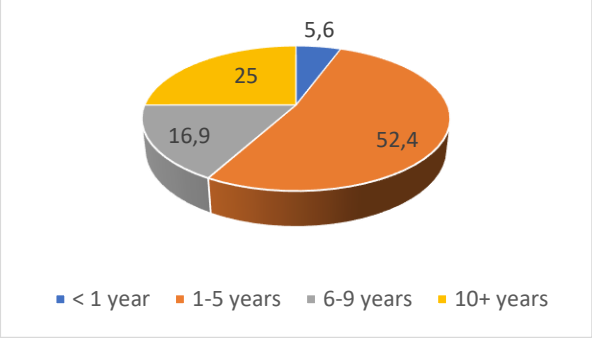


Figure: 4.4 Off-farm source of income



4.5: Farming experience of a farmer

4.3.4 Demography on the Production of Broiler Farming

Table 4.2: Demography on production of broiler farming

The results in Table 4.2 reflect that most broiler farmers (96%) sell their chickens locally. They do not have a market where they supply; rather, they depend on local people for support. Some farmers (4%) supply their chickens to Zimbabwe, where people from Zimbabwe, mostly Beitbridge, come to South Africa to purchase food. The peak selling period for both municipalities is summer at 75% due to the festive season. Some farmers (16,9%), keep the same stock over the season; this means their peak selling point will be the same. One of the reasons that influenced farmers to start broiler farming was unemployment (79%), while others (12.1%) wanted to increase income due to the expensive maintenance of homes because they were breadwinners. About 8.1% say there was a need for more supply in the company. They decided to sell broilers whereas only 8% is farming because of taking farming as a hobby. Farmers sustain the business differently by reinvesting the profit at 51.6%, which is the highest, followed by taking a loan at 30.6%. Most of the farmers (68.5%), spend their profit on household financial commitments such as taking children to school and buying food. At least 17% of the farmers reinvest in the business, and 14.5% of the farmers save money.

Table 4.2: Production and marketing of broilers

Parameter	Frequencies	Percentage
The reason behind starting a broiler business		
Unemployment	98	79.0
No supply in the community	10	8.1
To increase income	15	12.1
Hobby	1	0.8
Sustainability of the business		
Loan	38	30.6
By using income	64	51.6
Request assistance from the household	5	4.0
Use money from the salary	7	5.6
Ask for assistance from the children	1	0.8
By using grant	5	4.0
Free supply of chickens	2	1.6
Reduce the number of boxes	2	1.6
What do you spend your profit on?		
Save	18	14.5
Reinvest in business	21	17.0
Spend on household duties	85	68.5

4.4 Discussion

4.4.1 Demography of the household

The results in Table 4.1 show that adult-headed households (98.4%) were more dominant than child-headed households (1,6%). The results concur with the study done by Gunya *et al*. (2020), who showed that in the Eastern Cape, most of the households were adult-headed. *Household headed by adults have an advantage that children can perform their societal roles like attending school and participating in sports. The* results show that most household heads are married (54%). This is also like the study done by (Onyeneke *et al.,* 2020) who reflected that most of the household heads in Nigeria are married. Higher number of the household heads obtained secondary (48,4%) and tertiary (31.8%) education compared to the other educational levels. This shows that most of the household heads could read and write, attributes which are key in farming and living. These results concur with the findings of Sebatta *et al.* (2018), who showed that most of the household heads in Uganda had a secondary level of education. Most people in South Africa have secondary education (exiting at Grade 12) because it is offered for free up to this level in government school and in some instances, learners are provided with meals The results showed that most household heads (71.8%) relied on broiler farming. These findings concur with those of Bannor *et al*. (2023), who showed that in Ghana, 79.78% relied on poultry farming such as broiler farming, as a source of income. The results also reflected that the household heads owned 73.4% of the broiler farming and they also financed most (74.2%) of these businesses. These findings concur with the findings of (Hailemichael *et al.,* 2017) who reflected that most poultry in Ethiopia is being owned by the household head. This is mainly because the household heads are the one who are responsible for maintaining the household. Household heads typically have more expertise or knowledge in agricultural or animal husbandry, which can be useful in conducting a successful broiler farming enterprise. This experience may involve understanding market dynamics, managing risks, and dealing with agricultural practices. This study revealed that most of the households (66.0%) do not have any off-farm source of income. This is because most of these households are in rural locations where off-farm job opportunities are. Diverse job prospects exist in location proximity to urban centres, hence rural locations can be a barrier for farmers to get off-farm employment (Sengupta & Guchhait, 2023).

4.4.2 Demography of the farmer

The results showed that the farmers who were mostly involved in broilers were within the age range of 36-45 years, followed by 46-55 years. The study concurs with the findings of Olorunwa (2018), who reflected that the age group mostly involved in broiler farming was individuals between the ages of 30 to 49, followed by 50 to 59 of age. Most of the broiler

farmers within these age ranges were independent and household heads. Farmers have indicated that over the years they have gained skills, knowledge, and competence, this allows them to oversee broiler farming operations successfully which contribute to attaining a certain amount of financial security in their lives. The financial stability of farmers aged 30-59 years guarantees the funds needed to invest in broiler farming, which frequently necessitates upfront infrastructure, equipment, and starting stock costs (Turley & Uzsoki, 2018). The study findings do not agree with the findings of Ali *et al*. (2015), who showed that farmers aged 26-39 years were more involved in broiler farming than other age ranges. The reason behind the difference in the two study could be because Ali *et al*., 2015 indicated that most of the broiler farmers in Bangladesh had primary education as their highest qualification, which reflects that most farmers drop out at an early age and had to find work. The results show that the gender primarily involved in farming is female (79.9%) compared to males (21.1%). These findings do not concur with those of James *et al*. (2021) and Olorunwa (2018), who showed that the males in Nigeria were the ones primarily involved in broiler farming compared to females. One of the reasons that could contribute to females being dominant is males had opportunities for do salaried work elsewhere, which if not there they could have been involved in broiler farming.

Even though most of the household is being headed by female, the study also showed that most farmers were married. The findings are like those of James *et al*. (2021) who showed that most of the farmers were married and involved in broiler farming because of their responsibilities. Married couples in rural settings may engage in broiler farming to supplement their income and help the local economy. The results also showed that most of the farmers relied on broiler farming because they did not have off-farm sources of income. This is contrary with the findings of (Ogueri *et al*., 2018) who reflected that farmer based in Imo State, have off farm source of income even though is low. With regards to the level of education, most farmers (about 83%) in the study areas had higher education (tertiary and secondary), which gave them easy access to more information about broiler farming. The results revealed that 52,4% of broiler farmers had 1-5 years of experience. This is different from the results obtained by Suleiman *et al*. (2018), who reflected that most farmers had 6-10 years of farming experience in Nigeria.

