Effects of rolling blackouts and extreme weather conditions on smallholder poultry farmers' profitability: Nkomazi Municipality

by

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Declaration

I, Fortunate Nelisiwe Tshabalala, student no 201911248, I affirm that this dissertation, submitted in fulfilment of the Master of Science in Agriculture degree requirements, is my own original work and has not been presented to any other institution. I acknowledge my understanding of the University of Mpumalanga's stance on plagiarism and confirm that I have adhered to the established guidelines. I declare that all the research and findings presented here were conducted under the guidance of Dr Bongiwe Mcata and Prof Wisemen Chingombe.

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Dedication

I am dedicating this dissertation to my daughter, Enzokuhle Mavuso, as a motivation that everything you put your mind and heart into eventually works out. This is a testament to perseverance and dedication. I also dedicate this dissertation to my late dad, Dumisani Mishack Tshabalala whose encouragemement inspired me to pursue this degree.

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Abstract

Smallholder poultry farming plays an essential role in rural South African livelihoods and food security; yet, increasing energy instability and climate variability threaten its sustainability. This study investigated the effects of rolling blackouts and extreme weather conditions on the profitability of smallholder poultry farmers in selected areas of Nkomazi Local Municipality, Mpumalanga Province. This study specifically examined smallholder poultry farmers' socioeconomic characteristics, perceived and experienced challenges, profitability outcomes, and coping strategies adopted in response to energy and climate-related disruptions.

A mixed-methods research design was employed in the study, as primary data was collected through a structured questionnaire administered to 90 smallholder poultry farmers (n=90). Descriptive statistics, Likert scale analysis, gross margin analysis, and multiple linear regression models were employed to analyse the data. Additionally, gross margin (GM) was used as the primary measure of profitability, while regression analysis assessed both accounting-based determinants and contextual effects of rolling blackouts and extreme weather conditions.

The study findings revealed that most smallholder poultry farmers (92.2%) generated positive gross margins (R13, 973.00); however, profitability was highly volatile, ranging from R17,500.00 to R39,68.00 and sensitive to external shocks. Total variable costs had a statistically significant negative effect on profitability ($p < 0.01$), while price per bird exerted a positive influence ($p < 0.01$). Rolling blackouts and extreme weather conditions indirectly reduced profitability through increased operational disruptions, cost volatility, and bird mortality. Although farmers employed coping mechanisms such as alternative lighting, informal temperature regulation, and structural adaptations, 60% of the respondents reported having limited access to affordable energy alternatives, extension services, and 87% lacked financial support, which constrained their effectiveness.

The study concludes that while smallholder poultry farming remains economically viable in the short term, its profitability is fragile under persistent energy and climate stressors. Strengthening energy reliability, improving access to extension services, promoting climate-resilient infrastructure, and enhancing market and financial support mechanisms are essential to improving the long-term resilience and sustainability of smallholder poultry enterprises.

Keywords: *Smallholder poultry farming; rolling blackouts; extreme weather conditions; profitability; gross margin; South Africa*

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List of Acronyms/Abbreviations

SA	South Africa
SPSS	Statistical Package for the Social Sciences
GM	Gross Margin
TVC	Total Variable Cost
TR	Total Revenue
SAPA	South Africa Poultry Association

Chapter 1
Introduction

1.1 Background of the study

Electricity plays a crucial role in global economic and social welfare. It is essential to have reliable and accessible energy to ensure its benefits are widely available. South Africa (SA) has been experiencing rolling blackouts and variations in weather conditions (Kang et al., 2020). These rolling blackouts, also known as load-shedding, artificially cut off the power supply to some grid regions when insufficient generation capacity is available (Budlender, 2024).

Mlambo (2023) argued that the power supply infrastructure in SA is facing a structural deficit, and frequent rolling blackout incidents have only exacerbated the situation. Since the challenge's inception in 2007, the nation has exhibited a subpar history of establishing new-generation capacity to match the escalating demand (Mlambo, 2023). Furthermore, Tshidavhu and Khatleli (2020) noted that by 2016, the cost-to-completion for Medupi Power Station and Kusile Power Station had increased from the 2007 original estimates of about R69.1 billion to roughly R160 billion. This demonstrated serious budget and schedule overruns rooted largely in poor site management, lack of skilled labour, weak organisational structures, inadequate monitoring and control, and frequent scope/contract changes. Such that the power challenge severely limits South Africa's economic growth, making it difficult for the government to tackle unemployment (Jahns, 2023).

According to Berahab (2022), the country lost about 350,000 new jobs in 2021 due to an electricity shortfall. Additionally, Alexforbes calculated that the protracted stage 6 load-shedding could cause the government to lose R4 billion a day with each increase in load-shedding level (Mofokeng and Alberts, 2023). As a result, many sectors, including agriculture, suffer due to the challenges they encounter with electricity.

In this context, awareness of the economic impact of extreme weather conditions and load-shedding is a significant deliberation for South African smallholder poultry farmers, given the difficulty and forcefulness of the effects of rolling blackouts and extreme weather conditions they are currently facing. Smallholder poultry focuses on subsistence and involves raising unimproved or improved dual-purpose chicken breeds for meat and eggs (Bamidele and

Amole, 2021). Smallholder poultry farmers keep and raise these chickens using scavenging or semi-scavenging production methods, using locally available feed resources and family labour (Bamidele and Amole, 2021). Extreme weather conditions refer to uncommon, harsh, or out-of-season weather that falls outside the range of historical weather patterns; an increase in energy demand due to extreme weather or a rolling blackout results in a foreseeable and quantifiable loss of profitability (Strauss and Orlove, 2022). Therefore, despite being a crucial part of the South African economy, the poultry industry's susceptibility to load shedding is not widely acknowledged.

Consequently, the country's largest economy has been grappling with load-shedding that has become more rampant. The energy supply glitches are predominantly structural, but the impact of Cyclone Idai, which happened in February and March, further worsened the situation. The damage to Power lines and energy imports from Mozambique was disrupted, further compounding the problem (Nhamo and Chikodzi, 2021). Astral Foods, the largest poultry producer in South Africa, has been hit hard by load shedding, which cost them millions of dollars in 2022 (Van Zyl, 2021). The South African Poultry Association has also alerted that load shedding has intensified pressure on egg producers, leading to many small egg farmers leaving the business (Madibana et al., 2024).

1.2 Problem statement

There is a significant reliance on agricultural practices in rural areas like Nkomazi, where most communities are low-income, and poultry farming serves as a means to escape poverty and enhance livelihoods. Poultry farming necessitates a reliable power supply and sufficient temperature. The ideal temperature for chickens ranges from 19°C to 24°C, meaning that any temperature above 24°C can result in stress and organ damage, potentially reducing their lifespan (Vandana et al., 2021). Unfortunately, unexpected power outages and fuel shortages continue to pose common challenges for poultry businesses, significantly impacting both formal and informal sectors. The prolonged load-shedding periods pose significant challenges in production costs, profit margins, development, and business modernisation (Umar and Kunda-Wamuwi, 2019).

According to a report by Mpumalanga Custom Weather (2023), temperatures in Nkomazi drop to between 2°C and 6°C at their lowest and rise to between 28°C and 33°C at their highest.

Therefore, any temperature outside the ideal range is considered extreme. Consequently, the effects of rolling blackouts and extreme weather on smallholder businesses and individuals' welfare are significant concerns.

These issues contribute to the persistent challenges smallholder farmers face, including being resource-poor, lacking land, having limited formal education, and not utilising improved technology. Therefore, it is essential to investigate the impact of extreme weather conditions and rolling blackouts on smallholder poultry farmers. Thus, this study aimed to gain a deeper understanding of how load shedding and extreme weather conditions have affected the poultry revenue of smallholder farmers in Nkomazi Municipality of Mpumalanga Province, South Africa.

1.3 Research Objectives

The study's broad objective was to investigate the effects of rolling blackouts and extreme weather conditions on the profitability of smallholder poultry farmers in Nkomazi Municipality of Mpumalanga Province, South Africa.

1.3.1 Specific Objectives were to:

- Describe the socioeconomic status of smallholder poultry farmers in the selected areas.
- Explore smallholder poultry farmers' perceptions of the effects of rolling blackouts and extreme weather conditions on poultry farming.
- Determine the challenges faced by smallholder poultry farmers due to rolling blackouts and extreme weather conditions.
- Assess the profitability of smallholder poultry farmers in the event of rolling blackouts and extreme weather conditions.
- Describe the coping strategies smallholder poultry farmers use to mitigate rolling blackouts and extreme weather conditions.

1.4 Research questions

- What is the socioeconomic status of smallholder poultry farmers in the selected areas?

- What are smallholder poultry farmers' perceptions regarding the effects of rolling blackouts and extreme weather conditions on poultry farming?
- What challenges do smallholder poultry farmers face due to rolling blackouts and extreme weather conditions?
- What is the impact of rolling blackouts and extreme weather conditions on smallholder poultry farmers' profitability?
- What coping strategies are used by smallholder poultry farmers in mitigating rolling blackouts and extreme weather conditions?

1.5 Research hypothesis

- H_1 Rolling blackouts and extreme weather conditions affect the profitability of smallholder poultry enterprises in Nkomazi.

1.6 Justification of the study

Smallholder poultry farming plays a critical role in reducing poverty in most rural areas, while also serving as both a major source of income and a reliable contributor to household food security. Yet, with the increasing frequency of rolling blackouts and extreme weather conditions posing significant threats to the poultry production sector. While noting that poultry is highly sensitive to temperature fluctuations and relies heavily on a stable electricity supply for heating, ventilation, and feeding systems, these disruptions directly compromise bird health and survival. The result, hence, increases operational costs and leads to production losses, ultimately reducing farmers' profitability.

Despite the recognised importance of the poultry sector to rural livelihoods, limited empirical research has examined how load shedding and extreme weather events specifically affect smallholder poultry farmers in Nkomazi. This study, therefore, seeks to fill that gap by assessing how these two identified stressors influence day-to-day operations, production efficiency, and financial outcomes. It further explores the coping strategies that farmers have adopted and evaluates the extent to which these strategies enhance their resilience. Finally, the study aims to generate evidence-based recommendations that can support policymakers, farmer organisations, and development stakeholders in strengthening resilience, improving planning, and promoting sustainable growth among smallholder poultry farmers in rural communities.

1.7 Limitations of the study

Due to limited resources, the study only covered parts of Nkomazi Municipality rather than all areas. Consequently, only 90 respondents participated in the study. A significant problem arose during this research. Not all farmers were willing to participate in the areas surveyed. The first reason was their reluctance to disclose production costs, as they feared that the researcher would use the data collected for personal gain beyond the research itself. The second reason was that extension officers visited the farmers, promising grants and materials, but never returned to deliver them. As a result, the farmers lost interest in providing information to anyone, whether for research purposes or funding. The respondents ended up either over-reporting or under-reporting their production costs, losses, and profits, leading to biased income figures. The researcher aimed to address this constraint by employing various statistical tools to obtain more predictive results.

1.8 Dissertation outline

This dissertation outline comprises five distinct sections, each serving a specific purpose in elucidating the research while maintaining sound academic rigour.

Chapter 1 comprehensively introduces the study, thoroughly covering essential background information. It identifies the problem statement that prompted the research, clearly articulates the objectives that guide the inquiry, and outlines the key research questions and hypotheses underpinning the study. Additionally, this chapter explains the overall significance of the research.

Chapter 2 provides an in-depth review of relevant literature. It discusses various scholarly perspectives on how factors such as rolling blackouts and extreme weather events impact the profitability of smallholder poultry farmers.

Chapter 3 shifts focus to the specific study area chosen for investigation. This chapter provides detailed insights into the selected study area and locale and outlines the unique characteristics pertinent to the research objectives. It also elaborates on the research methodology employed, including the specific techniques used for data gathering and the analytical approaches applied to interpret the gathered data effectively while ensuring the methodological integrity of the research.

Chapter 4 presents the study's findings clearly and provides descriptive results, offering empirical results. These findings are crucial for understanding the research's implications and contribute to the broader discussion on the impact of environmental factors on agricultural profitability, affirming the study's academic contributions.

Chapter 5, the concluding chapter, summarises the entire study by outlining the key findings, presenting concluding thoughts that reflect the significance of the research, and providing thoughtful recommendations based on the results obtained.

Chapter 2
Literature Review

2.1 Introduction

This chapter provides an overview of poultry farming, arguments, and discussions based on what other scholars have said about rolling blackouts and extreme weather conditions, how poultry farmers are affected, and the challenges faced by smallholder poultry farmers during these conditions. Lastly, it provides coping mechanisms that other smallholder poultry farmers use during these conditions. Moreover, the conceptual framework developed by the researcher highlights the relationships between the key factors in a study based on the study subject.

2.2 Overview of poultry farming

Farming used to be something that only hunters and gatherers did, which meant that people relied on nature for food security (Gowdy, 2020). Thus, Animal husbandry is primarily concerned with delivering vital nutritional proteins from animals to the increasing human population worldwide (Kim et al., 2019). The poultry sector is a rapidly expanding segment of worldwide meat production, consumption, and trade, with developing and changing economies driving this expansion. Poultry, with its rapid feed conversion, has a distinct advantage over other livestock species, particularly ruminants, which allows them to attain the highest growth rates and lowest costs per unit of production. Over the last 50 years, the poultry market has developed, solidified, and globalised mainly owing to strong demand, making it the fastest and most adaptable to all animal industries (Ponnampalam et al., 2019).

The South African poultry industry is the most critical contributor to the agricultural sector, contributing 18.0% of the total agricultural gross value and 41% of animal-based goods (South Africa Poultry Association, 2020; Mdletshe and Obi, 2023). According to the South African Poultry Association (2020), approximately 76 % of hens are for meat and 24% for egg production. Moreover, poultry farming has greatly aided in satisfying the nutritional requirements of individuals of all ages by offering a consistent protein source, boosting financial capability, and integrating well into generally used farming systems (Mdletshe, 2023). However, the South African Poultry Association (2020) has reported a sharp decline in the poultry industry's success since 2004. This reduction is due to decreasing consumer income, more significant production costs, and increased customer demand for imported chicken products. In line with global patterns observed in most developed nations, the South African poultry sector has evolved similarly (Enahoro et al., 2021). There is a duality in the industry: many small-scale farmers work as independent poultry farmers or contract growers that only supply the unorganised market, while a small number of large-scale, fully integrated commercial producers control most of the market. The poultry industry faces competitive challenges due to the influx of imported dark chicken meat from other countries, priced below local production costs (Scanes and Christensen, 2019).

Farming, particularly poultry, has proven to be a realistic and feasible first step towards eradicating extreme rural poverty. Inevitably, distortions in policies and trade agreements isolate and alienate poor people; addressing these inefficiencies will improve the use of the opportunities livestock presents for economic growth and alleviate poverty.

2.3 Factors influencing poultry farming

A wide variety of factors influence poultry farming. The diagram below shows the biological, environmental, economic, and management factors influencing poultry production. These factors determine productivity, profitability, and sustainability.

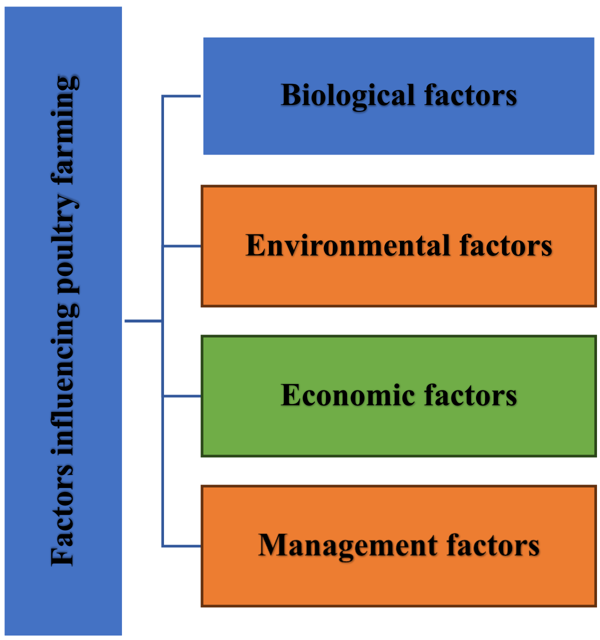

Figure 2.1 Factors Influencing Poultry Production

Source: Author (2024)

2.3.1 Biological factors

Sustainability plays a crucial role in poultry production, and selecting the right breed is vital, considering the local environment. Some breeds are more resistant to disease and have higher productivity rates (Bist et al., 2024). Over the years, disease outbreaks have affected poultry production, with common illnesses including avian influenza, coccidiosis, and Newcastle disease. If not managed properly, these diseases can lead to mortality. Toko and Geinoro (2023) add that effective management includes administering vaccines, maintaining proper hygiene, and implementing quarantine procedures when required. Additionally, providing quality feed and adequate nutrition is essential, as a balanced diet containing all necessary nutrients supports the growth and health of poultry and ensures optimal productivity. According to Kleyn and Ciacciariello (2021), the poultry sector's growth and trends towards intensification and concentration have raised several environmental problems over the past few years.

2.3.2 Environmental factors

Extreme weather poses serious challenges to smallholder poultry farmers and necessitates urgent attention. According to Ngongolo and Mrimi (2024), poultry production is particularly vulnerable to fluctuations in weather. Extreme conditions can cause heat stress, which decreases feed intake, egg production, and weight gain (Vandana et al., 2021). Structural changes, such as industrialisation, geographical concentration, and intensification in poultry farming, lead to waste generation that exceeds land disposal capacity, creating environmental issues (Himu and Raihan, 2023).

Environmental factors significantly affect poultry farming, bird growth, egg output, feed consumption, and farm profitability (Laca et al., 2021). Moreover, waste products like litter and excrement may contain traces of pesticides, microorganisms, disease-causing agents, pharmaceutical compounds (including antibiotics), hormones, metallic elements, and imbalanced macronutrients. These substances contribute to the contamination of air, earth, and water resources while promoting the development of pathogens resistant to antimicrobials and multiple drugs. According to Abadula et al. (2022), despite these concerns, chicken production is one of the most rapidly expanding agricultural sectors, and environmental factors hinder poultry production, leading to economic loss.

2.3.3 Economic importance of poultry farming

According to Erdaw and Beyene (2022), the poultry industry currently leads in animal product output, contributing to the country's economy. Chickens constitute 91% of the world's total poultry population, producing approximately 89% and 92% of poultry meat and eggs, respectively (Shifaw et al., 2021). Desta (2021) adds that the number of communities engaging in poultry farming amounts to 80% and has a substantial economic impact. Owing to the acceptance, consumption, and demand of poultry throughout the country, its production has become more significant in South Africa (Kleyn and Ciacciariello, 2021).

Furthermore, livestock serves as a renewable asset, a reliable source of income, and high-quality nutrients in the food people consume, and it is frequently required to fulfil crucial social and cultural demands and requirements (Adam, 2021). In addition, in rural areas, families use poultry farming as a means to escape poverty (Wilson, 2021). However, the cost of input and feed prices affects profitability in poultry farming, as feed accounts for 70 % of poultry production costs; thus, there is an inconsistency in feed prices. Creating a favourable atmosphere that provides those who are poor with access to loans, improved farming methods, products, services, enhanced genetics, and more excellent commercial prospects can have a substantial impact. Focusing on smallholder-based poultry systems as an efficient starting point for alleviating poverty programmes is gaining traction.

2.3.4 Management factors

According to Ramukhithi et al. (2023), the effective management of waste and water resources heavily influences the profitability of smallholder poultry farming operations. Therefore, proper waste handling techniques, including frequent cleaning and disposing of bird droppings, are essential to prevent ammonia buildup in poultry enclosures. Excessive ammonia concentrations can trigger respiratory issues in chickens, negatively affecting their overall well-being and productivity. Bist et al. (2024) note that by adopting efficient waste management approaches, farmers can create a more sanitary environment for their flocks, reducing mortality and enhancing feed utilisation.