4.4.3 Production and marketing of broilers

The study results reflected that most broiler farmers (79) were unemployed. STATS SA (2023) has reflected that the official unemployment rate was 31.9% in the third quarter of 2023. Satapathy *et al*. (2017) have reflected that broiler farming can be financially beneficial because it has a comparatively short production cycle. Balamurugan & Manoharan (2013) has reflected that broiler business was one of the profitable agro-industries that can successfully address

unemployment issues in rural regions, particularly among marginal and smallholders farmers. The results show that most smallholder broiler farmers sustain their business by using their income, a practice which allowed them to increase the number of birds during summer. This is supported by (Sugiarto *et al.*, 2021) who indicate that the farmers with low money flow affects their business run which leads their business into collapsing. Furthermore, the results reflect that farmers use the profit for household duties such as packing food and taking the children to school. This finding concurs with the findings of (MacDonald, 2014) who reflected that most of the broiler farmers in the United States depend on profit of the farm on mortgage payments and other expenditures within the household.

4.5 Conclusion

It can be concluded that broiler farming in Thulamela and Musina local municipalities is dominated by female farmers. Furthermore, most of the households are being headed by adults as compared to the youth. The results from the study also reflected that more farmers are married, and they have obtained tertiary qualifications. The results reflected more farmers are unemployed that's why they ventured in broiler farming, and they use their profit for household duties. Moreover, future studies might investigate the cost of production of the broiler business within the Thulamela and Musina local municipalities.

Chapter 5: Perception of smallholder farmers on the extent to which climate change affects broiler chickens

Abstract

Climate change has the potential to disrupt crop output and alter the availability and pricing of broiler feed ingredients. Droughts and floods are examples of extreme weather occurrences that can impair the production of vital feed crops like maize and soybean. The aim of the study what to determine the extent to which broiler production is affected by climate change. The study was conducted at Thulamela and Musina Local Municipalities in nine different service centers namely Tshixwadza, Khumbe, Thohoyandou, Matangari, Shishivhe, Mapani, Nwanedi, Tshipise and Masisi. Out of the 350 broiler farmers, 124 were randomly and purposively selected to represent 57 for Thulamela and 67 for Musina municipalities. Data were collected through face-to-face interviews using closed ended questionnaires. IBM SPSS statistics version 29 was used to determine frequencies and means scores using Descriptive analysis. The result from the study shows that during summer season 60.5% farmers observed that broiler chickens are always tired with no energy. Farmers (78.2%) perceived that there is high water intake in summer as compared to winter. In winter farmers (58.9%) have indicated that they reduce stocking density due to slow growth rate and they keep broilers for too long. As a results of climate change farmers (84.7%) have observed that there is increase in prices of feeds due to low availability of grains. In Thulamela and Musina municipalities, farmers are affected by climate change differently with more focus on heat stress and cold stress. Further research is needed which will also check the perception of climate change on broilers on other aspects such varying weather patterns.

5.1 Introduction

Broiler farming generates employment prospects in the local community. Broiler farming provides a valuable source of revenue for smallholder farmers, and it is also a consistent source of income, allowing these farmers to sustain their families and improve their financial situation. Broilers have a much shorter growth cycle than other types of livestock species. They can be ready for market in a few weeks, allowing smallholders to quickly generate profits on their investment (Ramukhithi *et al.,* 2023). Broiler farming requires less land and space. Smallholders can set up broiler units in relatively small spaces, making them ideal for persons with little finances (Bounds & Zinyemba, 2018). Starting a broiler farm often requires less upfront capital than other types of farming. This makes it more accessible to people with limited financial means. There is continuous and increasing demand for poultry goods, including broiler meat (Nkukwana, 2018). Smallholders can capitalize on this demand and create a consistent product market. Even though the demand for broilers is increasing significantly, certain setbacks are holding the production to increase. One of the setbacks is climate change

Climate change refers to long-term shifts in the average weather patterns that define the earth's climate (Abbass *et al*., 2022). It includes changes in temperature, precipitation, wind patterns, and other climate variables. Rising temperatures and the increased frequency of heat waves can cause heat stress in broilers (Lara & Rostagno, 2013). Poultry is especially susceptible to high temperatures, and extended exposure can result in lower feed intake, slower development rates, and more significant mortality (Oluwagbenga & Fraley, 2023). Temperature variations, precipitation patterns, and extreme weather events can all impact agricultural yields and quality (Skendžić *et al.,* 2021). This, in turn, may impact feed pricing and composition, possibly changing broilers' feed efficiency and growth rates. Climate change can potentially influence the spread and prevalence of poultry illnesses. Temperature and humidity variations can produce favourable conditions for the multiplication of some infections, resulting in elevated illness risks. Smallholder broiler farmers experience this impact on different levels depending on their location.

This study was conducted to gain insight into the perception of smallholder farmers on the extent to which climate change affects broiler production. It is important to study the extent to which climate change affects broiler production in Thulamela and Musina Local Municipalities and their insight will then assist in determining which adaptive methods they use.

5.2 Methodology

Kindly refer to Chapter 3

5.3 Results

5.3.1 Introduction

The results below reflect on the perceptions of farmers on the impact of climate change on broiler farming. The perceptions of the farmers were focusing mostly on summer and winter impacts. The mean score which ranks the perceptions of farmers have also been presented.

5.3.2 Perception of farmers on the impact of climate change on broilers farming

The results in Table 5.1 show farmers' perceptions of the impact of climate change on broiler farming. Changes in the housing system, increased water intake, and decreased summer sales were climate change's impacts on broilers perceived to be more critical by the farmers because they had mean scores of 2.63, 2.54, and 2.39, respectively. Another impact of climate change (covering management practices, chicken behaviour, and performance and marketing implications was perceived to be less critical because they had a mean score range of 3.23-4.73.

Table 5.1 Perception of farmers on the impact of climate change on broilers farming

Perception of farmers on the impact of climate change on broiler chickens	Strongly disagree	disagree	neutral	agree	Strongly agree	Mean scores
Changing the housing system in summer	54.0	2.4	0.8	12.1	30.7	2.63
Tiredness in summer with no energy	16.9	4.8	10.5	7.3	60.5	4.14
Increased water intake in summer	5.6	3.2	4.8	8.1	78.2	4.50
Fainting of broilers during summer	12.9	4.0	9.7	6.5	66.9	4.10
High mortality rate in summer	8.1	6.5	11.3	8.1	66.1	4.18
Reduced stocking density	21.8	2.4	6.5	10.5	58.9	3.82
Increased feed intake in winter	16.9	4.8	21.0	16.1	41.1	3.60
Increased water intake in winter	42.7	12.9	12.9	8.9	21.8	2.54
High mortality rate in winter	32.3	5.6	11.3	8.1	42.11	3.23
Keeping your broilers for long period of time	13.7	4.8	12.1	3.2	66.1	4.03
Increases disease outbreaks in winter	16.9	3.2	4.8	5.6	69.4	4.07
Slow growth rate in winter	5.6	1.6	7.3	4.8	80.6	4.53
Reduced body weights in winter	8.1	4.0	4.0	3.2	80.6	4.44
Decreased in sales volume in winter	23.4	7.3	14.5	7.3	47.6	3.48
Decreased in sales volume in summer	51.6	6.5	13.7	8.1	20.2	2.39
Increase in feed prices	1.6	0.8	4.8	8.1	84.7	4.73
Increase in chicks prices per box	4.0	1.6	1.6	5.6	87.1	4.70

Moreover, 69.4% of farmers strongly agree that disease outbreaks increase in winter; however, 16.9% strongly disagree. With the impact of climate change on broilers, 66.1% of farmers strongly agree that broilers are kept for a long period of time during winter, and 58.9% of farmers strongly agree that stocking densities are reduce. Due to the indirect impact of climate change on broilers, 84.7% of farmers strongly agree that the prices of feeds have increased, and whereas those with other perceptions were < 2% for each categories. Furthermore, the farmers (87.1%) strongly agree that the price per box of chicks has increased. With this impact, farmers (47.6%) strongly agree that there is a decrease in sale volume during winter and 23.4% of farmers strongly disagree. Furthermore, farmers (51.6%) strongly disagree that there is a decrease in sales volume in summer, whereas 20.2% of farmers strongly agree.

The farmers perceived impacts of climate change explained above differently, and the importance of their perceptions as denoted by the mean scores are explained in this section. According to the mean score (Table 5.1), decreased in sales volume in summer ($\bar{x}$=2.39), water intake in winter ($\bar{x}$=2.54) and changing the housing system ($\bar{x}$=2.63) were important. Whereas the least important perceived impacts of climate change ($\bar{x}$ range of 4.50-4.73) were increased water intake in summer, slow growth rate in winter, increase in feed prices, and increase in chicks' prices per box.

5.4 Discussion

High temperatures in the summer can have an impact on the health of broiler chickens (Wasti *et al*., 2020). Farmers may need to implement methods to control the temperature within the chicken houses, such as ensuring proper ventilation, employing cooling equipment, and modifying stocking densities to avoid heat stress. The farmers (56.4%) perceived that housing systems do not change during summer. Rather, curtains on side walls should be opened. Most of the broiler farmers use an open housing system in which, during high temperatures, they just open the curtains. Farmers (60.5%) perceived that broiler chickens are always tired and have no energy in summer. Similar observations were made by Sesay (2022), who indicated that during summer heat stress reduces feed intake, which leads to reduced feed efficiency which results in broilers not having energy. As such, farmers (66.9%) were of the view that the heat stress caused by rising temperatures causes broilers to faint due to climate change.

Farmers have indicated that when the temperature is high, the broilers spend more time drinking water and panting to reduce body temperature, thus leading to the broiler not having enough energy and always tired. Onagbesan *et al.* (2023) has indicated that heat stress can reduce the feeding process, nutrient absorption, and utilization even though water intake has

increased. This also concurs with the findings of the study that during summer, farmers (78.2%) perceived that broiler chickens tend to drink more water than in summer due to heat stress caused by climate change. Ochuko *et al*. (2021) have indicated that an increased environmental temperature causes water intake in broilers to increase. Aviagen (2019) has specified that birds frequently drink more water to cool down when they get too hot. Furthermore, continuous periods of elevated water intake may be a sign of heat stress, which has been shown to decrease intestinal integrity, which results in 70-80% of water being excreted or removed as moisture.

The results showed that 66.1% of farmers perceived that they face a high mortality rate during summer seasons. A study done Vieira *et al*. (2011) showed that chickens are inefficient heat dissipators, and ambient temperatures that exceed their comfort zone can cause physiological and metabolic abnormalities. Severe heat stress can cause organ failure and death. Hot weather increases birds' water consumption, and insufficient water supply or poor water quality can cause dehydration, leading to death (Conradie *et al.,* 2020). Dehydrated birds are more prone to stress-related health problems, including organ failure (Janssen *et al*., 2020). At least 57.2% of farmers perceived that there is an increase in feed intake during winter. The findings are different from those done by Qureshi *et al*. (2018), who found that cold-stressed broilers frequently show a decrease in feed consumption. The differences could be because of the study areas where the research was conducted because in areas such as Masisi and Musina during winter the temperature are within the optimum required growth temperature for the broilers which could make broilers to eat more. Reduced feed intake can result in slower growth rates and reduced body weight Wei *et al*. (2018). Even though there is increased feed intake, farmers have perceived that there is a slow growth rate in winter as compared to summer. This is caused by broilers' metabolic rates rising at cold temperatures as they struggle to generate more heat to keep their body temperature stable. The study findings concur with the findings of Esmail (2020), who reported that cold lower enzyme levels, resulting in less efficient feed digestion and utilization for growth and other physiological processes, resulting in poor broiler growth.

The study shows that 42.7% of farmers reflected that during winter, there is a decrease in water intake. Cold stress frequently leads to a decrease in feed intake in broilers. Because water intake is strongly linked to feed intake, reducing feed consumption may result in lower water intake (El Sabry *et al*., 2023). Broilers may consume less in chilly temperatures because they require more energy to maintain their body temperature. Broilers may prefer warmer water while under cold stress (Talebi *et al*., 2022). Providing slightly warmer water can encourage birds to drink more, allowing them to stay hydrated and potentially reducing the detrimental consequences of cold stress (Huang *et al*., 2023). Results showed that farmers

(42.11%) have perceived that during winter seasons, there is also a high mortality rate. Exposure to low temperatures can cause cold stress in broilers. Cold stress can cause reduced feed intake, slower growth, a weaker immune system, and an increased susceptibility to illnesses. Severe cold stress can potentially cause hypothermia and death. Cold stress can damage the immune system, leaving broilers more vulnerable to infectious infections. In crowded and stressful environments, infections can spread quickly, increasing mortality.

Respiratory infections are a common winter ailment. Specific disease vectors, such as mites, lice, and rodents, may increase in prevalence during the winter and summer season. These vectors can function as carriers of infections, contributing to disease transmission among the flock (Mojahed *et al*., 2022). As such, results showed that 69.4% of farmers have indicated that there are increased disease outbreaks during the winter season such as avian influenza. The observation by farmers concurs with the findings of Liu *et al*. (2022), who demonstrated that cold stress could reduce birds' ability to resist viruses, making them more susceptible to sickness. Due to cold stress, broilers pile close together throughout the winter to conserve heat, resulting in overcrowded situations. Gomes *et al*. (2014) has observed that overcrowding can cause stress in the birds and accelerate the spread of diseases within the flock. Stress affects the immune system and may lead to behavioural disorders, such as cannibalism or feather pecking, allowing disease to spread. Due to this impact of climate change, 58.9% of farmers have indicated that they reduce their stocking density during winter. The farmers reduce their stocking density because there is a slow growth rate in broilers, and this prolongs the growth rate. Most of the farmers, 66.1%, have indicated that they keep broilers for long periods of time due to poor growth rates. The farmers (84.7%) have indicated that broilers' feed prices are increasing yearly due to shortage of ingredients caused by low rainfall. Climate change affects the availability of grains used to make feeds. Climate change can alter the ideal locations for cultivating specific crops (EPA, 2017). This may cause adjustments in the locations where feed crops are usually grown, affecting the logistics and costs of acquiring these nutrients (Neupane *et al*., 2022).

Climate change may alter the nutritional profile of feed crops, affecting their suitability for use in broiler feeds (Babinszky *et al*., 2011). Feed compositions may need to be adjusted to meet the nutritional needs of broilers. Farmers (87.1%) have also indicated that the prices of chicks per box have increased significantly. Rising temperatures and heat waves can have an impact on hatchery efficiency (Maulu *et al.,* 2021). Maintaining ideal circumstances for egg incubation is critical, and excessive heat might impair hatch rates. To address these difficulties, hatcheries may need to invest in climate control technologies, thereby raising operational expenses and, as a result, chick prices (Hafez & Attia, 2020). Hence, farmers perceived that climate change contribute to higher prices for chick.