Effective management includes water management, which is equally vital, especially during hot periods. Ensuring birds have sufficient access to clean, fresh water is crucial for maintaining their health, regulating body temperature, and promoting optimal growth and egg production. In high-temperature conditions, poultry consumes more water to cool down, making it essential for farmers to provide a steady supply of uncontaminated water (Nyoni et al., 2019). Effective water management also involves monitoring water quality, preventing contamination, and maintaining appropriate pressure in drinking systems. Grace et al. (2024) add that by prioritising these management aspects, smallholder poultry farmers can improve bird welfare, decrease disease occurrence, and boost their profit margins through enhanced productivity and reduced operational expenses.

2.4 Study Conceptual Framework

The framework illustrates how rolling blackouts and extreme weather events cause disruptions within smallholder poultry farming systems. These external environmental events first create operational disruptions such as utility interruptions, breakdown of feed and water delivery, and increased mortality or equipment damage. According to Adeleke et al. (2023), climate-related shocks and energy instability disproportionately affect agricultural operations in developing contexts, often disrupting core production systems (FAO, 2022).

It’s worth noting that these operational disruptions intensify by causing cost and production impacts, including higher input costs and reduced output, which aligns with current research showing that energy and climate shocks lower farm efficiency and increase overheads (Mthembu and Antwi, 2023). Together, these mediators ultimately determine profitability, measured through indicators such as gross margin and net profit. At the end, profitability outcomes feed into broader resilience and policy outcomes, including improved adaptive capacity and sustainable production systems, key themes in modern agricultural resilience literature (IPCC, 2022; Abegunde et al., 2023).

Fundamentally, adaptation and coping strategies such as backup power, improved housing, better ventilation, and community-based adjustments moderate the relationships throughout the framework. These strategies help buffer farms from the negative effects of stressors, reducing both operational disruptions and subsequent financial losses. Evidence increasingly supports the idea that targeted adaptations significantly enhance resilience and profitability in smallholder systems facing climate and energy volatility (Kansiime et al., 2022; World Bank, 2023). Therefore, this conceptual framework illustrates a cause-and-effect pathway where stressors → disruptions → cost impacts → profitability → resilience, with adaptation strategies working as protective mechanisms across the chain.

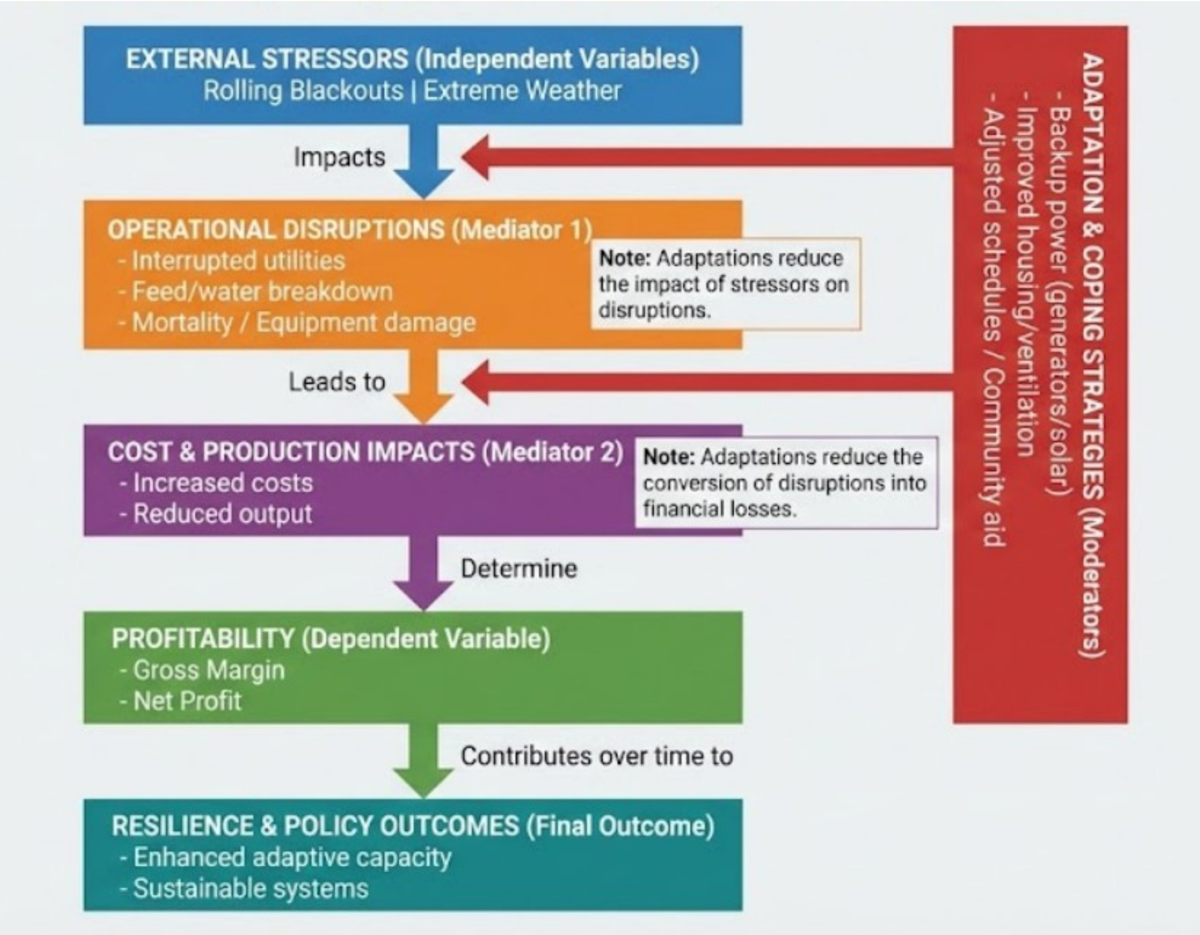

Figure 2.2 Conceptual Framework

Source: Author (2024) using Gemini AI. (2025)

2.5 Characterisation of Smallholder Poultry Farmers

According to Erdaw and Beyene (2022), smallholder poultry farmers possess various factors that shape their production systems, management methods, obstacles, and economic impacts. These farmers typically have minimal resources and operate on a small scale, often with flocks ranging from a few dozen to a hundred birds. Gwaka and Dubihlela (2022) add that smallholder poultry farmers also face constraints in terms of land and infrastructure; these farmers have become vulnerable to external shocks, making it difficult for their farming enterprises to survive. In developing countries, particularly in Africa, there are generally four types of poultry production systems: free-range or traditional village systems, backyard or subsistence systems, semi-intensive systems, and small-scale intensive systems (Wilson, 2021). Most farmers raise dual-purpose breeds, whereas some produce commercial broilers and layers. This farming empowers women and youth, allowing them to enhance their families' livelihoods by generating income and improving their food security. Desta (2021) adds that women's involvement in rural poultry improvement initiatives advances human development by giving them more access to resources and information while boosting productivity.

Smallholder poultry farms, while comprising a minor proportion of total farms, are crucial to the industry as they generate most of the output (Hedman et al., 2020). Despite the previously indicated possible roles chickens can play, smallholder poultry producers face many difficulties, such as poor egg output, deaths and slow growth rates (Erdaw and Beyene 2022). With rolling blackouts making the survival of poultry farms difficult, the long hours of rolling blackouts disrupt the day-to-day operations of poultry farmers, resulting in higher costs and farmers having to use alternative sources to sustain farms. Shah (2019) indicates that providing alternative sources such as generators, batteries, and more labour affects production costs as more expenses arise, and profit is thus affected. Therefore, farmers use fans and other equipment to make the infrastructure conducive to chicken survival to avoid heat stress. The long hours of rolling blackouts are a challenge because fans will not work during those hours, and adding chickens requires light for 24 hours to feed them.

2.5.1 The role of smallholder poultry production

The importance of poultry farming to small- and medium-sized rural farmers has grown. (Kumar et al., 2021) Almost every village family in developing countries, including the impoverished and landless, owns chicken. Productivity is viable at the village level, and low-cost technologies are required to boost productivity significantly (Desta, 2021). Achieving such a transition requires minimal investment, village production is ecologically beneficial, and land ownership is not limited. The contributions of smallholder poultry farmers to reducing poverty, improving food security, and advancing gender equality in developing nations are widely acknowledged (Ahmed et al., 2021).

Poultry farming by smallholder farmers is suitable to help feed the world's rapidly expanding population and give impoverished smallholder farmers-especially women-subsistence (Wiggins and Keats, 2022). Poultry farming by smallholder farmers allows for efficient use of locally accessible resources and requires little input. Mathiu et al. (2021) argue that although chicken farming is sometimes regarded as secondary to other agricultural operations by smallholder farmers, it plays a crucial role in providing residents with extra revenue and nutritious protein products. It is possible to sell or trade poultry products, such as clothing, food, and tuition, to pay for family necessities. A recent study by Birhanu et al. (2022), which focused on the case of smallholder poultry development in sub-Saharan Africa, showed how the local economy depends heavily on smallholder poultry and how more production could enhance food security, help reduce poverty, and lessen adverse economic effects.

2.6 Effects of Rolling Blackouts on Smallholder Poultry Farmers' Enterprises

Electricity is crucial to production in agriculture, especially for farmers who depend on energy-intensive practices, such as horticulture, dairy, poultry, grains, and agro-processing. Rolling blackouts have a significant effect on various industries, including agriculture. Thapa (2023) adds that electricity is still an essential component of the production of chickens, from lighting to heating, ventilation, and cooling. Because electricity is necessary for a successful poultry farm, it is also one of the most expensive inputs for raising chickens.

According to Siankwilimba (2019), power disruptions would severely affect hens hatching eggs because poultry are susceptible to heat and light. Layers require sufficient light to begin laying eggs and continue to do so. When the lighting system is disturbed, the layering phase will be affected, and egg production will be lower. Broilers require a lot of heat throughout the four crucial days that they are day-old chicks. Adequate light and heating also encourage broilers to consume sufficient nourishment. Furthermore, in the poultry farming industry, rolling blackouts not only cause disruptions in lighting schedules but also impact the warmth of broiler chicks during brooding and cool adult broiler roof irrigation, all of which decrease egg production.

Badmus and Alawode (2023) evaluated poultry farmers' preference for solar photovoltaics as a significant source of energy in Oyo State, Nigeria, and discovered that smallholder chicken farmers will probably be the most impacted by power outages and rationing because of the alternative energy sources that are available, like solar panels. It is worth noting that smallholder poultry farmers have limited means of coping with the effects of such crises. In industries that require high levels of productivity, such as agriculture, power outages can lead to missed economic opportunities, resulting in high costs.

Furthermore, smallholder poultry producers were affected by COVID-19, contributing to the drop in revenue and earnings because they suffered economically and needed to recover in the commercial sphere. The continuous rolling blackouts hamper their ability to recuperate. Smallholder poultry farmers employ fewer inputs to increase profitability by utilising the available resources. Given their minimal resources, such a strategy has always been effective. The cost of producing and processing commodities has increased owing to load shedding, primarily due to equipment start-ups, idle workers, overtime, and the need to purchase and run backup generators.

Therefore, the limitations on the power supply have increased the cost of producing and processing commodities. According to Naidoo (2023), because of increased manufacturing costs and price rises, consumers' cost of living keeps rising for other items. As shared by Mabunda et al. (2023), the results of the study verify that a number of farmers operated their production equipment using electricity. By cutting off the electrical supply, the machinery would not run, preventing them from continuing to produce. As a result of the reported decline in production, every farmer said they could not reach their monthly goals.

Extra labour, primarily temporary, is occasionally allowed to minimise manufacturing costs. Because broilers are less demanding than layer hens, several smallholder poultry farmers turn to broiler farming instead of dual poultry farming. The operating expenses of alternative equipment can be exorbitant, but production losses among smallholder poultry farms that can afford them are negligible with backup generators. Consequently, adopting mitigation strategies and alternative energy sources has increased farm operating expenses. For example, backup generators use gasoline, and fuel costs increase monthly. The long hours of the rolling blackouts increase the diesel needed for the generators to continue running. Thus, farmers are searching for mitigation techniques to help their businesses survive.

2.6.1 Smallholder Poultry Farmers' Coping Mechanisms During Rolling Blackouts

Smallholder poultry farmers implement coping strategies to reduce the impact of rolling blackouts on agricultural enterprises. According to Mabunda et al. (2024), commercial farmers and farming businesses have used their generators to guarantee a steady electricity supply as a mitigating step. Therefore, smallholder poultry farmers can also implement this, as poultry production mainly uses energy sources, and generators can help provide power for operations to continue, as the constant operation of feeders and drinkers cannot cease even during a power outage. Furthermore, because there is backup power, rolling blackouts will not be as effective, which might lead to increased production efficiency.

Ramukhithi et al. (2023) add that generators are an additional expense for farmers, but only a few businesses can afford them because of their high cost. The second measure is having farm labourers working with varying shifts, particularly when they have to run electrically powered equipment and have no other power source. The provision of labour will help with record keeping and ensure the chickens' safety from being stolen and the number of deaths (Mogodi et al., 2024).

2.7 Effects of Extreme Weather Conditions on Smallholder Poultry Farmers

Rising temperatures and limited ability to adjust have complicated and localised effects on smallholder and subsistence farming in developing nations, particularly Africa (Abegunde et al., 2019). Chickens thrive at normal temperatures and produce abundantly (both layers and broilers). When environmental pressures arise, such as extreme weather conditions, production suffers. During summer, when the prevailing heat is at its peak, chickens may sweat too much as they release surplus heat, hens lose energy and perish at a higher rate, and alternate sources are costly. This condition is known as heat stress. Heat stress occurs when the temperature is above the standard threshold in chickens.

According to Rostagno (2020), heat stress is one of the significant ecological irritants affecting poultry production globally. Feed intake declines when chickens are under stressful conditions, resulting in body weight loss, lower growth, and fatality. Thus, the ability of hens to reproduce is disrupted, thereby preventing egg production. The ability of smallholder poultry producers to meet customer demand is affected when production is disrupted, in addition to financial gain. Extreme weather conditions may contribute to the low poultry productivity in some smallholder poultry farming regions (in terms of eggs produced and the number of birds consumed and/or sold).

Few researchers have examined the adverse effects of weather conditions on poultry productivity because environmental stressors are shared globally. Extreme weather conditions negatively impact broilers and laying hens, resulting in lower growth and egg output and diminished poultry and egg quality. Furthermore, the public's understanding and concern about the detrimental effects of extreme weather conditions on poultry welfare have grown recently. Several studies cover the impact of heat stress on poultry immunity and productivity. Further research is necessary to understand the fundamental mechanisms underlying the detrimental effects of extreme weather conditions on chickens and to create efficient therapies. Popoola et al. (2019) explore poultry smallholder farmers' perception and adaptation responses in the Amathole district municipality, Eastern Cape Province of South Africa. The results from his findings indicated that farmers believed that some of the effects of rising temperatures on poultry production in the area were decreased output of eggs in terms of number, value, and size, reduced meat output due to a decrease in weight, and more remarkable bird fatality. Consequently, good chicken production and welfare depend on an understanding of the ability of farmers to manipulate environmental circumstances and find a way to survive under the prevailing extreme conditions.

2.7.1 Smallholder Poultry Farmers' Coping Mechanisms During Extreme Weather Conditions

According to George and George (2023), sustaining the internal temperature is critical to the continued output of birds. Summer management, which involves sprinkling water on roofs and spreading paddy or wheat straw, helps to control the temperature during intense summers. It is also advisable to employ coolers, foggers, and effective cross-ventilation. In winter, gunny sacks cover the sides, particularly in chicken houses with high ceilings. Nutritional management can increase feed digestibility and conversion ratios through feeding schedules and proper diet balancing (Ogunnusi and Akinwemoye, 2023).

Moreover, Shakeri et al. (2020) add that antioxidants, such as vitamin E, plant extracts, and trace minerals, such as zinc, chromium, and selenium, lower their stress levels and increase their ability to withstand heat. Therefore, adopting effective cooling devices and upgrading ventilation systems can reduce heat stress in hens and improve their general well-being and productivity. Sensor technology and routine maintenance are crucial for prevention (Astill et al., 2020).

2.8 Chapter Summary

This chapter presents a literature review on poultry production, the factors influencing poultry farming, and the characterisation of smallholder poultry farmers. The study used a conceptual framework to explain the effects of rolling blackouts and extreme weather conditions on poultry farming and covered coping strategies for mitigating these effects.

Chapter 3
Research Methodology

3.1 Introduction

This section outlines the steps applied by the researcher, such as research design, data collection methods, sample size, and data analysis procedures for this study, and further highlights the investigative approach taken to assess the impacts of rolling blackouts and extreme weather conditions on the profitability of smallholder poultry farmers in Nkomazi, Mpumalanga Province.

3.2 Description of the study areas

Nkomazi Municipality in Ehlanzeni District of Mpumalanga Province, South Africa, is at -25° 39' 59.99" S, 31° 39' 59.99" E. As a Category B municipality, it is the most compact within Ehlanzeni, covering an area of 4,787 km². According to the 2022 Census for Nkomazi Local Municipality, the population had grown from 96 202 in the 2011 Census to approximately 591,928, living in around 134,143 households, demonstrating significant growth in the municipality's demographic base (Stats SA, 2022).

Nkomazi Municipality lies in the summer rainfall zone, with precipitation from October to March. The average annual rainfall for the municipal area ranges between 750 mm and 860 mm, with the eastern portions averaging 450 mm to 550 mm and the higher-lying western sections averaging 1500 mm (Agholor et al., 2023). As a result, none of the municipal regions is designated as high-potential agricultural land. Conversely, 75.3% is classified as medium-potential land, while 15.3% is categorised as very low-potential land (Mkhabela, 2023). According to Sithole and Agholor (2021), most agricultural activities in the region, such as grazing and irrigation, occur on medium-potential land. Consequently, farmers in this community practice diversified farming, raising goats, sheep, chickens, pigs, and cattle and growing various crops and vegetables.