Climate change can impact the occurrence and distribution of poultry-related diseases. Disease outbreaks can raise chick mortality rates, affecting hatcheries' production costs. To avoid these risks, hatcheries may need to invest in disease-preventive measures, which could result in increased prices of chicks per box. Furthermore, 47.6% of farmers have revealed that the sales volume in winter decreases significantly. This is mainly caused by the slow growth rate, which makes the farmers keep broilers for extended periods of time, resulting in more feeds being used. Also, 51.6% of farmers have reflected that sales volumes remain relatively high during summer because in Thulamela and Musina Local Municipalities, the festive seasons are in summer, making the customers need more broilers. Even though the sales volumes increase, farmers are affected by heat stress caused by rising temperatures, resulting in a higher mortality rate.

5.5 Conclusion

The results in the study reflected that farmers perceive decreased in sales volume in summer, water intake in winter and changing the housing system as more important. Furthermore, farmers perceived cold and heat stress as the main factors that affects broiler chickens. With regards to indirect impact of climate change on broilers farmers perceive cost of feeds as more important because feeds are continuously increasing. Future studies may need to investigate the perception of farmers on other climate variations such as humidity on its impact on broilers

Chapter 6: Methods adopted by smallholder broiler farmers to adapt broiler production to climate change in Thulamela and Musina Local Municipality

Abstract

The aim of the study was to investigate methods adopted by smallholder broiler farmers to adapt broiler production to climate change in Thulamela and Musina Local Municipalities. For this study, 124 small-scale broiler farmers were purposively selected (those farming with less than 2000 broilers per cycle) to represent 57 for Thulamela and 67 for Musina municipalities. Data were collected through face-to-face interviews using open and closed ended questions. IBM SPSS statistics version 29 was used to determining frequencies using Descriptive statistics. The results reflect that about 49.2% of the farmers uses indigenous methods to adapt broilers to climate change. These methods include *Aloe vera*, Munzere (*Bridelia micrantha*) and cayenne paper added in drinking water of broilers for medicinal purpose. Open sided houses were used by 98.2% of farmers as a measure of ventilation during heat stress seasons, because cooling systems are expensive and loadshedding is persistent uses. About 48.4% of the farmers add ice on water to cool down broilers during heat stress. The farmers have adopted mostly indigenous methods in adapting to climate due to expensive conventional methods which reduces their profits. There is a need for investigating the effectiveness of the observed indigenous methods as most of them have not been researched.

6.1 Introduction

Driven by consumer enthusiasm for poultry-based products, broiler and layer chicken production has significantly increased due to investments made by the private and public sectors (Alloui & Ammar, 2012). Broiler farming is one of the fastest-growing businesses in rural areas, which plays a fundamental role in reducing unemployment (Satapathy *et al*., 2017). In rural areas, people are getting involved in poultry farming because of its short cycle and because it produces high-quality protein (Goel, 2021). Even though poultry is beneficial in rural communities it is being affected by climate change.

Wu *et al.* (2014) defined climate change as the continuous change of climatic parameters due to the structure of atmospheric gases. Furthermore climatic factors around the earth, such as temperature, humidity, solar radiation, and precipitation, change over time, resulting in climate change) Climate is one of the main problems affecting agriculture, especially poultry farming (Alade & Ademola, 2013). Poultry production performance levels depend highly on genetic makeup and environmental conditions (Nkukwana, 2018). Heat stress, one of the main factors affecting poultry production, directly results from climate change, leading to significant damage

to the poultry industry. The higher temperatures reduce feed intake, resulting in poor growth performance in broilers. As the temperature increases, chickens continuously stop feeding and drink water to regulate their body temperature (Erensoy *et al*., 2020). Moreover, when the temperature increases above 34 °C, the mortality rate of the chickens increases significantly

This impact of climate change on broilers affects the overall productivity. The production costs have increased due to climate which affects the livelihood of smallholder broiler farmers. As such farmers have adopted various methods which assist broilers in adapting to climate change. This study aims at investigating the methods that the smallholder broiler farmers have adopted in adapting broiler chickens to climate change.

6.2 Methodology

Kindly refer to chapter 3

6.3 Results

6.3.1 Introduction

The results below reflect the methods that smallholder broiler farmers have adopted in adapting broiler production to climate change. Methods where characterised into two aspects, which are indigenous methods and conventional methods. The indigenous methods include Aloe vera, Munzere (*Bridelia micrantha*), salt and sugar, dipping chickens in water, open sided housing, adding ice to the water that chickens drink, adding ice around the house and woodfire inside the house. The conventional methods include vaccination of birds, low stocking density, use of adapted breed, use of high protein feed in summer and use of high carbohydrate feed in winter.

6.3.2 Methods adopted by smallholder broiler farmers

The results in Table 6.1 show that farmers (49,2%) have developed strategies for adapting broiler production to climate change, which includes Aloe vera, Munzere (*Bridelia micrantha*), salt and sugar, dipping chickens in water as a measure of cooling the broilers, with the cooling system being expensive. Of these farmers, 98.4% prefer to use open-sided housing as ventilation compared to the cooling system. Broilers do not have sweat glands; as such, 48.4% of farmers prefer to add ice to the water to assist the broiler chickens in cooling off their temperatures. Furthermore, 28.2% of farmers places ice around the house so that they can reduce the temperature. Farmers indicated that they put water in refrigerators using 2-litre bottle to have it frozen for placing around broiler houses. Most farmers (79.8%) rely on wood fires to induce heat during winter. To controlling disease outbreaks, 91.9% farmers prefer the vaccination of birds. During winter seasons, 66.1% farmers prefer to reduce stocking density,

and only 20.2% farmers rely on adapted broiler strains. About 40.3% of the farmers have adopted the use of high protein feeds in summer because it reduces the quantities to be consumed to satisfy the nutrient requirements. Farmers who adopted this method indicated that it reduces the risk of broilers fainting. High carbohydrates feeds were adopted by 51.6% of the farmers in winter because carbohydrates provide high energy which is converted to heat in broilers.

Table 6.1: Methods adopted by smallholder broiler farmers to adapt production to climate change

		Yes		No		
Methods	Application of methods	Frequencies (n=124)	Proportion (%)	Frequencies (n=124)	Proportion (%)	Purpose of adoption
Indigenous methods						
Aloe vera	Pieces of fresh material are added into drinking water	61	49.2	63	50,8	Medication
Munzere (*Bridelia micrantha*)	Grounded powder is added into drinking water	1	0.8	123	99.2	Medication
Salt and sugar	Added as is in drinking water	5	4.16	119	95.83	Reduce stress
Dipping chickens in water	Manual dipping of chickens in bucket of water	20	16.12	104	83.87	Cool down broilers
Use of open sided housing	Curtains are used to control ventilation	122	98,4	2	1,6	Ventilation
Adding ice to water	Ice is added to the water that chickens drink	60	48,4	64	51,6	Cool down broilers
Placing ice around the house	Ice in 2 litre bottles are placed around the house	35	28,2	89	71,8	Reduce heat in the house
Brooding using firewood	Woods are burnt to provide heat	99	79,8	25	20,2	Increasing heat in the house
Conventional methods						
Vaccination of birds	Birds are vaccinated to prevent common diseases	114	91,9	10	8,1	Prevention of diseases
Use of adapted broiler strains	Farming with chickens likely to survive prevailing conditions	25	20,2	99	79,8	Adaptation
Use of high protein feed in summer	High protein feeds are given to chickens	50	40,3	74	59,7	Reduce fats
Use of high carbohydrate feed in winter	High energy feeds are given to chickens	64	51,6	60	48,4	Increase heat from broilers