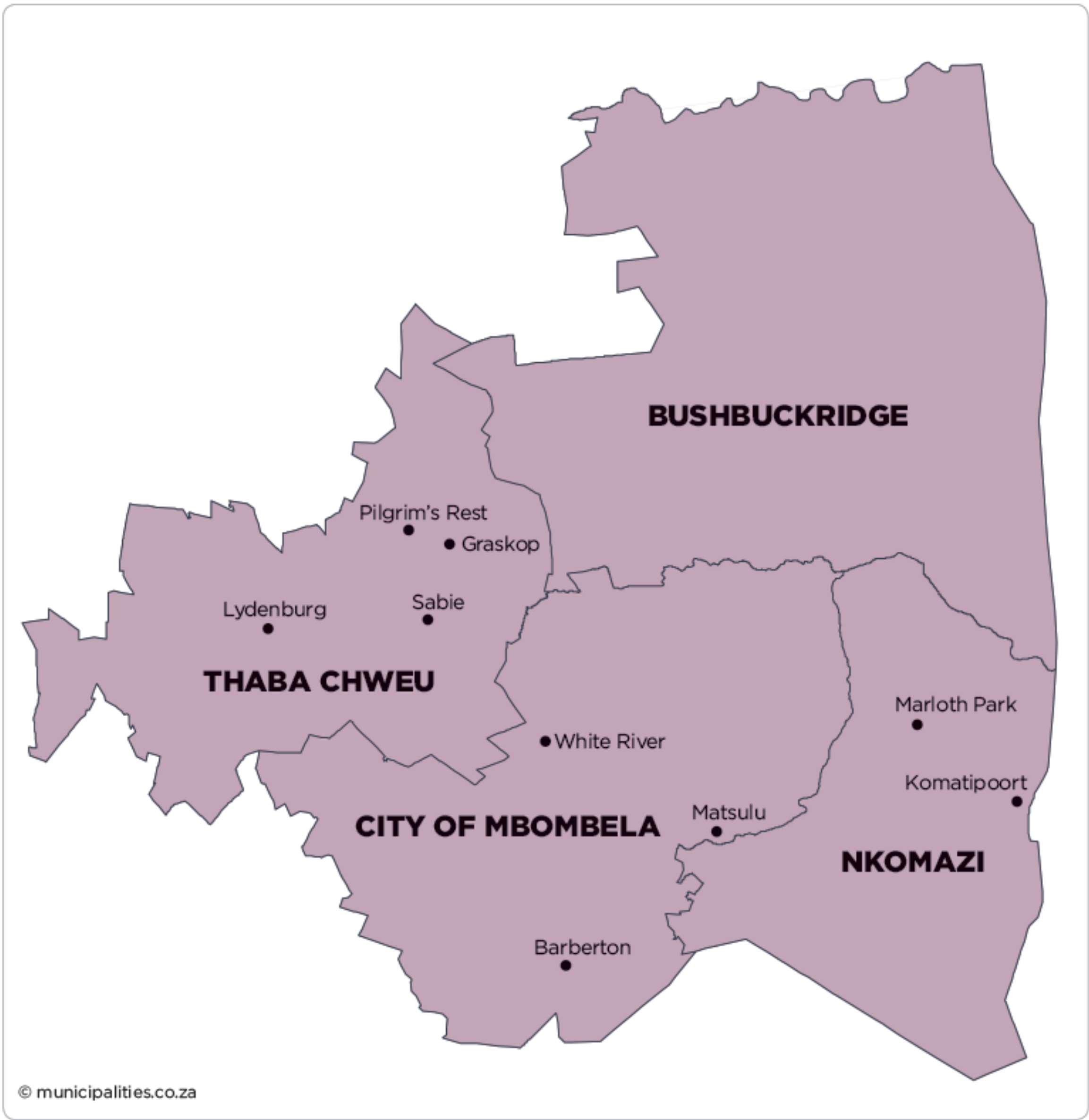

Figure 3.1 Nkomazi Municipality Map

SOURCE: GOOGLE (2025)

3.3 Study Area Demographics

3.2.1 Population

According to a community survey in 2016, the population of Nkomazi Municipality showed an upward trend, increasing from 393,030 in 2011 to 410,907 in 2016 and 446206 in 2019 (Nkomazi Local Municipality, 2022). This demographic growth is considered the most significant in the province, with Nkomazi accounting for 23% of Ehlanzeni's total population in 2016. Data indicates that between 2011 and 2016, the population rose by 17,877 individuals, reflecting an annual growth rate of 1.0%. The population increase can be attributed to a higher birth rate and a substantial influx of immigrants from Mozambique and Swaziland (Nkomazi Local Municipality, 2022).

Over the years, this population growth illustrates that the community has expanded while the Municipality's available revenue sources have remained constant. This situation presents considerable challenges for the Municipality, as it must strive to meet community needs with limited resources. Consequently, this has led to rising unemployment rates.

3.2.2 Ethnic group

Table 3.1 presents the racial composition of Nkomazi Municipality for the years 2011 and 2016. In 2016, the population was dominated by black residents with 98.79%, compared to 97.7% in 2011. While noting the proportion of white residents declining from 1.6% in 2011 to 0.94% in 2016, the coloured population also showed a slight change from 0.2% to 0.18% over the same period. The Indian population also decreased from 0.33% in 2011 to 0.09% in 2016, making it the smallest racial group in both census years. These figures illustrate a consistently dominant African population, with marginal shifts among minority racial groups between 2011 and 2016.

Table 3.1 Ethnic group in Nkomazi Municipality

Racial composition	**2011 %**	**2016 %**
Blacks	**97.7**	**98.79**
Indians	**0.33**	**0.09**
Coloured	**0.2**	**0.18**
Whites	**1.6**	**0.94**

Source: Stats SA Community Profile (Census, 2011; Census, 2016)

3.2.3 Age composition

Figure 3.2 presents that Nkomazi's population is heavily concentrated in the younger age cohorts, with the highest numbers found among children aged 0–4, 5–9, and 10–14, followed by young adults up to the 30–34 age group. This indicates a distinctly youthful population structure, with significantly more children and young adults than older age groups (Nkomazi Local Municipality, 2022). The prominence of preschool and school-age children reflects a community where dependency ratios are high and where demand for basic services continues to grow. As a result, the municipality must prioritise investment in education, early childhood development, healthcare, and broader social support systems to effectively meet the needs of this expanding young population.

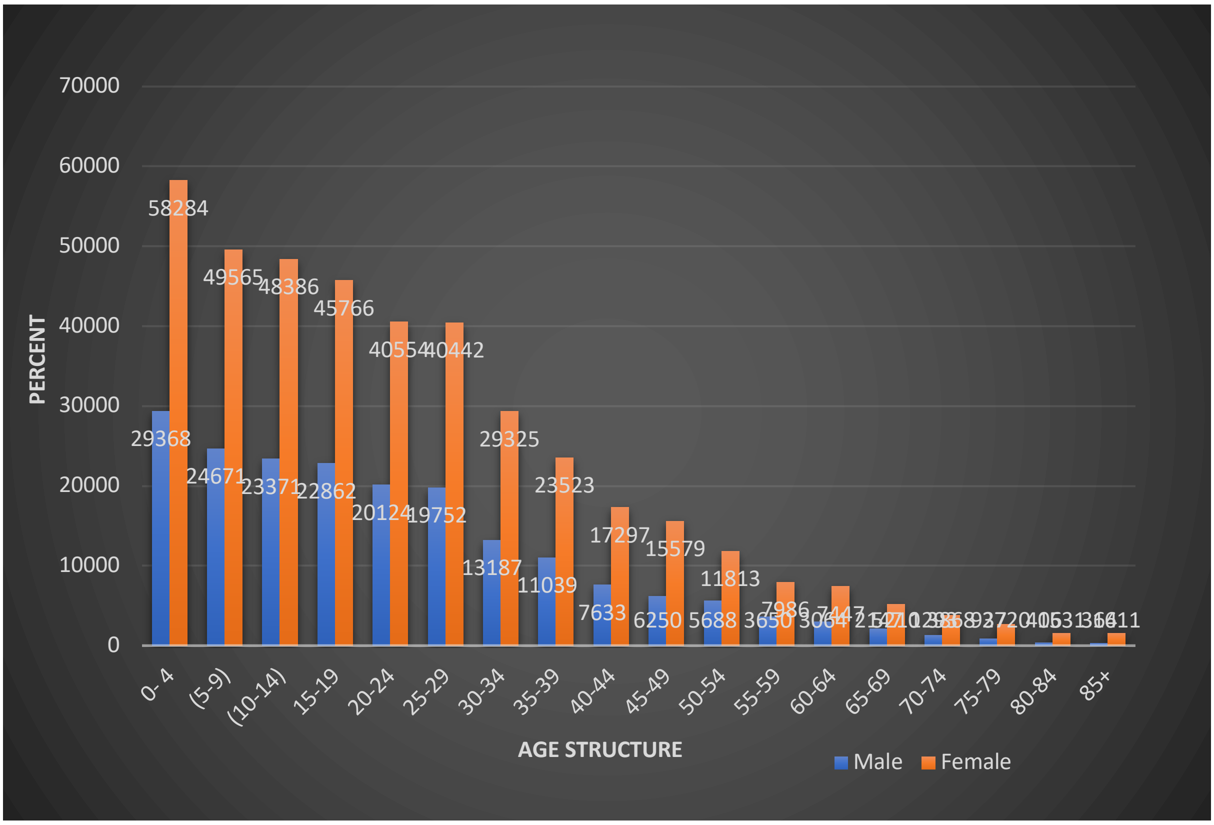

Figure 3.2 Age Distribution

Source: Stats SA Community Profile (Census 2011; Census 2016)

3.3 Socioeconomic status

This segment outlines the socioeconomic conditions of the Nkomazi study area, covering aspects such as joblessness, educational attainment, and economic engagement.

3.3.1 Unemployment

Nkomazi's unemployment rate worsened from 31.10% in 2014 to 32.40% in 2017, ranking it the sixth highest among all Mpumalanga municipal areas (Nkomazi Local Municipality, 2022).

The unemployment rates for women and youth raise significant concerns (Nkuna, 2021). As shown in Figure 3.3, about 41.5% of youths are unemployed, while 42.5% of women are employed. The municipality's leading employment sectors are community services, trade, and agriculture. In this regard, the importance of agriculture for employers can be emphasised. In addition to being a significant cause of unemployment, education is a crucial indicator of progress.

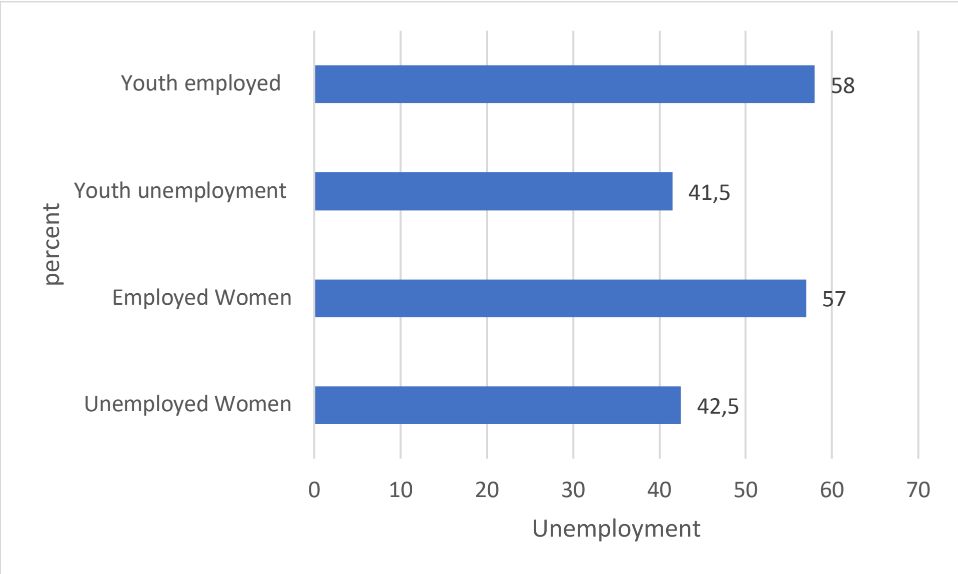

Figure 3.3 Unemployment Rates

Source: Stats SA Community Profile (Census 2011; Census 2016)

3.3.2 Sectors contributing to the Gross Domestic Product

As shown in Figure 3.4, the leading industries in terms of employment per sector in 2017 were agriculture, trade, community services, finance, transport, private households, mining, utilities, and construction. Comparing census 2011 data from 2014 with information gathered in 2017 reveals a decline in the agriculture and trade sectors, while community services experienced a 1.2% growth. According to Shongwe and Meyer (2023), the reduction in manufacturing is worrisome, as these industries offer significant potential for job creation and economic expansion.

The construction sector increased from 7.4 in 2014 to 7.9 in 2017. Employment levels directly impact individual and household earnings, and any decrease in these sectors can negatively affect households' capacity to meet their financial obligations, including rates and taxes (Mudiriza et al., 2024).

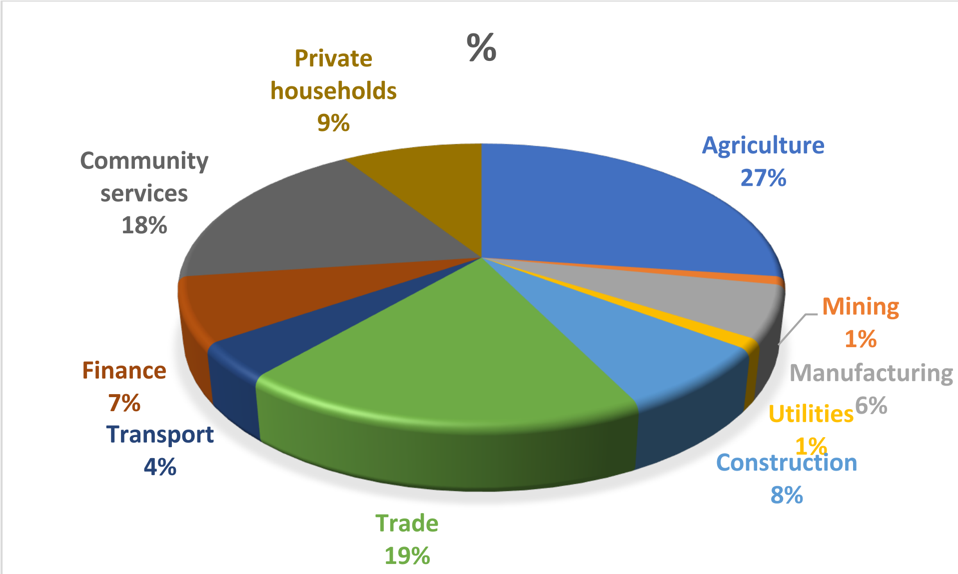

Figure 3.4 Sectors Contributing to the Gross Domestic Product
Source: Stats SA Community Profile (Census 2011; Census 2016)

3.3.3 Education

A critical measure of a population's development is its level of education. A population's access to educational services can be assessed in several ways. Dissecting education is crucial for assessing long-term educational provision. In Nkomazi municipality, there have been improvements in matric and post-matric qualifications (Mbombo-Dweba et al., 2021). The Community Survey 2016 indicates impressive outcomes; more than 60% of individuals have attained matric. Between 2011 and 2016, the highest education levels increased by over 10%. This progress has prompted the municipality to focus on creating additional classrooms in collaboration with the Department of Education.

3.4 Agricultural potential

Nkomazi offers enormous potential for improvements in agriculture and tourism, with abundant natural beauty, a fantastic environment, a good climate, and fertile soils for significant agricultural production (Khoza, 2024). The place offers diverse climatic conditions, which allow agricultural practices to be employed. The leading enterprises in the area are sugar cane farming, livestock farming, and vegetable farming. The availability of sugar cane farms contributes to the Municipality's economic development, allowing farmers to support their families. Women in the study area grow vegetables and can feed their families at the household level. Projects like the Lima projects help smallholders escape their isolation and become part of the agribusiness value chain by giving them access to markets, mechanisation, loans, input suppliers, and technical support. The original purpose of Lima was to address the requirements of South Africa's underprivileged farmers; smallholder farmers in rural regions are cut off from important markets and services that are thought necessary for creating prosperous agricultural businesses.

3.5 Research design

This study employed a mixed method with both quantitative and qualitative research approaches to investigate the effects of extreme weather conditions and rolling blackouts on smallholder poultry farmers' profitability in Nkomazi Municipality in Mpumalanga. The surveys were conducted using a semi-structured questionnaire as an instrument to obtain primary data.

3.6 Study target population

According to Willie (2023), a study's target population is a particular group of people or things that a researcher is interested in researching and planning to sample. These people share characteristics pertinent to the research question, such as age, location, or condition, and the study results will be generalised. In this study, smallholder poultry farmers in Nkomazi Municipality were the study participants as individuals involved in producing chickens and eggs.

3.7 Sampling procedure and sampling size

3.7.1 Sampling techniques

The study employed non-probability sampling techniques in which smallholder poultry farmers in the study area were purposefully sampled to obtain a greater depth of information that allowed for more accurate analysis and more pertinent replies to the study. According to Campbell et al. (2020), the evolution of purposive sampling has been extensive, with varying opinions on its complexity and straightforwardness. Additionally, this sampling technique improves the alignment between the sample and the research objectives, strengthening the study's rigour and increasing the reliability of its data and results. Furthermore, the study employed snowball sampling, wherein the respondents recommended other smallholder poultry farmers they knew in the area. This sampling method facilitates swift data collection in a specific area.

3.7.2 Sample Size

An extension officer in the study area provided information indicating that there are approximately 1,348 smallholder poultry farmers in Nkomazi Municipality. The initial sample size was calculated using Slovin's formula, which is commonly applied when the researcher has limited information about population variance (Tejada and Punzalan, 2012). The formula is expressed as:

$$\boldsymbol{n = \frac{N}{1 + Ne^2}}$$

Where:

N = population size

n = required sample size

e = margin of error

Applying the formula:

$$\boldsymbol{n = \frac{1348}{1+1348(0.05)^2} = 294}$$

It is worth noting that the recommended sample size of n=294 could not be achieved. Still, the study ultimately surveyed n=90 smallholder poultry farmers due to practical constraints, such as limited access to some farms and unwillingness to participate, which resulted in low response rates among targeted participants. Despite the reduced sample size, the realised sample of n = 90 remains statistically acceptable for quantitative analysis. According to Field (2018) and Gujarati and Porter (2009), the Central Limit Theorem (CLT) occurs when a sample size reaches approximately 30 or more respondents; the sampling distribution of the mean tends to approximate normality regardless of the population's distribution. This makes the estimated parameters reliable even when the population is large.

Furthermore, the CLT supports the use of inferential statistics with moderate sample sizes because estimates of population means and proportions become increasingly stable as sample size increases beyond 30 (Williams, 2020). Therefore, with n=90 respondents, this study exceeds the minimum threshold typically considered sufficient for generating robust and generalisable results in social science research. Lastly, the sample size used was adequate to produce credible statistical inferences, meet normality requirements, and provide meaningful insights into the socioeconomic characteristics and production practices of smallholder poultry farmers.

3.8 Data collection

Data collection is an important component of any research process and affects project effectiveness (Niyafard et al., 2024). It entails acquiring data that will be analysed to answer research questions, test hypotheses, and eventually attain research goals. The quality of the data collected primarily influences the authenticity and accuracy of the study findings; therefore, selecting adequate data-gathering methods is vital. Therefore, primary and secondary data were obtained for the study.

3.8.1 Primary data

Primary data is the original, unreported information researchers gather for a specific investigation (Bello, 2023). This data type is considered more reliable, valid, and unbiased than secondary data, as others have not altered it. The primary data for this study was obtained from smallholder poultry farmers in Nkomazi. The participants were briefed on the study's purpose and assured of their confidentiality regarding their responses before the interviews commenced. Each respondent was questioned individually, and face-to-face semi-structured questionnaires were utilised to collect information from the smallholder poultry farmers. This approach helped clarify misunderstandings or misinterpretations, enabling respondents to provide clear answers and address all questions. Additionally, it enhanced the data's reliability, as the interviewer could ask follow-up questions if a respondent seemed to misunderstand or provide inaccurate information.

Improving the level of understanding and providing correct answers, the questionnaires were presented in English and translated into the research region's native tongue (SiSwati). This enabled smallholder farmers to complete the questionnaire and provide accurate responses. Additionally, the survey design allows participants to respond without restrictions. The questionnaires consisted of both open-ended and closed-ended inquiries. Open-ended questions were crucial for eliciting detailed, informative responses, leading to more precise data. Conversely, closed-ended questions offered predetermined options for participants to select. The questionnaire incorporated a balanced mix of closed-ended questions that were answered swiftly. The data collection process spanned a total of 4 weeks.

3.8.2 Secondary data

According to Karunarathna et al. (2024), secondary data analysis is a systematic research process that involves reviewing previously obtained data in the area of interest. Secondary data entailed data collected and published by other scholarly writers. It is also a versatile approach that can be used in various ways. A systematic analysis was conducted in this study. Different results from different studies were statistically combined to provide comprehensive and unbiased information. Systematic analysis was used in the study's literature review, which provided the groundwork for planning research, evaluating findings, and comprehending background data. Before incorporating the secondary data into their research, the researchers thoroughly assessed its reliability, correctness, and applicability. Records, books, research articles, and online sources are the secondary data sources used in this study.

3.9 Data analysis

The primary data obtained were coded in Excel and exported to version 27 of the Statistical Package for the Social Sciences (SPSS) for analysis. Descriptive and inferential analyses were used. The descriptive analysis summarises the data collected using tables, charts, and summaries. An inferential analysis was used to determine the correlations between the variables to determine the factors that may affect the profitability of the smallholder poultry farming sector. Table 4.1 illustrates the study's research objectives, questions, and applied analytical tools. Finally, a systematic analysis was performed as guided by the study objectives.