6.4 Discussion

6.4.1 Indigenous methods adopted by smallholder broiler farmers

6.4.1.1 Application of Aloe vera as medicine for broilers

Aloe vera is the most used indigenous method in broiler farming. About 49.2% of the farmers used *Aloe vera* for medication. Lacetera (2018) has indicated that climate change causes a change in temperature, humidity, and precipitation patterns, which can influence the spread of pathogens that affect broilers. As such the application of Aloe vera assist in controlling the infection. Climate change may have an impact on the distribution and prevalence of poultry-related diseases. Higher temperatures and changed patterns of rainfall can promote the spread of some infections, potentially resulting in disease outbreaks on broiler farms. As such farmers use Aloe vera as a measure for disease control (Amber *et al*., 2020; Quaye *et al*. (2023) has indicated that *Aloe vera* have immunomodulatory effects, meaning it may help regulate or aid the immune system; this results in improved resistance to certain diseases. *Aloe vera* can help reduce discomfort and speed up the healing process for small wounds. Compounds found in *Aloe vera* have anti-inflammatory qualities (Sánchez *et al*., 2020). When the chickens experience irritation or inflammation, like respiratory problems, adding *Aloe vera* to their food or water can help reduce the symptoms (Shokraneh *et al*., 2016). *Aloe vera* is largely composed of water, and providing hydration is crucial for overall poultry health; adding *Aloe vera* to water helps maintain hydration levels, especially during periods of stress (Baruah *et al*., 2016).

6.4.1.2 The use of Munzere (*Bridelia micrantha*) as medicine for broilers

Farmers have indicated that they use *Bridelia micrantha* for medication purposes for broilers when they are sick. Even though there is not enough information on the use *of Bridelia micrantha* in broilers, Maroyi, (2017) found that extracts from *Bridelia micrantha* contains anti-inflammatory and analgesic (pain-relieving) effects. These effects may be due to the presence of bioactive substances such alkaloids and flavonoids. *Bridelia micrantha* extracts were observed to demonstrated antibacterial and antifungal activity. This suggests a possible function in treating bacterial and fungal illnesses (Adefuye & Ndip, 2013). *Bridelia micrantha* is traditionally used to cure wounds (Asumang *et al*., 2021). Some researchers have looked at its wound-healing abilities, which may be related to its anti-inflammatory and antibacterial characteristics (Lin *et al*., 2002). The plant includes antioxidants, which may help counteract oxidative stress and improve general health (Kevin *et al*., 2023).

6.4.1.3 Addition of salt (sodium chloride) and sugar to mitigation broiler stress

As a way of mitigating stress some farmers mixed water with salt and sugar to reduce stress in broilers. Sugar can deliver a sudden burst of energy. Broilers may have higher energy demands during stressful periods or environmental changes. The study findings concur with

the findings of Al-Enzy *et al*. (2020) who reflected that the addition of salt in water causes increase in body weight, weight gain, feed consumption, and a significant decreased in the mortality percentage. Rising temperatures caused by climate change can result in more frequent and severe heat stress incidents. Heat stress cause by climate change can cause excessive panting and increased water consumption, leading to electrolyte imbalances, especially sodium and potassium (Noll, 2022). As such the addition of salt is necessary because it assist in maintaining electrolyte balance in the body, and it can aid with stress management (Gamba *et al*., 2015). Adeyemo *et al*. (2018) has also reflected that the addition of salt in water can improve the productivity of broilers during heat stress.

6.4.1.4 The addition of Cayenne pepper (chilli paper) in broiler feeds for increasing feed intake.

Most of the farmers indicated that they add cayenne pepper in feeds. Spices like cayenne pepper can improve the flavour of feed, making it more appealing to broilers, this can lead to increased feed intake and, as a result, higher growth rates (Herrero-Encinas *et al*., 2023). Godde *et al*. (2021) has argued that due to climate change, the changes in temperature, precipitation, and atmospheric carbon dioxide levels may alter the content and nutritional value of crops used in animal feeds. These changes influences the flavour and palatability of such feeds. Marić *et al*. (2021) has indicated that including chilli pepper in broiler chicken nutrition has a good impact on production performance and improves the chicken blood lipid profile. Furthermore, a review by Abd El-Hack *et al*. (2022) has reflected that most studies have find out that the addition of chilli paper on feeds improves performance, weight gain, feed intake, feed convention ratio, and blood parameters, as well as antimicrobial effect and intestinal histomorphology enhancement, thus resulting in the highest profitability ratio.

6.4.1.5 Dipping broiler chickens in water to reduce heat stress

Due to rising temperatures caused by climate change, it causes heat stress on broilers as such farmers have resorted to dipping broiler chickens in water to reduce heat stress. This concurs with the study done by Liang *et al*. (2020) who reflected that the use sprinkler system appears to have good benefits in preserving the core cellular energy status and decreasing systemic and intracellular stress-induced by heat load, resulting in an improvement in poultry well-being and growth performance. Farmers sprays or dip chickens in a bucket full of water during excessive heat, this assist in making feathers to be wet, wet feathers aid in the removal of heat from the chicken's body. As water evaporates from the feathers, it removes excess heat (Mota-Rojas *et al*., 2021). Temperatures that are too high can cause dehydration in broilers as such dipping them in water helps them stay hydrated by minimising excessive water loss through breathing and encouraging drinking (Moon *et al*., 2023). When exposed to extreme high temperatures, chickens change their behaviour, such as eating less and drinking

more water, therefore dipping them in water offers brief alleviation and promotes normal behaviour (Wakenell, 2016).

6.4.1.6 The use of salt as a biosecurity measure

Farmers have indicated that due to expensive chemicals for biosecurity they have resorted to using salt. Salt can be used for cleaning and disinfecting surfaces, equipment, and buildings; however, it is usually coupled with other efficient disinfectants to achieve the complete removal of germs (Artasensi *et al*., 2021). This finding concurs with those of McKenzie (2019) who showed that a mixture of salt and water can be used to killing bacteria in soil and other areas. A literature review done by Mojahed *et al*. (2022) has reflected that climate change influences the distribution and behaviour of disease-transmitting vectors, fleas, mites, and ticks. Changes in temperature and precipitation patterns may broaden the range of these vectors, raising the risk of vector-borne illnesses in broiler chickens. Sruthi (2015) has reflected that Salt, particularly sodium chloride, is recognised for its desiccating (drying) qualities. It can be used to control external parasites by making the environment less conducive to their survival. Salt can be applied to litter and habitation areas to dehydrate and repel pests.

6.4.1.7 Adding ice to the water that chickens drink to reduce heat stress

Broiler chickens are sensitive to high temperatures and can suffer from heat stress. About 48,4% of the farmers added ice to cool the water because chickens would not drink warm or hot water under heat stress. Providing cool water through the addition of ice helps lower the overall temperature of the water, making it more comfortable for the chickens to drink and aiding it preventing heat-related issues (Lehr, 2021). Adequate water intake is crucial for the health and performance of broiler chickens. During hot weather, chickens may drink more water to stay cool. If the water is too warm, they might not consume enough to meet their hydration needs (Tabler, 2023). Adding ice can encourage them to drink more, ensuring proper hydration. Heat stress can negatively impact feed conversion rates in broilers and frequently it causes a decrease in feed consumption. Broilers consume less when exposed to hot temperatures. This drop in feed consumption has a direct impact on the feed convention ratio since there is less feed available for conversion into body weight (Andretta *et al*., 2021). Keeping the water temperature cooler by adding ice can help maintain optimal feed consumption and conversion rates, promoting better growth and performance (Park *et al*., 2015). Warmer water can be a breeding ground for bacteria and other pathogens. Keeping the water temperature lower with the use of ice may help reduce the risk of waterborne diseases and maintain better overall flock health (Maharjan *et al*., 2016)

6.4.1.8 Placing ice around the house to reduce heat in the house

Due to the high cost of cooling systems, 28.2% of farmers have adopted placing ice in broiler houses and they put them in broiler houses next to the open sides so that the air will be cooled as it flows to the inside. Heat stress can cause broilers to consume less feed, grow more slowly, and die faster (Li *et al*., 2015). Heat stress may be avoided by using ice to cool the air, and the broilers will be able to live in a more comfortable environment. Elevated temperatures can potentially diminish broiler appetite, resulting in reduced feed intake and conversion efficiency. To ensure that the broilers are effectively converting their feed into body weight gain, it can be helpful to maintain optimal feed intake by using ice to cool the atmosphere. Lowering humidity levels can help improve the air quality inside the broiler house (Gokul *et al*., 2020). Better air quality can stop illness transmission and is crucial for respiratory health. Broilers will display more typical behaviours like reduced feed intake when there is heat stress, but ice can help create a stress-free atmosphere that encourages natural behaviours and, as a result, improves general well-being (Jiang *et al*., 2015).

6.4.1.9 Brooding using firewood to reduce cold stress on broilers

Most smallholder farmers are based in rural areas with easy access to wood. About 79.8% of farmers burn wood to heat the broiler house during winter seasons. The wood assist in generating heat when it combusts. The heat produced raises the temperature inside the broiler house, reducing the cold stress through a comfortable environment for broilers (Vigoderis *et al*., 2018). Broilers are sensitive to temperature fluctuations; cold stress can affect growth and overall health. By keeping the broiler's temperature from decreasing excessively, burning wood can help keep the birds from becoming stressed (Elizabeth, 2021). Wood is a reasonably priced fuel source and may be more economical than alternative heating options in some locations (Reeb, 2013). This can be crucial for farmers looking to control expenses while preserving ideal growing conditions for broiler chicks. Wood is a cheap and easily accessible heating alternative in rural areas or places with limited access to other energy sources (Masekela & Semenya, 2021).

6.4.2 Conventional methods adopted by smallholder broiler farmers in adapting to climate change

6.4.2.1 Use of high carbohydrates feed in winter to increase metabolic heat on broilers

As shown in Tables 6.1 about 51.6% of farmers use high carbohydrate feeds in winter to increase energy intake of broilers. The increased energy in broilers generates more heat, thus reducing cold stress. Similar results were obtained by Bolden (2015), who has shown that some nutritionist increases energy in feeds during winter so that broilers can have sufficient energy. During the cold season, broilers experience cold stress, which results in high energy

required to maintain body temperature (Zhou *et al*., 2021). Without adequate energy in their diet, broilers may lose weight, impacting meat yield. Feeds with high carbohydrates help prevent weight loss and reach the desired carcass weight and quality during cold seasons (Mir *et al*., 2017). Feeds such as grains are added to the commercial feeds to assist the broiler in increasing its energy and help maintain the broiler's weight gain during the winter (Emmanuel *et al*., 2018). Carbohydrate-containing feed plays an important role in feed conversion, as it contributes to the energy density of the feed, leading to improved winter efficiency. Providing balanced feeds that have high energy density assists in increasing uniformity amongst broilers because uniform growth rates and good body condition contribute to increased profits in the farm (Silva, 2014). When a broiler digests carbohydrates, heat is generated through a metabolic process that provides warmth (Barzegar *et al*., 2020).

6.4.2.2 Using cooling system

Fans are installed in the houses to control the heat. Broilers are sensitive to extreme temperatures (Lin *et al*., 2011). High temperatures can lead to heat stress, reduced feed intake, slower growth rates, and increased mortality (Habeeb *et al*., 2023). Due to expensive cooling systems, only 34.7% of farmers were using cooling systems to reduce temperature. A cooling system helps regulate the temperature inside the poultry house, preventing overheating during hot weather and ensuring a comfortable environment for the broilers (Saeed *et al*., 2019). An effective cooling system helps maintain an optimal temperature range, allowing broilers to eat more consistently and gain more weight efficiently. Cooling systems play a vital role in preventing heat stress, reducing the risk of mortality, and improving overall flock health (Saeed *et al*., 2019).

6.4.2.3 Open sided housing

Mostly, smallholder farmers use natural ventilation, which is the opening of the sides of the poultry houses. Furthermore, they use simple broiler houses, which are mostly open sideways for ventilation. Opening-sided housing is a cheaper way to cool down the house's heat. Of the farmers investigated, 98,2% who reside in an area where it gets very hot prefer to use this method as opening is cheap and easy to adjust. The open side-housing system is mostly done in the direction in which the air moves so that there is a continuous supply of air in the houses. Gbedemah *et al*. (2018) have reflected that building low walls allows natural ventilation by opening the broiler house, and it allows airflow inside the house. Open-sided housing is adaptable to different climatic conditions. It allows farmers to manage the environment effectively by adjusting curtains or other elements based on the prevailing weather conditions (Sans *et al*., 2021). Open-sided housing promotes better air exchange, reducing the concentration of dust, ammonia, and other airborne contaminants (Guo *et al*., 2022). Improved air quality is crucial for broiler chickens' respiratory health, helping minimize respiratory

diseases and stress. Improved ventilation and airflow help reduce the risk of disease transmission within the flock. Lower humidity levels and better air quality create a less favourable environment for the proliferation of pathogens (Soliman & Hassan, 2020).

6.4.2.4 Vaccination of birds

Climate change leads to conditions which can cause several different diseases which affect the profitability of farms. It can also critically influence the prevalence and spread of infections, and poultry farming more especially counting broilers, which are especially defenceless (Popoola *et al*., 2019). About 91,9% of farmers vaccinate their birds against common diseases. Most broiler farmers receive their broiler chickens vaccinated from the supplier. Broilers may need characteristic insusceptibility to these modern pathogens, making immunization basic to avoid or decrease the effect of such illnesses (Bhuiyan *et al*., 2021). Vaccination may be a proactive technique that permits poultry ranchers to adjust to changing illness designs and relieve the effects of climate-related challenges (Schat, 2014). By vaccinating broilers, the chickens can adapt to the advancing dangers related to climate change. Climate-related stressors, such as warm stretches, can compromise the safe framework of broilers. A disabled resistant reaction makes them more helpless to contaminations (Lara & Rostagno, 2013). Vaccination makes a difference in reinforcing the safe framework providing proactive protection against diseases.