Table 3.2 Summary Table with Research Objectives, Research Questions, and Analytical Tools

Research Objectives	**Research Questions**	**Analytical tool**
Describe the socioeconomic status of smallholder poultry farmers in the selected areas.	What is the socioeconomic status of smallholder poultry farmers in the selected areas?	Descriptive Analysis
Explore the smallholder poultry farmers' perceptions of the effects of rolling blackouts and extreme weather conditions on poultry farming**.**	What are the perceptions of smallholder poultry farmers on the effects of extreme weather conditions and rolling blackouts on poultry farming?	Descriptive Analysis Likert scale method
To determine the challenges faced by smallholder poultry farmers due to rolling blackouts and extreme weather conditions.	What are the challenges faced by smallholder poultry farmers due to rolling blackouts and extreme weather conditions?	Descriptive Analysis
Assess the smallholder poultry farmers’ profitability in the event of rolling blackouts and extreme weather conditions.	What is the smallholder poultry farmers’ profitability in the event of rolling blackouts and extreme weather conditions?	Gross Margin Analysis (Profitability Measure) Multiple Linear Regression Model (MLR)
Describe the coping strategies smallholder poultry farmers use to mitigate rolling blackouts	What coping strategies are used by smallholder poultry farmers in mitigating rolling blackouts and extreme weather conditions?	Descriptive Analysis

Research Objectives	Research Questions	Analytical tool
and extreme weather conditions.		

3.9.1 Descriptive analysis

Descriptive analysis employed percentages, bar graphs, means, and standard deviations. Moreover, it is described as a method of examining data that helps demonstrate and provide a clear summary of data points, thereby revealing patterns that meet all the data requirements (Doyle et al., 2020).

3.9.1.1 Likert Scale Method

A Likert scale is a rating scale commonly used in surveys or questionnaires to gauge people's level of opinion and agreement (Robinson, 2024). It can be helpful in various situations, as it is an attitude scale and cannot be used to measure behaviours. This study used the Likert scale method to explore smallholder poultry farmers' perceptions of the effects of weather conditions and rolling blackouts on poultry farming. This study included an equilibrium of favourable and unfavourable elements to reduce response-set bias. Employing a two-sided scale, such as strongly agree, agree, undecided, disagree, or strongly disagree, allowed the respondents to express their opinions on the effects of extreme weather conditions and rolling blackouts on poultry farming. Each subject's responses were graded on a scale of 1 to 5, with negative items reverse-coded.

3.9.1.2 Gross Margin Analysis

Gross margin (GM) analysis is a commonly used farm-level profitability tool that assesses the financial performance of a farm production enterprise by measuring the difference between gross income (GI) and total variable costs (TVC) (Nariswari and Nugraha, 2020). Hence, GM represents the portion of income that remains after covering all variable production expenses and is therefore an effective indicator of economic resilience, particularly under unstable production environments such as rolling blackouts and extreme weather shocks.

In smallholder poultry systems, gross margin analysis is significant because it captures the effect of fluctuating production input costs, such as feed, labour, veterinary supplies, and bedding, on the overall profitability of farmers. Omondi (2019) emphasises that GM offers a clear, practical measure of the returns obtained after accounting for operational expenditures, making it suitable for evaluating the financial viability of small-scale poultry enterprises.

In this study, gross margin analysis is used to assess how rolling blackouts and extreme weather conditions impact the profitability of smallholder farmers. This was done by quantifying gross income (GI) and total variable costs (TVC), GM allows the researcher to determine whether farmers are operating at a profit or loss during high-risk periods.

Gross Margin Formula:

$$\mathrm{GM} = \mathrm{GI} - \mathrm{TVC}$$

Where:

GM = Gross Margin (Rand)

GI = Gross Income (Rand)

TVC = Total Variable Costs (Rand)

Meaning that:

- $GM > 0 \rightarrow$ farmer is profitable
- $GM = 0 \rightarrow$ break-even
- $GM < 0 \rightarrow$ farmer is operating at a loss

For the study purpose, the Gross Margin was computed using the midpoint conversion method applied to all n=90 smallholder farmers who participated in the study and calculated as:

- **Gross Income (GI)** = Number of birds × Price per bird
- **Total Variable Cost (TVC)** = Feed + Labour + Veterinary + Transport + Sawdust
- **Gross Margin (GM)** = GI – TVC

3.9.2 Inferential analysis

Inferential statistical analysis was employed to examine the relationships between profitability and selected explanatory variables among smallholder poultry farmers (Gujarati, 2004). Inferential analysis provided a room to test the theoretical relationships and the estimation of the magnitude and direction of influence of independent variables on profitability as a dependent variable. This study adopted a multiple linear regression (MLR) model as the principal inferential tool due to its suitability for modelling continuous dependent variables and its extensive application in agricultural economics and farm profitability studies (Wooldridge, 2016).

The dependent variable for inferential analysis was gross margin (GM), measured in monetary terms (Rand). Gross margin was selected as an appropriate proxy for profitability because it directly reflects the difference between gross income and total variable costs, making it particularly suitable for smallholder farming systems where fixed costs are often minimal or irregular.

3.9.2.1 Model Specification: Multiple Linear Regression Model (MLR)

The study applied the Multiple Linear Regression Model (MLR) in two ways to ensure methodological rigour and improve the interpretability of profitability drivers. This was done by firstly separating the models, which assisted with avoiding misspecification, as combining accounting-based profitability components (e.g., prices and variable costs that mechanically determine gross margin) with perception-based and ordinal shock variables (e.g., load shedding and extreme weather indicators) in one equation would possibly distort coefficient estimates and artificially inflate goodness-of-fit. Secondly, the two-model approach improved analytical clarity: whereby regression 1, which was the primary profitability model, explained how gross margin is formed through enterprise cost–price relationships, while regression 2 on the complementary shock model, explained why profitability becomes threatened under rolling blackouts and extreme weather disruptions. Thirdly, conducting separate estimate modelling enhances interpretability by preventing dominant accounting variables from masking the effects of environmental stressors and coping responses. Lastly, this staged modelling strategy is consistent with empirical practice in smallholder and climate-impact research, where structural farm performance is often analysed separately from vulnerability and shock-related pathways to distinguish efficiency effects from exposure and resilience dynamics.

3.9.2.1.1 Multiple Linear Regression for Profitability (Gross Margin)

The first model focused on the accounting and production determinants of profitability. This model quantified the direct effects of farm-level production variables on gross margin. This specification is grounded in gross margin theory, where enterprise profitability is determined by gross income (driven by price and output) minus variable costs. Gross margin is widely used in farm management as a practical measure of enterprise profitability and comparative performance (FAO, 2007).

Model Specification

$GMi = β0+β1FSi+β2TVCi+β3Pi+εi$

Where:

- (GM_i) = Gross margin of the (i^{th}) farmer (Rand)
- (FS_i) = Farm size (number of birds)
- (TVC_i) = Total variable costs (feed, labour, veterinary, energy)
- (P_i) = Price per bird (Rand)
- (β_0) = Intercept
- $(\beta_1 – \beta_3)$ = Coefficients to be estimated
- $(εi)$ = Error term

Estimation Procedure

All monetary variables were measured on a continuous scale, ensuring compatibility with linear regression assumptions. Also, total variable costs and output prices were included as they reflect the theoretical foundation of gross margin analysis, whereby profitability is directly determined by revenues and variable inputs. Farm size was incorporated to test for scale effects, acknowledging that increased flock size does not necessarily translate into higher profitability in smallholder systems.

Table 3.3 Explanatory Variables and Expected Outcomes

Variable	Description	Measurement / Coding	Expected Outcome	Theoretical Justification
Gross Margin (GM)	Profitability of the i^{th} farmer	Continuous (Rand)	Dependent variable	GM reflects enterprise profitability as the difference between gross income and variable costs
Farm Size (FS)	Number of birds kept per production cycle	Continuous (Number of birds)	Positive (+)	Larger flocks may benefit from economies of scale, spreading variable costs over more output
Total Variable Costs (TVC)	Feed, labour, veterinary, energy and related costs	Continuous (Rand)	Negative (−)	Increases in variable costs directly reduce gross margins
Price per Bird (P)	Selling price received per bird	Continuous (Rand)	Positive (+)	Higher output prices increase gross income and profitability

Source: Author, 2025

3.10 Explanation of the variables in the multiple regression analysis

3.10.1 Gross Margin

Gross Margin is utilised to measure how profitable an enterprise is in agricultural economics. It shows the difference between gross revenue and the total variable costs(Evmenchik et al., 2021). The variable costs include feed costs, vaccination and labour costs. Gross Margin indicates how enterprises generate income using variable inputs(Zhang, 2024). There is a positive and negative gross margin, whereby a positive gross margin indicates that an enterprise is able to make a profit, while a negative gross margin indicates that the enterprise has high variable costs. In poultry production, gross margin is used to measure if production shocks such as loadshedding, extreme weather conditions affect the profitability of the farm.

3.10.2 Farm size

Farm size is determined by the number of birds a farmer maintains. Generally, farmers with larger-scale bird operations tend to generate higher profits than those with fewer birds on their farms. These observations align with the findings of Adewale and Yusuf (2024), who showed that egg production in the poultry industry is profitable, with profitability levels varying according to the production scale. Consequently, farm size is anticipated to correlate positively with smallholder poultry farmers' profitability.

3.10.3 Total Variable Costs

3.10.3.1 Feed cost

According to Ogunnusi and Akinwemoye (2023), good feeding techniques increase feed conversion efficiency, allowing broilers and layers to convert feed into body weight more efficiently and boost profitability. Doyin and Akinfala (2023) add that a well-balanced diet that satisfies these needs encourages healthy growth, weight gain, and development. The larger the number of birds kept on a farm, the higher the poultry feed cost per production cycle. Feed cost was expected to correlate negatively with smallholder poultry farmers' profitability. This means that feed costs reduce the profitability of smallholder poultry farmers.

3.10.3.2 Labour cost

Labour is an important component for growing and proper monitoring of the chickens to ensure efficiency (Wu et al., 2022). The larger the farm, the more labour is required. Labour costs were measured as the total wages spent per month. Labour costs are expected to negatively correlate with profitability because money spent on hired labour may reduce the profitability of smallholder poultry farmers.

3.10.3.3 Veterinary cost

The health of birds is an essential component of poultry production. Therefore, Serbessa et al. (2023) add that proper medication and vaccines reduce death rates, keep birds healthy throughout the production cycle, and keep them safe from diseases such as avian flu. The veterinary cost was measured as the total expenditure on veterinary care per cycle. The profitability of smallholder poultry farmers is likely to be inversely related to the expenses associated with veterinary care.

3.10.4 Energy and related costs

Energy and related costs are the costs poultry farmers incur to ensure efficient poultry production and a constant power supply (Hajiyev et al., 2022). A constant power supply helps the production system work well, and the systems include cooling, heating, and lighting. George and George (2022) add that these systems are important as they help maintain an optimal environment conducive to lowering the death rate of the birds and increasing growth performance. In the realm of smallholder poultry production, energy expenses frequently escalate considerably owing to dependence on electricity-dependent technologies and the necessity for alternative energy sources during times of load shedding(Soeker, 2025).

3.10.4.1 Price per bird

Chickens, as well as eggs, have become increasingly expensive because of the high production, vaccine, and transportation costs that farmers experience. For instance, feed costs continue to increase, and farmers are increasing the selling price of birds and eggs. Erdaw and Beyene (2022) add that poultry products are extraordinarily nutrient-dense as they help provide protein diets that are otherwise lacking in certain nutrients by preventing stunting. However, eggs and poultry meat are expensive in Africa because of the high feed cost and low yield. Price per bird was expected to have a positive relationship with the profitability of smallholder poultry farmers.

3.11 Multiple Linear Regression for Effects of Rolling Blackouts and Extreme Weather on Profitability

The second regression model was done to examine how rolling blackouts and extreme weather events have an effect on profitability. This model captured indirect and behavioural influences that are not reflected in accounting variables but are critical for understanding production vulnerability. As a result, rolling blackouts and extreme weather are associated with profitability through operational disruption, mortality risk, and coping responses. According to Cloete (2025), there has been evidence that load shedding raises costs and disrupts production systems, including livestock and poultry value chains (BFAP, 2023). Furthermore, doing the second regression also aligns with poultry climate literature showing that heat stress and climate extremes can reduce productivity and increase mortality, thereby depressing farm margins (Nawab et al., 2018; Oke et al., 2024).

Model Specification

$GM_i = \beta_0 + \beta_1 FLS_i + \beta_2 DLS_i + \beta_3 BP_i + \beta_4 LB_i + \beta_5 RBP_i + \varepsilon_i$

Where:

- (FLS_i) = Frequency of rolling blackouts
- (DLS_i) = Duration of rolling blackouts
- (BP_i) = Use of backup power
- (LB_i) = Loss of birds due to extreme weather
- (RBP_i) = Rolling blackouts leading to reduced profits (binary)
- Other terms are as previously defined

Estimation Procedure

This model was also estimated using OLS, via categorical and Likert-scale variables treated as ordered numerical indicators, a practice commonly adopted in applied socio-economic and agricultural research. The model was estimated separately from the primary profitability model to avoid multicollinearity and to prevent the mechanical identity between gross margin, costs, and revenues from obscuring the effects of environmental stressors.

Table 3.4 Explanatory Variables and Expected Outcomes

Variable	Description	Measurement / Coding	Expected Outcome	Theoretical Justification
Frequency of Load Shedding (FLS)	Number of blackout events	Ordinal	Negative (−)	Frequent outages disrupt feeding, ventilation, and temperature control
Duration of Load Shedding (DLS)	Length of blackout periods	Ordinal	Negative (−)	Longer outages exacerbate production interruptions and mortality risks
Backup Power Use (BP)	Use of generators/solar/batteries	Categorical	Positive (+)	Backup energy improves continuity of operations, despite added costs
Loss of Birds (LB)	Mortality due to extreme weather	Binary (Yes/No)	Negative (−)	Bird losses directly reduce output and income
Rolling Blackouts Reduce Profits (RBP)	Farmer-reported profit reduction	Binary (Yes/No)	Negative (−)	Reflects perceived and actual profitability decline due to outages

Source: Author, 2025

3.12 Explanation of the variables in the multiple regression analysis

3.12.1 Frequency of load shedding

High poultry mortality rates are associated with the occurrence of frequent rolling blackout, which disturbs the daily operations of smallholder poultry farmers in the study area. These disturbances negatively affect production systems that are essential for optimal production, from cooling, heating and ventilation systems (BDO South Africa, 2023). The frequency of loadshedding was measured by the number of times it occurs per week/ per month, and it had a negative relationship with the profitability of smallholder poultry farmers.

3.12.2 Duration of load shedding

While noting the frequency of rolling blackouts, it is also important to look at the duration of rolling blackouts. Longer rolling blackout periods further disturb the poultry operations of smallholder poultry farmers, more especially in intensive poultry systems. These types of systems are dependent on consistent controlled temperature for high productivity (DAFF, 2023). Thus, this results in increased stress, reduced feeding frequency in the birds, and production losses. Therefore, the duration of rolling blackouts was measured in hours per day, and results demonstrate a clear negative relationship between the duration of rolling blackouts and production performance.

3.12.3 Backup Power Use

Having backup power when rolling blackouts occur can help an enterprise to survive because operations can continue even when the electricity is disrupted. Although it is costly, it comes in handy as the cooling systems, heating will still continue, especially in a controlled environment where the birds are kept. Farmers with backup power are less exposed to higher losses (BDO South Africa, 2023). Access to backup power was expected to have a positive relationship with the profitability of smallholder poultry farmers.

3.12.4 Loss of Birds

Effective management techniques can improve production efficiency, reduce losses, and protect chicken welfare (George and George, 2023). The survival of birds depends on management and several other circumstances, making poultry farming a 50/50 venture.

According to Biswal et al. (2022), birds can be lost because of various factors, such as extreme weather conditions and disease outbreaks. High temperatures can result in heat stress in poultry. High temperatures have a detrimental effect on the health of the birds, as thye can cause heat stress, which can result in the birds having reduced feed intake and increasing the chances of diseases (FAO, 2022).

3.12.5 Rolling Blackouts Reduce Profits

Poultry production systems heavily rely on a steady supply of power. When rolling blackouts occur, it compels farmers to use alternate energy sources like diesel generators or battery systems. Rolling blackouts raise operational costs. The added fuel, equipment, and maintenance costs associated with these backup solutions increase the overall variable costs. Gross margins fall, and profitability decreases when energy-related expenses increase and production losses happen at the same time. According to FAO (2021), energy instability greatly impairs farm performance by raising operating risks.

3.13 Ethical Consideration Statement

Before collecting data, the University of Mpumalanga granted ethical clearance. The purpose and objectives of the study were communicated to all respondents, and ethical considerations were upheld without discrimination.

- **Respect**

It is crucial to show respect to the farmers and members of the community during the study. The researcher showed respect towards farmers, greeting them respectfully and asking for permission for their time with dignity and integrity. The researcher listened to what they had to say without interrupting them.

- **Respect for Privacy and Confidentiality**

The farmers were assured confidentiality, and the respondents' identities were kept anonymous. For confidentiality purposes, the researcher provided questionnaires that required the participants to provide only their signatures and dates instead of their names. Where they did not want to participate, the researcher accepted their decisions and respected their privacy.

- **Free and Informed Consent**

Before participating in the study, respondents received information about the survey's procedures and purposes. The researcher first explained the study objectives, why the research was conducted, and the importance of this study. Therefore, this allowed the participants to indicate if they were willing to participate. Where the language was a barrier to the farmers, the questions were asked and explained in their native language to ensure understanding. The researcher found one person in the area who knew the language best to speak, so the farmers could be free.

- **Honesty**

Participants were expected to answer the questionnaires truthfully and not to provide any information during their participation in the study. The researcher also showed transparency and honesty towards the participants throughout the research.

- **Beneficence and non-maleficence**

The study will benefit smallholder poultry farmers by providing alternative measures to help them sustain their poultry enterprises during rolling blackouts and extreme weather conditions. It also highlighted other smallholder poultry farmers' challenges and how they survive. This study did not endanger the health or interests of the respondents, as it contributes to the body of knowledge and provides information to smallholder poultry farmers.

- **Avoiding harm**

The researcher ensured that the respondent's well-being was prioritised. This research was about poultry farmers, and the researcher did not necessarily do any experiments, but asked permission to take pictures of the chickens to include in their research to show the visits done on the farms.

3.14 Chapter Summary

This chapter provides a quick overview of the study area. It explains and examines the research area's infrastructure, economic activity, and demographic distribution. The most common business models are reflected in the socioeconomic and agricultural industries or economies of the studied areas and their agroecological characteristics (e.g., climate and vegetation). This facilitates a better understanding of the characteristics of the research region.

This chapter further provides a comprehensive overview of the research methodology employed in the study. It encompasses the research design, target population, and sampling strategies utilised. The chapter delves into the processes of gathering and using both primary and secondary data sources. Additionally, it outlines the specific data collected and the analytical techniques applied to generate results. The study also introduces and defines the explanatory variables incorporated in the multiple regression model, exploring the determinants of smallholder poultry farmers' profitability and anticipated outcomes. The following segment presents and analyses the research's descriptive findings.

Chapter 4
Presentation of Descriptive and Empirical Results Discussions

4.1 Introduction

The first section of the chapter begins by explaining the demographic features of the sampled smallholder poultry farmers and how they relate to the dependent variable, profitability. This chapter's demographic characteristics include the age distribution of smallholder poultry farmers, their gender and educational level, respondent occupation, household size, total source of income, and energy sources used. This is followed by socioeconomic characteristics and farm activities (production data). The farm characteristics presented in this chapter include the type of poultry farming the smallholder poultry farmers are involved in, farming experience, number of birds kept, type of labour used, labour breakdown, where the birds are sourced, type of bedding material used in the farm, type of structure the birds are kept in, access to extension services as well as an abattoir, feeding frequency and type of feed used, vaccinations used, and finally the gross margin. The chapter further presents descriptive statistics such as mean values, frequencies, and percentages through tables, figures, and narrative descriptions. This section presents the empirical findings of the study. A multiple regression model was used to identify the factors affecting smallholder poultry farmers' profitability. The significance of the independent (explanatory) variables is evaluated, and inferences are drawn from the outcomes.