6.4.2.5 Use of adapted broiler strains

Few (20.2%) farmers have indicated that they use adapted strains such as Ross and Comb, whereas 79,8% have indicated that they do not know the strains they are using. The farmers receive day-old chicks from the suppliers, who mostly do not indicate which strain it is. Some of the farmers indicated that it affected them negatively because they were given layer chicks that do not grow. Broiler strains adapted to specific climates can better tolerate temperature fluctuations (Kpomasse *et al*., 2021) and may demonstrate better feed efficiency (Oke *et al*.,2024). This is very important because climate change can affect feed consumption and digestion through stress; it can be heating stress. Improved feed convention plays a huge role in the growth of broilers. This contributes to economic sustainability and reduces the environmental impact of poultry farming (Leinonen & Kyriazakis, 2016). Changes in precipitation patterns may affect water availability and quality. Climate change can lead to extreme weather events, such as heatwaves, but adapted breeds can exhibit greater resilience to such events, resulting in sustained production.

6.4.2.6 Use of high protein feed in summer

In summer, broiler chickens experience heat stress, which reduces their feed intake (Abed *et al*., 2011). Close to half (40.3%) of the farmers have resorted to high protein feeds, thus

reducing carbohydrates rich feeds during summer seasons High protein feed allows birds to achieve their protein needs even though they are consuming less feed and support muscle development (Beski *et al*., 2015). High-protein diets can help reduce the impact of heat stress by supporting the maintenance of body weight and muscle mass (Pesta & Samuel, 2014). Increased nutrient density in the feed ensures that broilers receive essential vitamins and minerals for optimal growth, especially during hot weather (Teyssier *et al*.,2022).

6.5 Conclusion

In conclusion farmers adopt both conventional and indigenous methods to ensure that broiler chickens adapt to climate change. Due to some methods being expensive farmers opted for their indigenous methods such as Aloe vera, Munzere (*Bridelia micrantha*), salt and sugar and dipping chickens in water. Furthermore, farmers are using open sided housing as a measure of providing ventilation. Some of the conventional methods includes vaccination of birds and use high protein feeds.

7 General discussion, Conclusion and Recommendations

7.1 General discussion

The results of the study have reflected that most of the household are being headed by females, also including the gender which is dominant on broiler farming. A study done by Hadebe (2015) showed that most woman are dominant in broiler farming as compared to man. Furthermore, the results reflected that the dominate age in broiler farming is 36-45 years old. These findings concur with the results of Gharib *et al*. (2023) who reported that 67.50% of farmers where between the age of 30-45. Furthermore, the results reflected that most farmers have tertiary education level. Due to high unemployment in South Africa the results showed that most farmers rely on broiler farming for income, and they use the profits household maintenance such as buying of foods and taking their children to school. Some farmers have indicated that they invest profit to sustain their business during hard times. The demographic factor plays a role in understanding the impact of climate change on broilers.

On the perception of smallholder broiler farmers, the results reflected that farmers perceived that during summer due to hear stress broilers they are always tired with no energy. This has been supported by Goel (2021) who affirm that high temperatures can cause dehydration, decrease feed intake, and cause general discomfort. Broilers, which are developed for rapid growth, can be especially sensitive to heat, and excessive heat can cause lethargy and decreased activity (Ahmad *et al*., 2022). The farmers have also perceived that there are high mortality rates during summer. This is mainly caused by shortage of water during heat stress. Dehydration is a regular occurrence in hot temperatures. If broilers do not have access to adequate and clean water, they may get lethargic, consume less feed, and die (Chikumba & Chimonyo, 2014). During winter seasons farmers have perceived that there is slow growth rate of broiler and reduced water intake. With this impact affecting the overall performance of broilers farmers have adopted methods so that they can adapt to climate change.

The results have shown that farmers rely mostly on *Aloe vera* and Munzere *(Bridelia micrantha)* for disease control. A study conducted by Quaye *et al*. (2023) shows that *Aloe vera* constitute a variety of bioactive substances, including vitamins, minerals, and antioxidants, which may help to support the immune system. A stronger immune system can help broilers withstand infections and stress. The results also reflect that most farmers use adapted breed for farming. This assist in increasing the profits of farmers because the breed will the resistant to temperatures and diseases.

7.2 Conclusion and Recommendations

Smallholder broiler farmers in Thulamela and Musina indicated that they adapt production to climate change by using tradition and conventional methods. The tradition methods they reported were use of *Aloe vera*, Munzere (Bridelia micrantha), salt and sugar, dipping chickens in water, use of open sided housing, adding ice to the water that chickens drink, adding ice around the house, woodfire inside the house. The conventional ones were vaccination of birds, use of adapted broiler strains, use of high protein feed in summer, and use of high carbohydrate feed in winter. Due to expensive conventional methods farmers opt to use indigenous methods to tackle some of the climate change challenges. *Aloe vera* is one of the most used indigenous methods as a medication because it consists of antibiotic. Furthermore, it can be recommended that there is a need to research on indigenous ways of adapting to change in climate particularly the impact of Munzere (*Bridelia micrantha)* as there is little knowledge on its application on broiler farming. It can be also recommended that there is a need to research on the quantity and the effectiveness of the traditional methods.

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APPENDICES

Appendix A: Letter from Department of Agriculture and Rural Development

LIMPOPO
PROVINCIAL GOVERNMENT
REPUBLIC OF SOUTH AFRICA

DEPARTMENT OF
AGRICULTURE AND RURAL DEVELOPMENT

Ref: 12R
Enquiries: Dr T. Raphulu

12 May 2023

Khuguvhila Shumani (Student Number: **14004506**)
University of Venda

RE: APPLICATION TO CARRY OUT RESEARCH UNDER THE DEPARTMENT OF AGRICULTURE & RURAL DEVELOPMENT

1. Kindly take note that your request to conduct research titled ***"INVESTIGATION OF METHODS ADOPTED BY SMALLHOLDER BROILER FARMERS IN ADAPTING TO CLIMATE CHANGE"*** has been granted.

2. The permission entails interviewing sampled broiler farmers face-face in the Thulamela and Musina Municipalities. You are required to contact the office of the Deputy Director: Vhembe Central (Thulamela) and Deputy Director Vhembe North (Musina) to brief them on the research or study, to request up-to-date broiler farmers database (100-5000 broilers per production cycle) and assistance.

3. The Department is prepared to embark on any activity that could assist our broilers farmers to improve production.

4. Kindly take note that you will be expected to hand over a copy of your final report to the Department for record purposes. You may also be invited to share your findings in the Departmental Research Forum.

5. Hoping that you will find this in order.

Kind regards

Dr. T. Raphulu
Chairperson: Research Committee

12/05/2023
Date

67/69 Biccard Street, POLOKWANE, 0700, Private Bag X9487, Polokwane, 0700
Tel: (015) 294 3135 Fax: (015) 294 4512 Website: http://www.lda.gov.za

The heartland of Southern Africa - development is about people!

Appendix B: Letter of informed consent

My name is Khuguvhila Shumani. I am a student at the University of Venda doing a master's degree in Rural Development. My research investigates methods smallholder farmers adopt to adapt broiler production to climate change.