4.2 Profiling of study respondents

4.2.1 Demographic characteristics

Demographic characteristics are essential for profiling respondents and contextualising production behaviour within the study area. These characteristics provide insight into the personal attributes of farmers that may influence farm management decisions, productivity, and profitability. In this study, demographic variables were used to support the analysis of factors influencing the profitability of smallholder poultry farmers in Nkomazi Local Municipality (Mashego, 2024).

The study was conducted in Nkomazi Local Municipality, a Category B municipality located in the eastern part of the Ehlanzeni District, Mpumalanga Province. The area is characterised by a significant presence of smallholder poultry producers, making it suitable for assessing demographic and socioeconomic drivers of poultry farming profitability.

4.2.1.1 Age distribution

Table 4.1 presents the age distribution of smallholder poultry farmers in Nkomazi, indicating that the sector is predominantly driven by older and middle-aged individuals. Farmers aged above 50 years constituted the largest proportion of respondents (28.9%), followed by those aged 40–49 years (24.4%) and 30–39 years (23.3%). In contrast, youth participation was minimal, with only 2.2% of respondents falling within the 19–24-year age category.

This distribution suggests that smallholder poultry farming in the study area relies heavily on accumulated experience and long-term engagement rather than youthful entry. While the dominance of older farmers reflects stability, experience, and managerial competence, the low involvement of younger farmers raises concerns regarding generational succession and the long-term sustainability of the poultry sector. These findings differ from those of Ndashe et al. (2024), who reported higher youth participation in smallholder poultry farming, highlighting context-specific differences in agricultural engagement.

Table 4.1 Demographic Characteristics of Respondents (N=90)

	Variables	**Frequency**	**Percentage %**
Gender	Male	43	47.8
	Female	47	52.2
Age categories	19-24	2	2.2
	25-29	19	21.1
	30-39	21	23.3
	40-49	22	24.4
	>50	26	28.9
Level of Education	No formal education	20	22.2
	Primary	12	13.3
	Secondary	32	35.6
	Tertiary	26	28.9

Source: Survey data (2024)

4.2.1.2 Gender

The results indicate a relatively balanced gender distribution among respondents, with females constituting 52.2% and males 47.8% of the sample (Table 4.1). The slightly higher participation of women suggests that poultry farming plays an important role in supporting female-led livelihoods within the municipality.

This gender composition provides an opportunity to assess gender-specific production practices and management strategies in smallholder poultry farming. According to Statistics South Africa (2011), women often demonstrate strong competencies in poultry production, particularly in record keeping, enterprise monitoring, and financial management. The findings of this study are consistent with those of Mdletshe (2023), who also observed higher female participation in smallholder poultry farming across similar rural contexts.

4.2.1.3 Level of education

The educational profile of respondents shows that most smallholder poultry farmers had attained some level of formal education. Specifically, 22.2% of respondents had no formal education, 13.3% had primary education, 35.6% had secondary education, and 28.9% had tertiary education.

Education is a critical factor influencing farmers' ability to adopt improved production technologies, interpret extension advice, and make informed management decisions. Khan et al. (2022) support these findings, noting that education positively influences technology adoption and productivity, thereby enhancing profitability in poultry farming. Formal education equips farmers with the cognitive skills required to analyse production costs, manage risks, and respond effectively to operational challenges.

4.2.2 Socioeconomic characteristics

4.2.2.1 Energy Sources used

Energy access is fundamental to the efficiency and sustainability of poultry enterprises, as it supports key production activities, such as lighting, temperature regulation, feeding, and water provision. Modern poultry production systems rely heavily on stable energy sources to maintain optimal production conditions.

As presented in Table 4.2, the majority of respondents (98.9%) relied on electricity as their primary energy source, while only 1.1% used fossil fuels. No respondents reported using renewable or alternative energy sources. This heavy dependence on electricity exposes smallholder poultry farmers to significant production risks during power interruptions, particularly in the context of rolling blackouts. Shumba et al. (2021) similarly emphasised the importance of reliable energy access in sustaining poultry productivity and reducing operational losses.

Table 4.2 Socioeconomic Characteristics of Respondents

Variables	Categories	Frequency	Percentage
Household size	1-4 people	30	33.3
	5-7 people	42	46.7
	8-10 people	16	17.8
	>10 people	2	2.2
Household source of income	Salaries	27	30.0
	Wages	1	1.1
	Old age pension grant	18	20.0
	Self-employed	33	36.7
	Child support grant	2	2.2
	Retirement pension grant	1	1.1
	Covid 19 grant	8	8.9
Energy sources used	Electricity	89	98.9
	Fossil fuels	1	1.1
	Mass fuels	0	0
	Renewable energy	0	0
	Other	0	0
Weather predictions	Tv	37	41.1
	Radio	17	18.9
	Weather app via phone	23	25.6
	Social media	6	6.7
	Google weather	6	6.7
	Other	1	1.1

Source: Survey data (2024)

4.2.2.2 Household source of income

Household income sources play a critical role in supporting farm investment, input procurement, and enterprise sustainability. According to Mukherjee et al. (2019), diversified income sources enhance the resilience of smallholder farmers by reducing vulnerability to farm-level shocks.

The results show that 36.7% of respondents were self-employed, 30.0% received salaries, and 20.0% relied on old-age pension grants. Other income sources included COVID-19 grants (8.9%), child support grants (2.2%), wages (1.1%), and retirement pensions (1.1%). These findings indicate that many farmers depend on non-farm income sources to support poultry production.

Reliance on a single income source may constrain a farmer's ability to absorb losses and reinvest in production inputs, particularly during periods of energy disruptions or extreme weather events. Income diversification, therefore, plays an important buffering role in sustaining poultry enterprises.

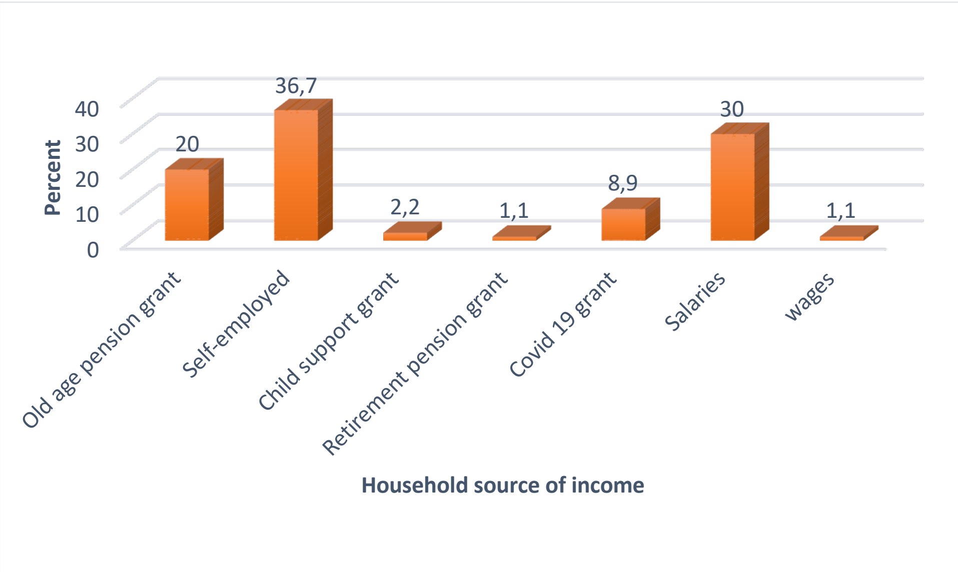

Figure 4.1 Household Source of Income for Smallholder Poultry Farmers

Source: Survey data (2024)

4.2.2.3 Weather predictions

Access to reliable weather information is essential for effective farm planning and risk management. Accurate weather forecasts enable farmers to anticipate adverse conditions, reduce losses, and optimise the use of resources (Nyoni et al., 2022).

As shown in Figure 4.2, the majority of respondents accessed weather information through television (41.1%), followed by weather applications on mobile phones (25.6%) and radio broadcasts (18.9%). Smaller proportions relied on Google weather (6.7%), social media platforms (6.7%), and personal knowledge (1.1%). The findings indicate increasing use of digital platforms alongside traditional media for accessing weather information, suggesting a gradual shift towards technology-assisted decision-making among smallholder poultry farmers.

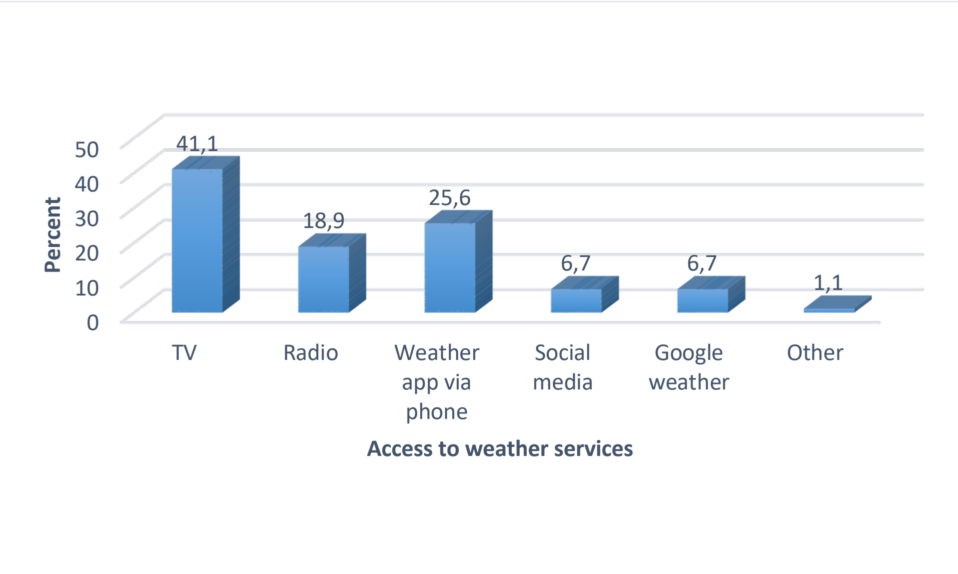

Figure 4.2 Access to weather services

Source: Survey data (2024)

4.3 Farming Characteristics

The resilience and profitability of an agricultural enterprise are largely determined by its production practices, management capacity, and scale of operation. Farming characteristics provide insight into how smallholder poultry farmers organise production, allocate resources, and manage risks. Table 4.3 presents key farming characteristics of the respondents, including type of poultry farming, farming experience, flock size, labour use, bird sourcing, age of birds stocked, feeding frequency, and feed type. These characteristics are critical for understanding variations in productivity and profitability among smallholder poultry farmers in the study area.

Table 4.3 Farm Characteristics of the Respondents

Variables	categories	Frequency	Percentage %
Type of farming	Broiler	71	78.9
	Layers	14	15.6
	Mixed	5	5.6
Farming experience	1 Year	19	21.1
	2 Years	16	17.8
	4 Years	20	22.2
	6 Years	10	11.1
	>6 Years	25	27.8
No of birds kept	50	18	20.0
	100	22	24.4
	200	12	13.3
	350	9	10.0
	>350/ Other	26	28.9
Type of labour	Family labour	59	65.6
	Permanent labour	19	21.1
	Temporal labour	8	8.9
	Other	4	4.4
Birds source	Alzu	27	30.0
	Early bird	16	17.8
	TOMACCESS poultry farm	1	1.1
	Farmers meet supply	4	4.4
	Other	42	46.7
Age of birds sourced	1 Day old chick	48	53.3
	2 weeks	23	25.6
	4 weeks	14	15.6

Variables	categories	Frequency	Percentage %
	6 weeks	1	1.1
	7 weeks	1	1.1
	Other	2	2.2
	Egg machine	1	1.1
Feeding frequency	4 times a day	26	28.9
	2 times a day	34	37.8
	3 times a day	30	33.3
Feed type	Starter, Grower & finisher	44	48.9
	Grower/ Finisher	27	30.0
	Layer pellets	9	10.0
	Yellow maize meal	1	1.1
	Mash	9	10.0

Source: Survey data (2024)

4.3.1 Type of poultry farming

The results indicate that the majority of respondents (78.9%) were engaged in broiler production, while 15.6% specialised in layer production, and only 5.6% practised mixed farming involving both broilers and layers (Figure 4.3). The dominance of broiler production reflects farmers' preference for enterprises with shorter production cycles and quicker cash returns.

Broiler farming offers faster turnover compared to layer production, which requires higher initial investment and longer production periods before returns are realised. The limited adoption of mixed farming suggests risk aversion among smallholder farmers, as managing multiple production systems simultaneously requires higher technical skills and capital investment.

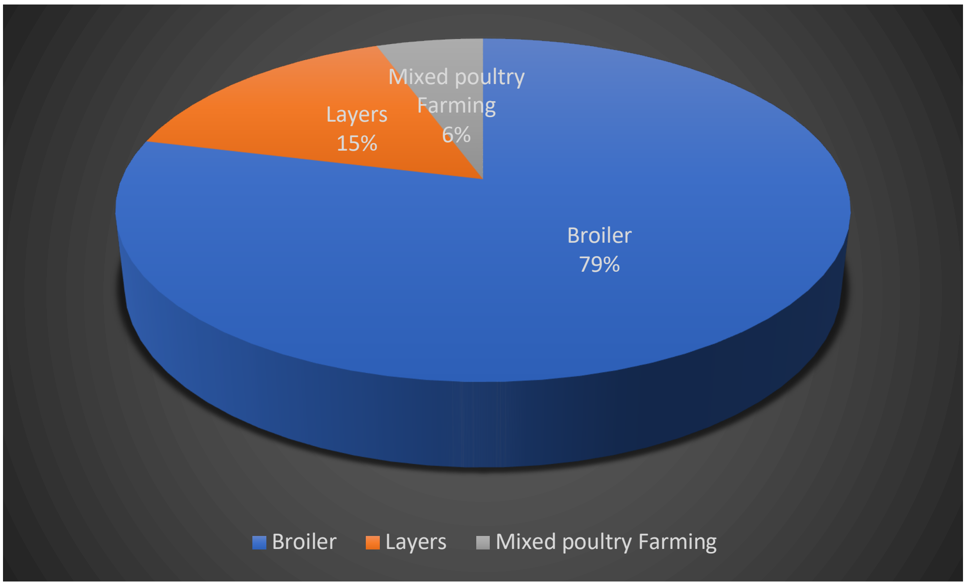

Figure 4.3 Types of Poultry Farming Practised by Respondents

Source: Survey data (2024)

4.3.2 Training on Poultry Farm Management

Access to training is fundamental to effective poultry production, particularly among smallholder farmers. Training enhances farmers' understanding of feeding regimes, disease prevention, housing management, and biosecurity practices. Yusuf and Popoola (2022) report that trained farmers demonstrate improved production efficiency and better management of poultry enterprises compared to untrained farmers.

As illustrated in Figure 4.4, a substantial proportion of respondents (77.0%) indicated that they had not received any formal training prior to engaging in poultry farming, while only 23.0% reported having received training. Training opportunities reported by respondents included free government-supported programmes and paid training offered by private agribusinesses through face-to-face or online platforms. However, the cost associated with paid training was identified as a major barrier to participation.

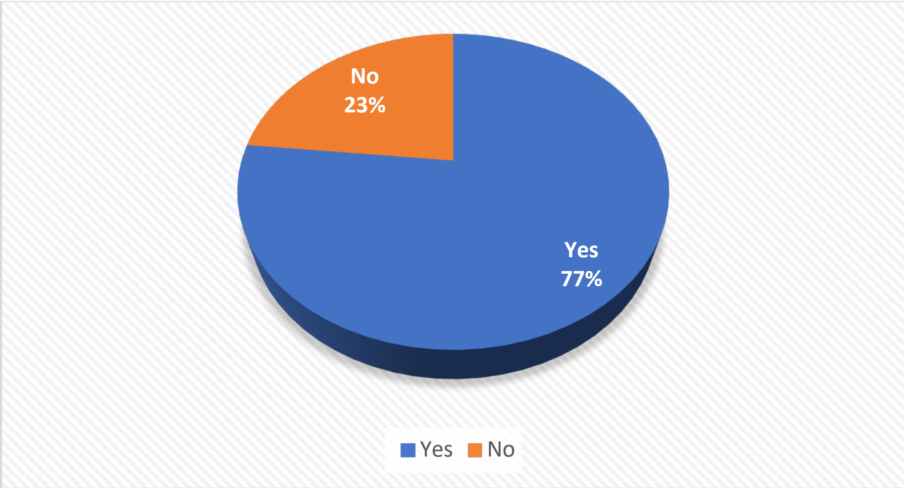

Figure 4.4 Training on Poultry Farm Management

Source: Survey data (2024)

The lack of training among most respondents has implications for farm productivity and profitability, as untrained farmers may struggle with disease management, feed optimisation, and vaccination protocols. Grace et al. (2024) emphasise that training equips farmers with essential knowledge on poultry health management, appropriate vaccination schedules, and correct administration of vaccines, which are critical for reducing mortality and improving production outcomes.

4.3.3 Vaccines

Vaccination is a critical component of poultry health management and disease prevention. Failure to vaccinate poultry against common diseases such as Newcastle disease can result in mortality rates of up to 50% in broiler projects (Grace et al., 2024).

Figure 4.5 shows that 42.22% of respondents reported that they do not vaccinate their birds. Reasons provided included the assumption that chicks were already vaccinated upon purchase, lack of awareness regarding vaccination requirements, and the perception that disease-related losses were due to natural causes. Consequently, some farmers experienced avoidable bird losses without investigating the underlying disease causes.

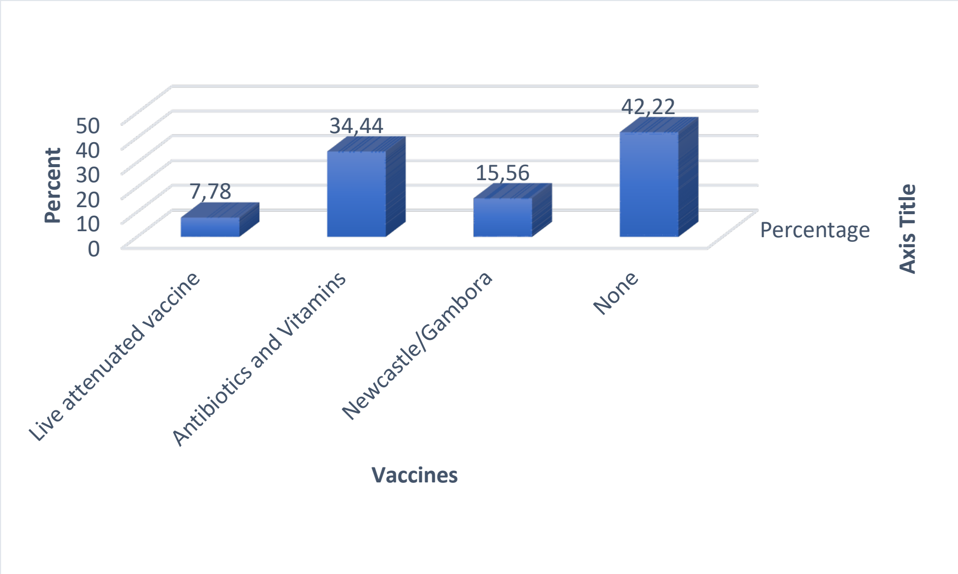

Figure 4.5 Vaccination Practices Among Smallholder Poultry Farmers

Source: Survey data (2024)

In contrast, 57.78% of respondents reported using various disease control measures. Of these, 7.78% used live attenuated vaccines, 15.56% administered vaccines against Newcastle disease and Gumboro disease, while 34.44% relied on antibiotics and vitamin supplements to enhance bird immunity. Although the use of antibiotics and vitamins may support general health, they do not substitute for proper vaccination protocols.

The high proportion of farmers who do not vaccinate their birds suggests inadequate extension support and limited access to veterinary guidance. Simbizi et al. (2021) highlight that insufficient extension engagement often results in poor disease management practices among smallholder farmers. Antwi-Agyei and Stringer (2021) further note that extension officers play a vital intermediary role in disseminating agricultural knowledge and supporting informed decision-making to enhance sustainable production.

4.3.4 Access to extension officers

Extension services are essential for strengthening farmers' technical capacity, improving farm management practices, and enhancing productivity. Manyakanyaka (2022) emphasises that extension programmes serve as key channels for transferring agricultural knowledge, while Maulu et al. (2021) argue that their effectiveness depends on responsiveness to farmers' local needs.

As shown in Figure 4.6, the vast majority of respondents (92%) reported having no access to extension services, while only 8% indicated that they had access to extension officers. Respondents noted that extension services, where available, offered potential benefits such as access to funding opportunities, production inputs, and technical advice. However, many farmers expressed dissatisfaction, citing infrequent visits, unfulfilled promises, and limited follow-up support.

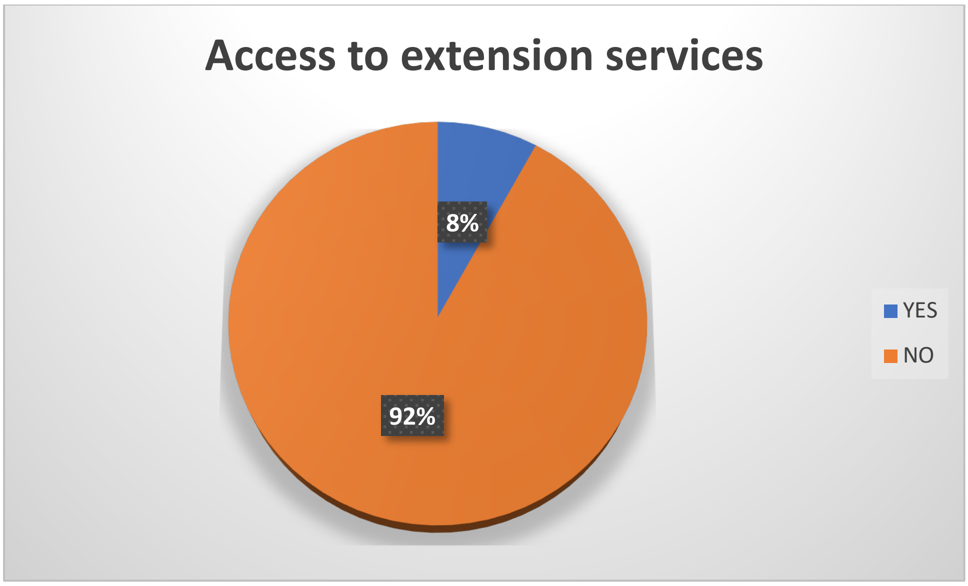

Figure 4.6 Access to Extension Services by Smallholder Poultry Farmers

Source: Survey data (2024)

Some respondents further indicated that they were unaware of the existence of extension services, despite having farmed for several years. The limited access to extension support likely constrains farmers' ability to adopt improved production practices, manage disease effectively, and access markets. Enhancing extension service delivery could therefore play a significant role in improving productivity and economic returns for smallholder poultry farmers.

4.4 Perceptions of smallholder poultry farmers on rolling blackouts

Understanding farmers' perceptions is essential for identifying production risks and informing targeted interventions aimed at improving farm resilience. According to Mfulwane (2023), farmers' perceptions provide insight into the challenges experienced at the farm level and highlight critical areas requiring policy and institutional support. In this study, perceptions of smallholder poultry farmers were analysed using a five-point Likert scale to assess the perceived effects of rolling blackouts on poultry production and profitability.

The findings presented in Table 4.4 indicate that respondents generally perceived rolling blackouts as a major constraint to poultry production. High perception levels were recorded for statements relating to poultry health, reduced operating hours, increased operational costs, reduced production, and declining profitability. These results suggest that farmers are highly aware of the direct operational and financial consequences of electricity interruptions.

Specifically, a high proportion of respondents agreed that rolling blackouts pose significant challenges to poultry health (Mean = 1.96), reduce the number of hours their enterprises are able to operate (Mean = 2.14), and lead to increased operating costs (Mean = 2.02). Furthermore, respondents strongly perceived that rolling blackouts negatively affect farm production (Mean = 2.07) and overall farm profitability (Mean = 2.03). These findings underscore the central role of electricity in maintaining optimal production conditions, including lighting, temperature control, feeding, and water supply.

In contrast, respondents demonstrated relatively low perception levels regarding the broader structural and long-term implications of rolling blackouts. Statements relating to economic instability (Mean = 1.86), hindrance to enterprise diversification (Mean = 1.94), availability of backup power as a mitigation strategy (Mean = 1.80), and the role of infrastructure and support systems (Mean = 1.79) were rated as low perception. This suggests that while farmers clearly recognise the immediate impacts of rolling blackouts on daily operations and profitability, there is less awareness or confidence regarding long-term mitigation strategies and institutional solutions.

The overall grand mean score of 1.95 indicates that smallholder poultry farmers in the study area generally perceive rolling blackouts as having a substantial negative impact on their farming activities. However, the relatively low perception of mitigation measures highlights gaps in access to information, technical support, and infrastructure development. These findings point to the need for enhanced extension services, improved energy infrastructure, and increased awareness of alternative energy solutions to strengthen farmers' capacity to cope with electricity disruptions.

Table 4.4 Perceptions of Smallholder Poultry Farmers on Rolling Blackouts and Extreme Weather Conditions

Perception Statements	SA%	A (%)	Un (%)	D (%)	SD (%)	Mean	σ	Decision
1. Rolling blackouts hinder the diversification of poultry farmers' services	47 (52.2)	24 (26.7)	6 (6.7)	3 (3.3)	10 (11.1)	1.94	1.319	Low perception
2. Rolling blackouts results in economic instability	52 (57.8)	22 (24.4)	3 (3.3)	3 (3.3)	10 (11.1)	1.86	1.320	Low perception
3. Rolling blackouts can pose significant challenges, impacting poultry health	50 (55.6)	22 (24.4)	1 (1.1)	6 (6.7)	11 (12.2)	1.96	1.398	High perception
4. Availability of backup power can help mitigate rolling blackouts	54 (60.0)	22 (24.4)	1 (1.1)	4 (4.4)	9 (10.0)	1.80	1.291	Low perception
5. Rolling blackouts of electricity enable my enterprise to operate for fewer hours	49 (54.4)	15 (16.7)	4 (4.4)	8 (8.9)	14 (15.6)	2.14	1.533	High perception
6. Rolling blackouts of electricity cause an increase in operation cost	51 (56.7)	18 (20.0)	2 (2.2)	6 (6.7)	13 (14.4)	2.02	1.476	High perception
7. Rolling blackouts affect production of the farm	51 (56.7)	17 (18.9)	1 (1.1)	7 (7.8)	14 (15.6)	2.07	1.520	High perception
8. Rolling blackouts affect overall profit of the farm	52 (57.8)	16 (17.8)	1 (1.1)	9 (10.0)	12 (13.3)	2.03	1.487	High perception
9. Efforts to improve infrastructure and support systems can help mitigate some of the rolling blackouts challenges	55 (61.1)	20 (22.2)	2 (2.2)	5 (5.6)	8 (8.9)	1.79	1.276	Low perception

Source: Survey data (2024)

SA=Strongly Agree, A=Agree, UN= Uncertain, D= Disagree, SD= Strongly disagree, grand mean=17.55/9=1.95

4.5 Challenges Faced by Smallholder Poultry Farmers due to Rolling Blackouts

Smallholder poultry farmers experience considerable operational and financial challenges as a result of persistent rolling blackouts. These challenges are further intensified by rising living costs, which have increased the prices of poultry products such as eggs and chicken meat (Henchion et al., 2021). The frequency and unpredictability of rolling blackouts disrupt routine farm operations, leading to income losses, increased production costs, and elevated bird mortality rates (Madibana et al., 2024).

Figure 4.7 illustrates the major challenges encountered by smallholder poultry farmers during rolling blackouts. The results show that rolling blackouts significantly constrain farmers' ability to plan production activities, as outages vary in frequency and duration across different areas. Approximately, 89% of respondents reported experiencing rolling blackouts at least twice per day, with some experiencing outages up to four times daily. A further 11% reported experiencing rolling blackouts three times per day consistently.

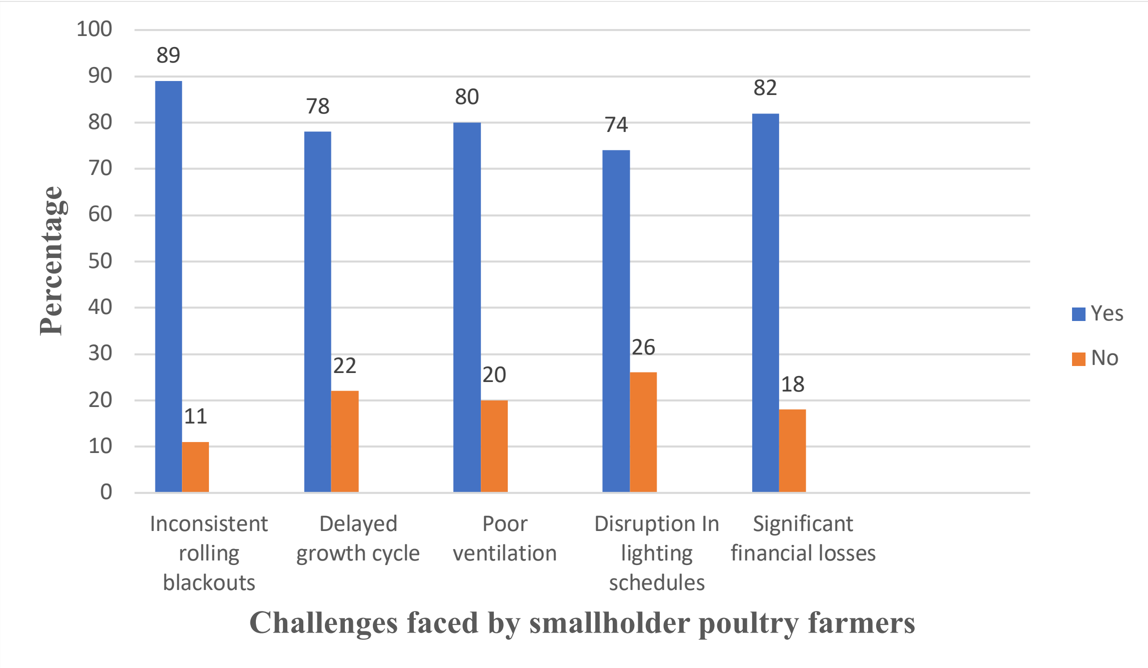

Figure 4.7 Challenges Faced by Smallholder Poultry Farmers Due to Rolling Blackouts

Source: Author (2024)

Respondents indicated that adapting to these frequent disruptions is difficult, resulting in challenges such as interrupted growth cycles, inadequate ventilation, and disrupted lighting schedules. Notably, 74% of respondents reported that rolling blackouts affected lighting schedules, while 26% indicated no effect. Disrupted lighting schedules negatively influence feed intake and growth performance, as poultry require consistent lighting to maintain regular feeding behaviour. As a result of these operational challenges, approximately ten respondents reported having closed their poultry enterprises.

Financial losses were identified as one of the most severe consequences of rolling blackouts, with 82% of respondents indicating significant economic losses. These findings are consistent with Wright et al. (2024), who argue that government responses to mitigate the effects of rolling blackouts on food security remain inadequate. Similarly, Kintu (2022) found that rolling blackouts significantly disrupted the operations of small and medium-sized enterprises, including those in the agricultural sector.

4.6 Coping Mechanisms

Coping strategies adopted by smallholder poultry farmers vary widely and are shaped by individual circumstances, resource availability, and production systems (Bist et al., 2024). Sime and Aune (2019) emphasise that farmers must adopt context-specific coping mechanisms to enhance resilience and ensure enterprise survival during periods of economic, environmental, or infrastructural stress. Developing and implementing effective coping strategies is, therefore, essential for sustaining poultry production under adverse conditions such as rolling blackouts and extreme weather events.

4.6.1 Coping Mechanisms for Rolling Blackouts

4.6.1.1 Alternative Power Sources Used During Rolling Blackouts

Alternative energy sources play a critical role in sustaining poultry production during electricity outages. However, Figure 4.8 shows that the majority of respondents (60%) did not use any alternative power sources during rolling blackouts. Instead, these farmers suspended operations until electricity was restored, largely due to the high costs associated with alternative energy technologies.

Only 12% of respondents reported using generators, while 16% relied on solar panels, which were perceived as more affordable than generators. A further 12% utilised battery-powered systems due to their lower operational costs. Some respondents noted that broiler production cycles of four to five weeks required limited electricity, reducing the perceived need for alternative power sources. Similarly, some layer producers reported minimal reliance on electricity for daily operations.

These findings align with Kintu (2022), who highlights that while alternative energy solutions are critical for enterprise survival, high capital costs often limit their adoption among smallholder farmers.

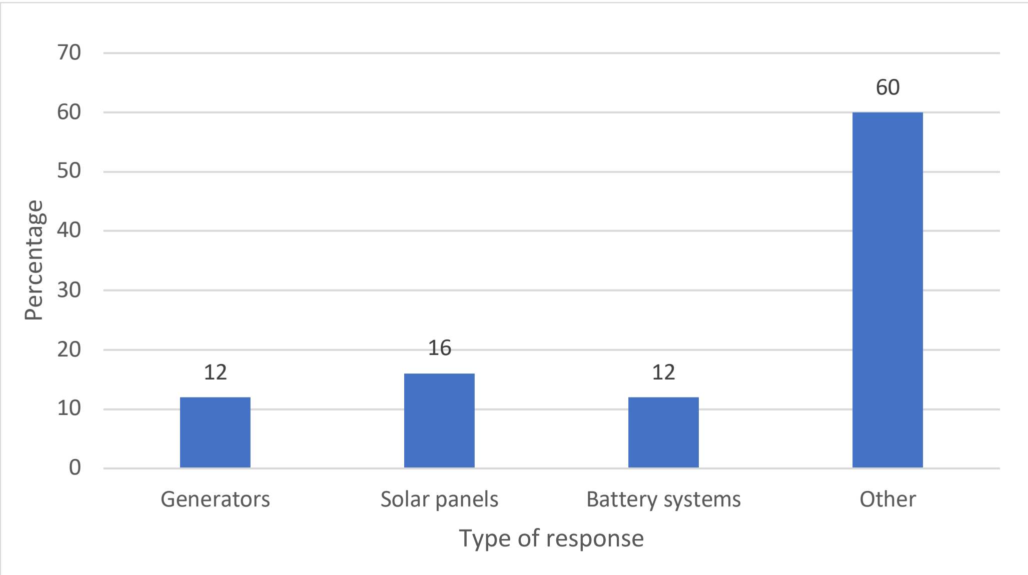

Figure 4.8 Alternative Power Sources Used During Rolling Blackouts
Source: Survey data (2024)

Alternative power sources play an important role in poultry production, especially when the main sources that the majority of farmers use are not available (electricity). According to Kintu (2022), putting alternative sources to cope with the inconsistent rolling blackouts is key to the survival of poultry farming enterprises**.** Strategies smallholder poultry farmers use during rolling blackouts. Interestingly, 60% of the respondents indicated that they did not use any alternative power sources during rolling blackouts. Instead, they suspend operations until power is restored because they cannot afford additional costs to their enterprises. Moreover, 12% of smallholder poultry farmers used generators during rolling blackouts to keep their businesses running and growing. Another 16% used solar panels because they are more affordable than generators.

Additionally, 12% of the respondents relied on battery systems despite being cost-effective. Furthermore, some smallholder poultry farmers who raise broilers for 4-5 weeks mentioned that they do not require much electricity during this period because the chickens are already grown. Similarly, poultry farmers who raise layers noted that their operations do not require much electricity and thus do not need additional power sources.

4.6.1.2 Lighting solution used during rolling blackouts

Lighting is essential for poultry growth, feed intake, and thermal comfort (Sakata and Siqueira, 2023). Figure 4.9 indicates that the majority of respondents (69%) used rechargeable LED lights during rolling blackouts, while 22% relied on battery-powered lights and 9% used solar-powered lighting systems.

Rechargeable LED lights were preferred due to their availability, affordability, and ability to provide both light and limited heat. These findings are consistent with Egwuma et al. (2019), who reported widespread adoption of artificial lighting systems among poultry farmers to maintain optimal production conditions. However, respondents using solar-powered lighting noted that prolonged rolling blackouts reduced charging efficiency, limiting the effectiveness of these systems.

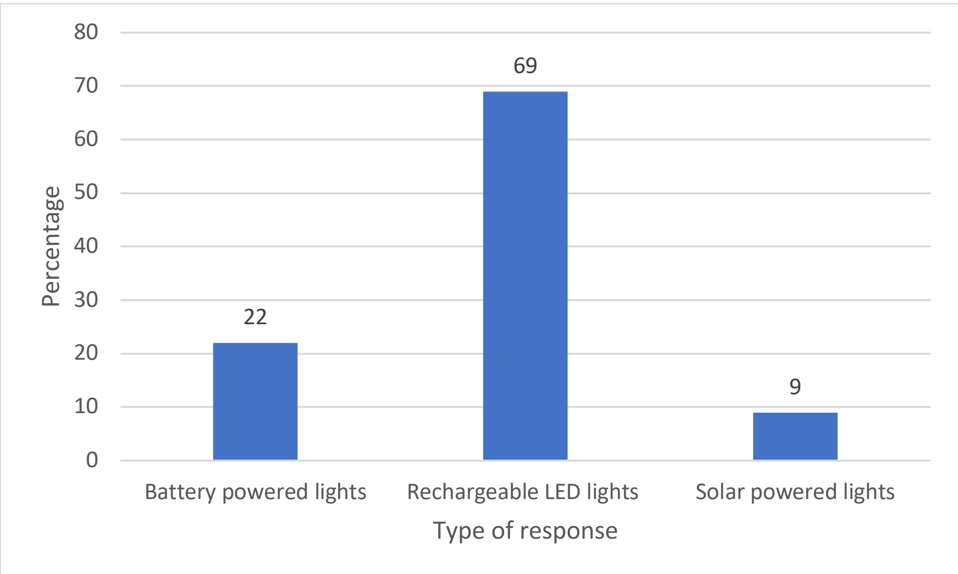

Figure 4.9 Lighting Solutions Used During Rolling Blackouts
Source: Survey data (2024)

According to Sakata and Siqueira (2023), lighting allows chickens to grow quickly, and for that to occur, the birds need to have the right conditions. Consequently, lighting has a direct impact on the chickens' development. The survey results indicate that most respondents use rechargeable LED lights, which are readily available and provide heat for their chickens, especially broilers. This finding is consistent with Egwuma et al. (2019), who found that 78% of farmers in Kaduna State had implemented proper lighting, heat, and humidity in their poultry houses. Additionally, the infrared lamps reach an average temperature of 33°C and are specifically designed to distribute enough heat to warm all sections of the poultry room when placed correctly. Besides, 69% of the respondents were using rechargeable LED lights. In comparison, 20% reported using battery-powered lights, which only require batteries to operate and help keep the poultry houses lit, allowing the chicks to feed day and night without interruptions. The 8% percent indicated using solar-powered lights, which charge from sunlight to provide light when there is no electricity. However, respondents noted that frequent rolling blackouts affected the solar-powered lights because they would be out for longer hours than usual, causing them to use more power to stay on and not charge enough.