I kindly request your participation in this research by expressing your views on climate change. The study's primary purpose is to identify the methods used by smallholder farmers in adapting broiler production to climate change and assess the extent to which the birds are affected by climate change.

Participation is voluntary. If you feel like you cannot continue, you have the right to stop participating in this research. You can use your home language when answering questions. Your privacy will be observed (no name or other identification will be disclosed), and all personal data will be removed when analyzing the data. The data which will be collected will be used for educational purposes only.

Signature of the researcher ……...Date……...

Consent by the participant

I have understood everything explained to me by the researcher. I understand and consent to participate in the study.

Name…….

Signature……Date…….

Appendix C: The questionnaire

My name is Khuguvhila Shumani. I am a student at the University of Venda pursuing a master's degree in Rural Development. My research investigates methods smallholder broiler farmers adopt in adapting broiler production to climate change.

The following are the research questions that I am requesting you as a participant to answer. You can use your home language. Kindly be honest when answering. There is no right or wrong answer.

Name of the investigator……

Code of the respondent ……

Questionnaire number…….

This questionnaire can be answered by anyone who is involved in farming or who has knowledge about broiler farming within a household.

Section A. (Demographic factors of the broiler farmers in the Vhembe district)

1. Location Thulamela ◯ Musina ◯
2. Type of household adult female-headed ◯ Adult male-headed ◯
   child-headed ◯ other
   (specify)…….
3. Marital status HHH Single ◯ Married ◯ Widowed
   ◯ Other (specify)…….
4. Schooling HHH none ◯ primary ◯ secondary ◯
   college ◯ university ◯

Other (specify)…….

5. Occupation HHH Farmer ◯ Other ◯

(specify)…….

6. Who owns the business?

……..

7. Who finances the business?

……

8. Age of the owner 18- 35 ◯ 36-45 ◯ 46-55 ◯ 56-65 ◯ Above 65 ◯

9. Gender of the owner Male ◯ Female ◯ Not keen to mention ◯

10. Farming experience of the owner <1 year ◯ 1- 5 years ◯ 6-9 years ◯ 10+ years ◯

11. Occupation of owner Farmer ◯ Other ◯

(specify)…….

12. Off-farm sources of income of HH……..

13. Kindly answer the following questions based on the production.

	Summer	Winter
What is the number of broiler production houses?		
What is the stock size per cycle per house when starting		

What is the stock size per cycle per house when selling?		
What is the number of production cycles per annum?		
What is the targeted selling weight of broilers?		

14Where do you sell your chickens/ who are your customers?

……

……

……

15 What is your peak selling period? Summer ◯ Winter ◯

16 Do you consume broilers from the business? Yes ◯ No ◯

If yes how many per month……

17 Do you donate your broilers? Yes ◯ No ◯

If yes to which establishment……

18 Do you give friends and relatives broilers as gift?

If yes, state on what occasion

……

19 What is the reason behind starting a broiler chicken business?

……

……

……

20 Is there space to add other houses? Yes ◯ No ◯

Given the opportunity, do you intend to expand your business? Yes ◯ No ◯

21 How do you see the sustainability of the business?

……

22 What is the price of the following?

Category	Growth stages		
	0-2 weeks	2-4 weeks	4-6 weeks
Feeds per 50 kg bag			
Medication used			
Number of chicks reared per cycle			
Sawdust			
Labor			
Transportation			
Other expenditures			
Total expenditure per batch			
Total income per batch			

23 What do you do with the money you make from the business?

……
……
……

Section B (The extent to which climate change affects broiler chickens)

24 Based on the questions below kindly complete the following score sheet, your answers should be based on the following scores: 1 strongly disagree. 2 disagree, 3 neutral, 4 agree, 5 strongly agree.

	1	2	3	4	5
Do you know the strain that you are farming with					
Have you changed any activities because of winter					
Have you change any activities because of summer					
Did climate change force you to change the housing system					
Did climate change force you to install ventilation					
Do you use fans for ventilation					
Are you using open sided house because of climate change					
Due to cold stress do you use lights to increase heat in the house					
Do you use fire to overcome cold stress					

	1	2	3	4	5
Do you know the strain that you are farming with					
Have you changed any activities because of winter					
Have you change any activities because of summer					
Did the climate change force you to reduce your stocking density					
Did climate change force you to increase feeds for broilers in summer					
Did climate change force you to increase feeds for broilers in winter					
Is there any increase in water intake in winter					
Is there any increase in water intake in summer					
Do you experience high mortality rate in summer					
Do you experience high mortality rate in winter					
During summer do your chickens faint					
Due to climate change do you keep your broilers for short period of time					
Due to climate change do you keep your broilers for long period of time					
Did climate change increases disease outbreaks					
Do your chickens releases excretion mixed with blood					
Do your chicken releases white stools					
Are your chickens always tired in summer with no energy					
Is there a slow growth rate in winter					
Has profit changed due to climate change					
Do you easily achieve market required					

	1	2	3	4	5
Do you know the strain that you are farming with					
Have you changed any activities because of winter					
Have you change any activities because of summer					
Has the sales volume increased					
Has the sales volume decreased					
Have the feed prices increased due to climate change					
Have the price of chicks increased					
Have you experienced reduced body weights due to climate change					

Section C (Methods that smallholder farmers use to ensure that broiler chickens adapt to changes in climate)

25 What are the necessary measures that you have taken to overcome challenges faced in different seasons?

	Tick/cross
Prohibit unnecessary visitors	
Cleanse and disinfect any shared equipment	
Preventing the entry of rodents, birds, and other animals	
Foot bath	
Using cooling system	
Open sided housing	
Sawdust	
Brooding lights	

vaccination of birds	
Using dose treatments	
Use of indigenous methods to control diseases	
Water supply *ad libitum*	
Low stocking density	
Use of adapted breed	
Use of cheap/affordable feeds	
Use of high protein feed in summer	
Use of high carbohydrates feed in winter	
Adding ice around the house	
Adding ice on the water which chickens drink	
Wood fire inside the house	
Other (Specify)	

Appendix D: Ethical clearance Certificate

ETHICS APPROVAL CERTIFICATE

ETHICS APPROVAL CERTIFICATE

FACULTY OF SCIENCE, ENGINEERING AND AGRICULTURE
RESEARCH ETHICS COMMITTEE

NAME OF RESEARCHER/INVESTIGATOR: Khuguvhila Shumani

STAFF/ STUDENT NO: 14004506

PROJECT TITLE: Investigation of methods adopted by smallholder broiler farmers in adapting to climate change

ETHICAL CLEARENCE NO: FSEA/22/IRD/04/1707

SUPERVISORS/ CO-RESEARCHERS/ CO-INVESTIGATORS

NAME	INSTITUTION & DEPARTMENT	ROLE
Dr M Manjoro	University of Venda, Institute for Rural Development	Supervisor
Dr A.J. Netshiphale	University of Venda, Animal Science	Co-supervisor
Dr M Tshikororo	University of Venda, Agricultural Economics and Agribusiness	Co-supervisor

Type: **Student research**

Risk: **Minimal risk to humans, animals, or environment (Category 1)**

Approval Period: **November 2022-January 2025**

The Faculty Research Ethics Committee (FREC) of the Faculty of Science, Engineering and Agriculture hereby approves your project as indicated above.

University of Venda

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