4.6.2 Coping Mechanisms for Extreme Weather Conditions

4.6.2.1 Structural and Environmental Adaptation

Extreme weather conditions pose significant risks to poultry health and productivity (Nyoni et al., 2019). As shown in Table 4.7, 60% of respondents relied on poultry houses constructed with durable materials, while 40% employed windbreaks and shade structures to protect birds from strong winds, heavy rainfall, and excessive heat. These low-cost structural adaptations were perceived as effective in safeguarding poultry during adverse weather conditions.

Table 4.5 Coping Mechanisms Used During Extreme Weather Conditions

Sample size	Solutions	Frequency	Percentage
	Poultry houses with durable material	**54**	**60**
90	windbreaks and shade to protect poultry houses from strong winds and provide shade during extreme heat.	**36**	**40**

Source: Survey data (2024)

4.6.2.2 Temperature Regulation

Temperature regulation is critical in poultry production, as extreme heat or cold can result in significant mortality and productivity losses (Goel, 2021). In the absence of electricity, many respondents reported using alternative methods such as heating with wood or cooling poultry houses by pouring water on metal roofing sheets. While these methods were described as cost-effective, they were also labour-intensive and less efficient.

A small proportion of respondents (7%) used battery-operated systems for temperature regulation, while 6% relied on insulation materials. Approximately 3% indicated that no temperature control measures were necessary, as their birds were sold shortly after reaching market weight.

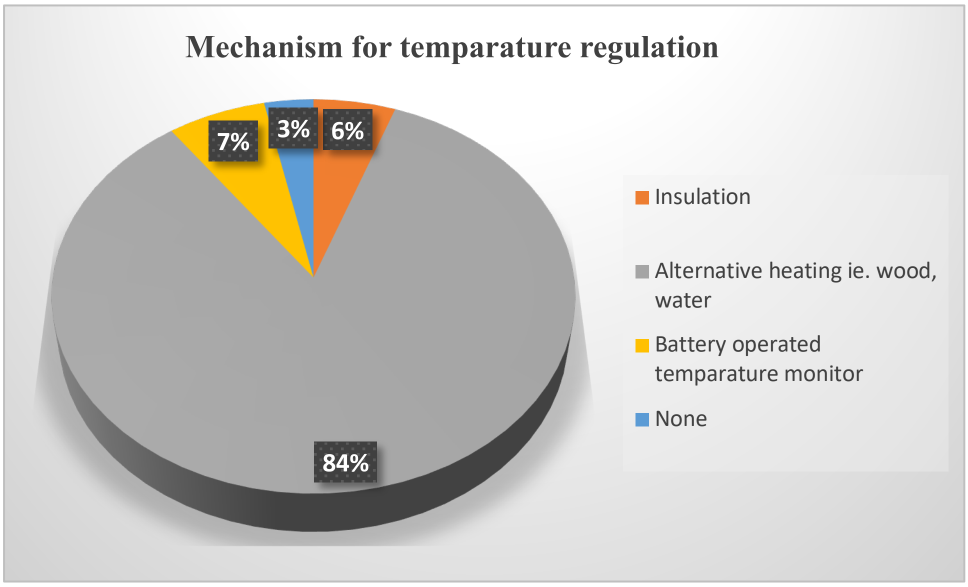

Figure 4.10 Coping Mechanisms for temperature regulation

Source: Survey data (2024)

4.6.2.3 Ventilation and Air Quality

Proper ventilation is essential for maintaining air quality, regulating temperature, and preventing disease outbreaks (Gerritzen et al., 2022). Figure 4.9 shows that 97% of respondents relied on poultry houses with movable windows and ventilated roofing structures to ensure adequate airflow. Hofmann et al. (2020) confirm that effective ventilation reduces disease prevalence and improves overall poultry welfare.

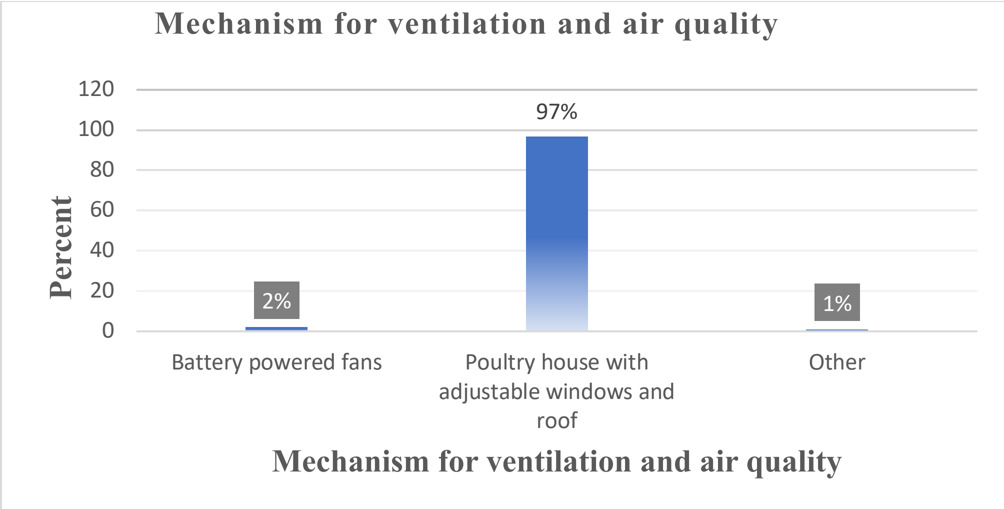

Figure 4.11 Ventilation and Air Quality Mechanisms
Source: Survey data (2024)

4.6.2.4 Provision of heat

Provision of heat is particularly important for day-old chicks, which are highly sensitive to cold conditions (Vieira et al., 2019). Figure 4.10 shows that 61% of respondents last provided heat within the previous month, 18% the previous day, and 13% the previous week. A small proportion (8%) reported not providing heat, citing well-insulated poultry houses that retained warmth.

These findings align with Mukuma (2020), who observed that farmers often use charcoal as an alternative heat source during rolling blackouts, particularly during winter months.

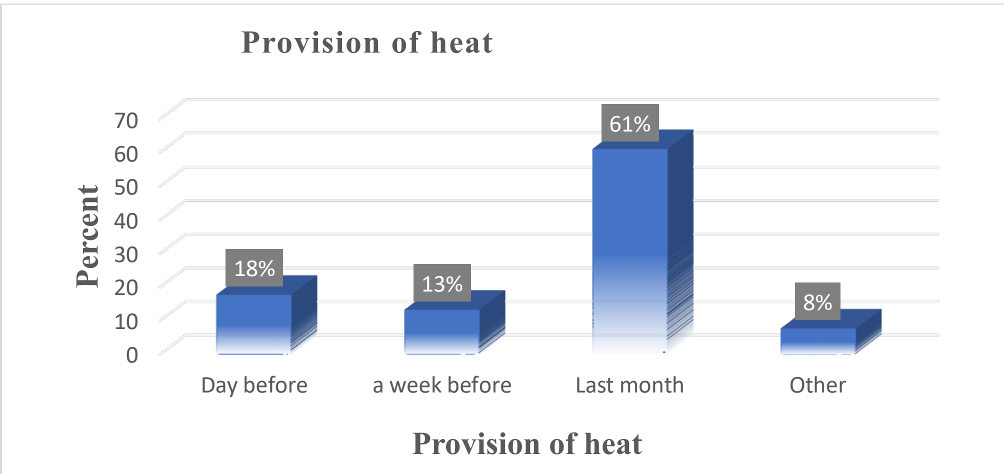

Figure 4.12 Provision of Heat During Extreme Weather Conditions
Source: Survey data (2024)

4.7 Financial aid Used During Extreme Weather Conditions and Rolling Blackouts

Figure 4.11 illustrates the financial coping mechanisms adopted by respondents. The majority of respondents (87%) reported having no access to financial aid, insurance, or emergency funds. However, 8% reported using pension savings as emergency funds to purchase generators, solar panels, and fans, while 5% had insurance coverage.

Respondents with insurance indicated that it was particularly beneficial during disruptions caused by rolling blackouts and extreme weather events. These findings are supported by Attia et al. (2022), who highlight the importance of financial risk management tools in building resilience among smallholder farmers.

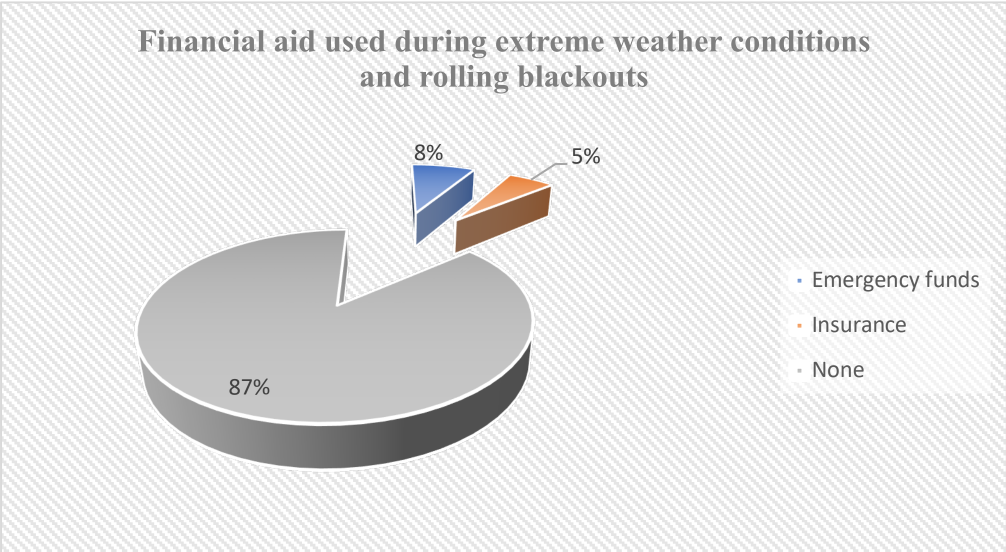

Figure 4.13 Financial Aid Used by Respondents

Source: Survey data (2024)

4.8 Smallholder Poultry Farmer's Profitability Classification

Gross margin framework is highly useful in smallholder farmer's contexts because it isolates short-term operational efficiency from fixed asset considerations. As a result, for smallholder poultry producers, this allows for the identification of cost categories most sensitive to shocks, a necessary step in improving farm-level decision-making and resilience (Omondi, 2019).

For this study, the gross margin analysis was used by applying the methods mentioned in Chapter 3. The study results revealed that while smallholder poultry production can remain profitable, profitability margins are highly volatile. Factors such as Feed price inflation, labour costs, and climate-related shocks are the primary threats to the sustained gross income of these farmers. Hence, strategic interventions such as cost-sharing mechanisms, input subsidies, and renewable energy integration could help improve GM stability and farmer livelihoods. Table 4 revealed that 92.2% of the respondents were profitable as their GM was greater than zero (GM>0), while 7.8% of the respondents had a loss as their NM was less than or equal to zero (GM ≤ 0).

Table 4.6 Profitability Status of Smallholder Poultry Farmers (n = 90)

Profitability category	**Frequency**	**Percentage (%)**
Profitable (GM > 0)	83	92.2
Loss-making (GM ≤ 0)	7	7.8
Total	**90**	**100**

Source: Survey data (2024)

Table 4.6 further presents the GM results, demonstrating a significant variability in financial performance across the smallholder poultry farmers (n=90) as the study participants. The average GM was calculated to be R13,973, indicating that most farmers were able to generate a positive return after covering variable costs. This suggested that gross income exceeded variable costs, denoting sustainable production in the short term (Omondi, 2019).

However, the minimum GM value of –R17,500 demonstrates that a subgroup of farmers operated at a loss during periods characterised by rolling blackouts and extreme weather conditions. Negative margins among some farmers reflect the vulnerability of smallholders to high input costs, particularly feed and labour, which often account for more than 70% of production expenses (Mottet and Tempio, 2017). These findings align with Ahaibwe et al. (2013), who found that poultry enterprises with high feed and veterinary costs experience reduced profitability, especially during supply disruptions. Additionally, the wide range between the 25th percentile (R2,125) and the 75th percentile (R26,450) further highlights gaps in profitability of the farmers, which is likely driven by differences in feed expenditure, labour intensity, mortality events, and market prices. These findings suggest that while the poultry enterprise remains viable for many farmers, there were external shocks such as power outages and climate-related issues that significantly weakened the smallholder poultry farmer's profitability, making them vulnerable.

Table 4.7 Profitability Classification of Smallholder Poultry Farmers (n = 90)

Respondents	Number of Birds	GI (R)	TVC (R)	GM (R)	Profitability Category
1	125	10,625	6,925	3,7	Profitable
2	125	10,625	1,25	9,375	Profitable
3	200	17	6,925	10,075	Profitable
4	500	42,5	15,55	26,95	Profitable
5	500	42,5	13,4	29,1	Profitable
6	200	17	6,125	10,875	Profitable
7	500	42,5	19,2	23,3	Profitable
8	125	10,625	3,9	6,725	Profitable
9	30	2,4	700	1,7	Profitable
10	500	42,5	19,65	22,85	Profitable
11	30	2,4	800	1,6	Profitable
12	125	10,625	2,815	7,81	Profitable
13	30	2,4	800	1,6	Profitable
14	125	10,625	600	10,025	Profitable
15	350	29,75	8,125	21,625	Profitable
16	500	42,5	12,8	29,7	Profitable
17	125	10,625	550	10,075	Profitable
18	125	10,625	6,215	4,41	Profitable
19	200	17	6,215	10,785	Profitable
20	500	42,5	17,35	25,15	Profitable
21	500	42,5	11,2	31,3	Profitable
22	125	10,625	10,65	-25	Loss-making
23	650	55,25	17,65	37,6	Profitable
24	200	17	10,45	6,55	Profitable
25	30	2,4	1,3	1,1	Profitable
26	125	10,625	12,3	-1,675	Loss-making
27	500	42,5	12,45	30,05	Profitable
28	500	42,5	13,7	28,8	Profitable
29	500	42,5	16,85	25,65	Profitable
30	500	42,5	16,05	26,45	Profitable

Respondents	Number of Birds	GI (R)	TVC (R)	GM (R)	Profitability Category
31	125	10,625	3,65	6,975	Profitable
32	30	2,4	800	1,6	Profitable
33	125	10,625	4,665	5,96	Profitable
34	125	10,625	7,35	3,275	Profitable
35	500	42,5	16,85	25,65	Profitable
36	200	17	5,15	11,85	Profitable
37	500	42,5	18,35	24,15	Profitable
38	350	29,75	6,35	23,4	Profitable
39	500	42,5	18,55	23,95	Profitable
40	650	55,25	16,8	38,45	Profitable
41	125	10,625	6,35	4,275	Profitable
42	500	42,5	20,1	22,4	Profitable
43	125	10,625	3,415	7,21	Profitable
44	30	2,4	400	2	Profitable
45	350	29,75	17,825	11,925	Profitable
46	125	10,625	5,15	5,475	Profitable
47	500	42,5	7,6	34,9	Profitable
48	125	10,625	5,15	5,475	Profitable
49	125	10,625	6,35	4,275	Profitable
50	650	55,25	27,4	27,85	Profitable
51	200	17	10	7	Profitable
52	30	2,4	350	2,05	Profitable
53	350	29,75	10,15	19,6	Profitable
54	30	2,4	350	2,05	Profitable
55	30	2,4	6,3	-3,9	Loss-making
56	200	17	9,3	7,7	Profitable
57	30	2,4	3,15	-750	Loss-making
58	30	2,4	6,15	-3,75	Loss-making
59	500	42,5	11,35	31,15	Profitable
60	200	17	4,265	12,735	Profitable
61	30	2,4	800	1,6	Profitable
62	125	10,625	4,265	6,36	Profitable
63	125	10,625	5,465	5,16	Profitable
64	125	10,625	5,465	5,16	Profitable
65	350	29,75	11,35	18,4	Profitable
66	500	42,5	17,45	25,05	Profitable
67	200	17	2,3	14,7	Profitable
68	500	42,5	12,8	29,7	Profitable

Respondent s	Number of Birds	GI (R)	TVC (R)	GM (R)	Profitability Category
69	500	42,5	17,9	24,6	Profitable
70	500	42,5	10,15	32,35	Profitable
71	125	10,625	600	10,025	Profitable
72	200	17	6,35	10,65	Profitable
73	200	17	5,15	11,85	Profitable
74	125	10,625	6,15	4,475	Profitable
75	500	42,5	24,9	17,6	Profitable
76	200	17	9,3	7,7	Profitable
77	350	29,75	8,35	21,4	Profitable
78	350	29,75	10,65	19,1	Profitable
79	500	42,5	24,35	18,15	Profitable
80	30	2,4	400	2	Profitable
81	30	2,4	800	1,6	Profitable
82	30	2,4	800	1,6	Profitable
83	500	42,5	2,815	39,685	Profitable
84	500	42,5	7,6	34,9	Profitable
85	30	2,4	3,15	-750	Loss-making
86	350	29,75	5,15	24,6	Profitable
87	30	2,4	8,15	-5,75	Loss-making
88	350	29,75	5	24,75	Profitable
89	500	42,5	8,85	33,65	Profitable
90	30	2,4	2,3	100	Profitable

Source: Survey (2024)

When it comes to poultry production, environmental stresses such as heatwaves or power outages further exacerbate production losses by increasing mortality and reducing productivity (Njisane and Muchenje, 2017). Also, noting that these events increase variable costs as there might be a need for cooling systems or feed preservation while at the same time trying to lower income. Thus, resilience in smallholder systems depends heavily on adaptive strategies that minimise these production risks (Okike et al., 2020). From the study results, it can be concluded that the majority of the smallholder poultry farmers' farmers' gross margin was positive, meaning that, on average, the farmers were making a profit. Phiri et al. (2023) add that a business is generally considered profitable in agriculture if the gross margin is positive.

4.9 Empirical Results

4.9.1 Multiple Linear Regression Results for Profitability (Gross Margin)

The multiple linear regression results demonstrate that variables comprising the total variable cost had a statistically significant and negative effect on profitability ($\beta = -1.000$, $p < 0.01$). This confirmed that every additional Rand spent on variable inputs such as feed, labour, veterinary services, and energy directly reduces gross margins by an equivalent amount (Mulaudzi, 2022). This finding is consistent with gross margin theory, which posits that profitability in smallholder farming systems is primarily driven by cost containment rather than scale expansion(Mugabo and Warner, 2024). Sama (2023) notes that rising variable input costs diminish gross margins and constrain smallholder farmers' capacity to reinvest in production, thereby jeopardising the sustainability of their enterprises.

On the other hand, price per bird also revealed a positive and statistically significant relationship with profitability ($\beta = +1.000$, $p < 0.01$), which indicated that higher output prices substantially improve farm performance. This underscores the critical role of market access and price stability in sustaining smallholder poultry enterprises, particularly under conditions of rising input costs (Birhanu et al. 2023).

Even though farm size (number of birds) showed a positive coefficient, the relationship was revealed to be statistically insignificant ($p > 0.05$). This might suggest that larger flock sizes do not automatically translate into higher profits unless accompanied by effective cost management and favourable output prices. Thus, the result aligns with empirical evidence from smallholder agriculture, where economies of scale are often constrained by input inefficiencies and external shocks(Gebreyes et al., 2021).

Table 4.8 Multiple Linear Regression Results for Profitability (Gross Margin)

Variable	Coefficient (β)	Std. Error	t-value	p-value
Constant	−0.000	0.000	−0.51	0.613
Farm size (number of birds)	+0.000	0.000	0.17	0.866
Total Variable Cost (feed, labour, veterinary, Additional energy access)	**−1.000**	0.000	-3.6×10^{14}	**0.000***
Price per bird	**+1.000**	0.000	4.6×10^{12}	**0.000***

* Significant at $p < 0.01$

Model diagnostics

Statistic	Value
R^2	1.000
Adjusted R^2	1.000
F-statistic	4.42×10^{29}
Prob > F	0.000
Observations	90

4.9.2 Multiple Linear Regression Results for Effects of Rolling Blackouts and Extreme Weather on Profitability

When examining the effects of Rolling Blackouts and Extreme Weather on Profitability beyond accounting identities, as a secondary study, a regression model. The model described that approximately 21.6% of the variation in profitability ($R^2 = 0.216$), indicating that energy disruptions and climate-related shocks contribute meaningfully to profitability outcomes, although they do not solely determine them. The negative adjusted R^2 and the statistically insignificant F-statistic reflected the exploratory nature of the model, the small subsample size, and the indirect pathways through which environmental stressors affect farm performance. Even though coefficient estimates from the contextual regression model provide economically meaningful insights into how rolling blackouts and extreme weather events affect profitability, standard errors and significance tests were not emphasised due to the small subsample size and the ordinal nature of several explanatory variables. As such, results were interpreted directionally rather than inferentially.

The positive coefficient associated with the length of load shedding reflected increased operational instability during prolonged electricity outages. Studies have shown that extended power interruptions compromise ventilation, lighting, and temperature regulation in poultry systems, leading to inefficiencies and higher management costs (FAO, 2019). However, from the current study, longer outages did not directly increase profitability but instead heightened cost volatility, as smallholder poultry farmers were forced to adopt emergency coping mechanisms such as manual feeding or alternative energy use. This finding aligned with the literature, as it suggested that energy disruptions affect farm performance through cumulative operational stress rather than immediate output losses (BFAP, 2023).

The negative relationship between backup power use and profitability highlights the cost–resilience trade-off commonly reported in smallholder farming systems. While backup power reduces production interruptions and mortality risk, it also introduces additional costs related to fuel, equipment maintenance, and capital investment. Similar findings have been reported by Cloete (2025) and the World Bank (2020), who argue that small-scale farmers often adopt energy alternatives as defensive strategies to avoid losses rather than as investments that enhance profitability. The results of this study, therefore, support the view that backup power functions primarily as a risk-mitigation mechanism.

Loss of birds due to extreme weather exhibited the strongest negative association with profitability. This finding is consistent with extensive poultry production literature, which documents the adverse effects of heat stress, temperature extremes, and weather variability on bird survival and productivity (Nawab et al., 2018; Oke et al., 2024). In smallholder systems, bird mortality represents an irreversible shock: production costs are incurred upfront, while income is reduced immediately. The magnitude of the coefficient underscores the critical role of climate resilience in sustaining poultry enterprise profitability.

The negative coefficient associated with the perception that rolling blackouts reduce profits further reinforces the cumulative impact of energy disruptions. Literature on load shedding in South Africa highlights reduced operating hours, increased stress on livestock, and higher energy-related expenses as key pathways through which profitability declines (Mahlobo and

Obi, 2021; BFAP, 2023). The present findings corroborate these observations, suggesting that profitability losses emerge through interconnected channels rather than isolated cost increases.

Although statistical significance was limited, this outcome is not unexpected given the small subsample size, ordinal measurement of several variables, and multicollinearity among coping strategies. Similar methodological challenges have been acknowledged in applied climate–agriculture studies, where environmental shocks influence profitability through indirect and non-linear pathways (FAO, 2019).

Table 4.9 Multiple Linear Results Regression for Effects of Rolling Blackouts and Extreme Weather on Profitability

Variable	Coefficient	Economic interpretation
Length of load shedding	+5,872	Longer outages increase operational disruption and cost volatility
Backup power use	−908	Backup power reduces losses but increases operating expenses
Loss of birds due to extreme weather	−7,077	Mortality significantly erodes profitability
Rolling blackouts reduced profits	−2,759	Confirms negative profitability effects of energy disruptions

Model Fit (Contextual Model)

Statistic	Value
R^2	0.216
Adjusted R^2	−0.176
F-statistic (p-value)	0.666
Observations	10 (pilot subset)

Overall, the findings indicate that while traditional cost–price dynamics explain how profitability is generated, rolling blackouts and extreme weather conditions explain why profitability remains fragile. This distinction reinforces the need for policy interventions that enhance energy reliability and climate resilience alongside conventional farm management strategies.

4.10 Chapter Summary

Chapter 4 presented and analysed the descriptive and empirical results on the profitability of smallholder poultry farmers in Nkomazi Local Municipality under conditions of rolling blackouts and extreme weather events. The demographic and socioeconomic findings revealed that poultry farming in the study area is largely undertaken by older and middle-aged farmers, with limited youth participation, and with women playing a slightly dominant role. Most farmers were self-employed, relied primarily on farm income, and depended almost entirely on electricity for poultry production. Farming characteristics showed a strong dominance of broiler production due to shorter production cycles and faster cash turnover; however, productivity was constrained by limited access to training, inadequate vaccination practices, and minimal extension support. Descriptive results further highlighted that rolling blackouts disrupted lighting schedules, ventilation, temperature regulation, and feeding patterns, leading to increased production costs, bird mortality, and farm closures for some respondents. While several coping mechanisms were adopted, such as alternative lighting, informal temperature regulation, and structural adaptations, most farmers lacked affordable alternative energy sources and financial safety nets.

The empirical analysis reinforced these findings by demonstrating that profitability among smallholder poultry farmers is primarily driven by internal cost–price dynamics. Gross margin analysis showed that most farmers generated positive margins; however, profitability was highly volatile, with a subset of farmers operating at a loss during periods of energy and climate-related shocks. The multiple regression results confirmed that total variable costs had a strong and statistically significant negative effect on profitability, while price per bird exerted a significant positive effect, underscoring the importance of cost control and market access. Although farm size was not statistically significant, complementary regression analysis indicated that rolling blackouts and extreme weather conditions indirectly undermined profitability through increased cost volatility, bird mortality, and production disruptions. Overall, the findings demonstrate that while smallholder poultry farming remains viable in the short term, profitability is fragile and highly sensitive to energy instability and climatic stressors, highlighting the need for improved resilience, energy reliability, and institutional support.

Chapter 5
Summary, Conclusions and Recommendations

5.1 Introduction

This chapter presents a concise summary of the study, draws conclusions based on the empirical findings, and proposes practical, policy-relevant recommendations. The discussion is structured to directly align with the study objectives and address the central research question concerning the effects of rolling blackouts and extreme weather conditions on the profitability of smallholder poultry farmers in Nkomazi Local Municipality, Mpumalanga Province, South Africa.

5.2 Summary of the Study

The primary objective of this study was to investigate the effects of rolling blackouts and extreme weather conditions on the profitability of smallholder poultry farmers in Nkomazi Municipality. Specifically, the study sought to describe farmers' socioeconomic characteristics, explore their perceptions of energy and climate-related disruptions, identify the challenges they face, assess profitability under these stressors, and examine coping strategies adopted to mitigate their effects.

The findings from the descriptive analysis revealed that smallholder poultry farming in the study area is dominated by older and middle-aged farmers, with women slightly more represented than men. Most respondents were self-employed and relied heavily on farm income, with electricity being the primary energy source for poultry production. Access to training and extension services was notably limited, and vaccination practices were inconsistent, increasing vulnerability to disease outbreaks. The majority of farmers practised broiler production, reflecting a preference for shorter production cycles and quicker returns.

Empirical results demonstrated that rolling blackouts and extreme weather conditions significantly disrupted poultry operations through interrupted lighting schedules, inadequate temperature regulation, poor ventilation, and increased bird mortality. Gross margin analysis showed that while most farmers recorded positive margins, profitability was highly unstable.

The multiple regression analysis confirmed that total variable costs had a strong negative effect on profitability, while price per bird had a significant positive influence. The complementary regression further showed that prolonged load shedding, bird losses due to extreme weather, and reliance on costly backup power systems indirectly eroded profitability. These findings validate the study hypothesis that rolling blackouts and extreme weather conditions negatively affect smallholder poultry profitability.

5.3 Conclusion

The study concludes that smallholder poultry farming in Nkomazi Municipality remains economically viable in the short term; however, its profitability is fragile and highly sensitive to energy instability and climatic stressors. Rolling blackouts and extreme weather conditions do not merely reduce output but increase production cost volatility, disrupt biological production cycles, and heighten mortality risks, thereby undermining financial sustainability.

Although many farmers have adopted coping mechanisms such as alternative lighting, informal temperature regulation, and structural adaptations, these strategies are largely defensive and insufficient to fully offset losses. The absence of affordable energy alternatives, limited access to extension services, inadequate training, and weak financial safety nets further compound farmers' vulnerability. Therefore, without targeted institutional, infrastructural, and policy support, smallholder poultry farmers are likely to remain exposed to recurring profitability shocks driven by energy and climate risks.

5.4 Recommendations

The study recommends the following:

5.4.1 Energy and Infrastructure Support:

Government and development agencies should prioritise investment in rural energy resilience by promoting affordable renewable energy solutions such as subsidised solar systems for smallholder poultry farmers. Reliable energy access will reduce operational disruptions, stabilise production cycles, and lower long-term costs associated with backup power.

5.4.2 Strengthening Extension and Training Services:

There is a critical need to expand and revitalise agricultural extension services in Nkomazi Municipality. Regular farm visits, targeted poultry management training, and education on vaccination, biosecurity, and climate-smart practices would enhance productivity and reduce avoidable losses.

5.4.3 Cost Management and Market Access:

Policies aimed at reducing input costs, particularly through bulk purchasing schemes, cooperatives, or targeted subsidies, should be encouraged. Additionally, improving access to reliable markets and supporting value addition initiatives can help farmers secure better prices and improve gross margins.

5.4.4 Climate Adaptation Support:

Support for improved poultry housing, ventilation systems, and early-warning weather information should be strengthened. Climate-resilient infrastructure and timely climate advisories will help farmers prepare for extreme weather events and minimise mortality losses.

5.4.5 Financial Risk Management:

Smallholder poultry farmers should be supported in accessing affordable insurance products, emergency funds, and financial literacy training to improve enterprise resilience against shocks.

5.5 Suggestions for Future Research

Future studies should extend this research by examining the broader socioeconomic impacts of rolling blackouts and extreme weather conditions on household welfare and food security. Further research could also compare smallholder and commercial poultry systems to assess differential vulnerability and adaptive capacity. Additionally, longitudinal studies incorporating larger samples and objective climate and energy data would provide deeper insights into long-term resilience and profitability dynamics.

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Appendices

Appendix A: Questionnaire

Creating Opportunities

Date of interview……………………………………..

Place of data collection: **Enumerator:**

Questionnaire no.:

INFORMATION LEAFLET

Researcher: Fortunate, Tshabalala (201911248)

Supervisor: **Co-Supervisor:**

Name: **Dr Bongiwe Mcata** Name: **Prof Wisemen Chingombe**

Telephone: **013 002 0451** Telephone: **0130020221**

E-mail: Bongiwe.Mcata@ump.ac.za Email: Wisemen.Chingombe@ump.ac.za

Dear Potential Research Participant,

I am, Fortunate Tshabalala, a Master of Science in Agriculture student at the University of Mpumalanga, in the School of Agricultural Science and Faculty of Agriculture and Natural Science. You are invited to participate in a research project titled Effects of rolling blackouts and weather conditions on smallholder poultry farmers' profitability: Nkomazi Municipality.

Specific research objectives

1. To explore the perceptions of smallholder poultry farmers on the effects of rolling blackouts and weather conditions on poultry farming.
2. To describe the challenges faced by smallholder poultry farmers due to rolling blackouts and weather conditions.
3. To determine the coping mechanisms used by smallholder poultry farmers as mitigation to rolling blackouts and weather conditions.
4. Assess the profitability of smallholder farmers during rolling blackouts and weather conditions.

If you decide to take part in the study, you will be required to do the following:

- Sign this informed consent form

The study involves questionnaires. There will be open-ended and closed-ended questions. In open-ended questions, participants are required to explain in detail. Whereas with closed-ended questions, participants are required to choose the options given.

1. Participants are required to sign and fill out the questionnaires, and if they do not understand the questions, they are asked for clarity.

2. Participants are required to take 15 minutes of their time to fill out the questionnaires.
3. Participants must follow the instructions and be honest when answering questionnaires.

The questions are strictly for the purpose of this research study. Please note that your participation in answering this questionnaire is completely voluntary, and you are allowed to withdraw at any time should you wish to. Your name will not be recorded anywhere, and no one will be able to connect you to the answers you give. Your answers will be given a code number or a pseudonym, and you will be referred to in this way during data analysis and discussion of results in the research report. All responses will be summed together as a group with other respondents, with no reference to individuals. This research is strictly for educational or academic purposes.

Your co-operation and participation in the study will be greatly appreciated. Please sign the informed consent below if you agree to participate in the study.
Kindly answer each question honestly and accurately, as your participation in this process is essential to the success of this study.

Yours faithfully

Signature
Fortunate Tshabalala

CONSENT FORM

1. I ____________________________________agree to and am voluntarily taking part in this research project.
2. I understand that I have the right to withdraw from the study at any time, and may choose not to participate without having to explain myself.
3. I am aware that the information I provide on the questionnaire is for educational/academic purposes.
4. I understand that my name will not be recorded.
5. I have been provided with and have read the information leaflet regarding this research study.
6. I have had the opportunity to ask any questions related to this study and received satisfactory answers to my questions, and any additional details I wanted.
7. I agree to answer the questions to the best of my ability.
8. I understand that I may refuse to answer any questions that I do not feel comfortable answering.
9. By signing this letter, I give free and informed consent to participate in this research study.

DATE			
PARTICIPANT SIGNATURE			
RESEARCHER NAME	Fortunate Tshabalala	RESEARCHER SIGNATURE	

This research is being conducted by Fortunate Tshabalala.

Telephone: 0607682818 E-mail: 201911248@ump.ac.za. If there are any further questions about the research study or the questions themselves, please contact the Supervisor, **Dr Bongiwe Mcata** and Co-Supervisor, Prof Wisemen Chingombe, at UMP. The Supervisor(s)' contact details are as follows:

Supervisor: Name: **Dr Bongiwe Mcata**
Telephone: **013 002 0451**
E-mail: Bongiwe.Mcata@ump.ac.za

Co-Supervisor: Name: **Prof Wisemen Chingombe**
Telephone: **0130020221**
Email: Wisemen.Chingombe@ump.ac.za

This research project has received ethical approval from the UMP

SECTION A: Respondents' demographic information

A1	A2	A5	A6	A7	A8	A9	A10	A11
What is the gender of the respondent	**What is the age of the respondent?**	**What is the education level of the respondent?**	**Respondent occupation**	**Household size**	**Household source of income**	**Total household income**	**Energy sources used at home**	**How do you get weather predictions (specify)**
1.Male	1. 22	1. No formal education	1.Full-time farmer	1. 4 people	1. Salaries 2. Wages	1. R350	1. Electricity	1. TV
	2. 25	2. Primary	2.Employed	2.7 people	3. Old age pension grant	2. R500	2. Fossil fuels 3 Mass fuels	2. Radio
2.Female	3. 35	3. Secondary	3.Pensioner	3. 10 people	4. Self-employed	3. R800	4. Renewable energy: (specify)	3. Weather app via phone
	4. 45	4.Tertiary	4.Other (specify)	4.	5. Child support grant	4. R3500	5. Other (Specify)	4. Social media
	5. Other	5. Other (Specify)			6.Retirement pension	5.R6000		5. Google weather
		)			7.Covid grant (R350)			6 Other (specify)

					Other (specify)			

Section B: Farm Characteristics and Activities

B1	B2	B3	B4	B6	B7	B8	B9	B10	B11	B12	B12	B13	B14	B15
Farm type	**Farming experience**	**Training on poultry farm management**	**Number of birds**	**What type of labour is used (Farm labour)?**	**Labour breakdown per farm activity**	**Bedding material used**	**Where are the birds sourced (specify)**	**Age they are sourced (specify)**	**Poultry structure (specif)**	**Access to abattoir (specify)**	**Access to Extension services (specify)**	**Feeding frequency**	**Feeding type used**	**Vaccination used**
1. Broilers	1.1 Year	1.Yes	1. R50	1. Family labour 2. Permanent labour	1. feeders	1. saw dusts	1. Alzu	1. Day old chicks 3 weeks 2. 8 weeks	1. Steel structure	1. yes	1.Yes	1. 4 times a day	1. Starter feed	1. Live attenuated vaccines

	2. 2 Years		2. R100	3. Temporal labour	2. cleaners	2. Husk	2. Early bird	3. 12 weeks chicks	2. Chicken sheds	2. No	2. No	2. twice a day	2. Grower feed	2. *Infectious bronchitis*
	3. 4 years		3. R200	4. Other, please specify	3. slaughterers	3.Crop residue	3. TOMACCESS poultry farm	4. 20 weeks chicks	3. Other			3. 2 - 3 times a day	3. Layer pellets	3. Antibiotics Vitamins
2. Laying hens		2.No	4. R350				4. Farmers meet supply	5. 30 weeks					4. Yellow maize	Other
			5.Other										5. Mash	
3. Mixed	4. 6 Years													

B16. Cost breakdown (variable + fixed)

Variable costs	**Values/ Amount**	
Cost of labour		
Feed cost		
Transportation costs		
Vaccines		
Hay/ bedding litter/ saw dust		
Packaging material costs		
Diesel		
Electricity		
Maintenance of Water Lines and feeding systems		
Maintenance Cost (Tools, Machines & Equipment)		
Farmer expenses (Motorcycle petrol, motorcycle service, etc)		
Miscellaneous Cost		
FIXED COSTS		
Rent/ structure		
SALARIES		
LOANS		
Generator		

Ventilation fans		
Equipment (feeder, drinker)		
Miscellaneous Expenses		
Total Production Cost		

C. Perceptions of smallholder poultry farmers on load shedding/ rolling blackouts

Please indicate whether you strongly agree, agree, uncertain, disagree or strongly disagree with the following statement.

Statements	**Strongly Agree**	**Agree**	**Uncertain**	**Disagree**	**Strongly disagree**
You have full knowledge and understanding of blackouts					
1. Rolling blackouts hinder the diversification of farmers' services					
2. Rolling blackouts of results in economic instability					
3. Rolling blackouts can pose significant challenges, impacting poultry health,					
4. Availability of Backup power can help mitigate rolling blackouts					
5. Rolling blackouts of electricity enable my enterprise to operate for fewer hours					
6. Rolling blackouts of electricity cause an increase in operation cost					
7. Rolling blackouts affect production of the farm					

8. Rolling blackouts affect overall profit of the farm					
9. Efforts to improve infrastructure and support systems can help mitigate some of the rolling blackouts challenges					

D: Challenges faced by smallholder poultry farmers (EXTENT OF ROLLING BLACKOUTS)

D1	**D2**	**D3**	**D4**	**D5**	**D6**	**D7**	**D8**
How many times (frequency) do you experience rolling blackouts in a week?	How long (length in hours) do the rolling blackouts take?	During uninterrupted power supply, how many hours do you operate? (Normal hours of Operation)	Have rolling blackouts enabled your enterprise to operate for fewer hours? Yes/ No (Specify)	Are there advance warning arrangements made between you and the power utility company before rolling blackouts? Yes/ No (Specify)	Are you able to adapt to rolling blackouts?	Do you face difficulties with farm operations during rolling blackouts?	Do you experience significant financial losses due to rolling blackouts?
1.2 times	1. 2 hours	1. 6 hours	1. Yes	1. Yes	1.Yes	1.Yes	1.Yes
2. 3 Times	2. 4 hours	**2. 12 hours**	**2. No**	**2. No**	**2. NO**	**2. NO**	**2. NO**
3. 4 times	**3. 6 hours**	**3.**					

E: Coping mechanisms used by smallholder poultry farmers **MEASURES EMPLOYED/ ENERGY ALTERNATIVES**

E: Alternative mechanisms for coping with rolling blackouts

E1	**E2**	**E3**	**E4**	**E5**
Which backup power solutions does your farm use?	What mechanism do you use for temperature regulation?	What mechanism do you use for Ventilation and Air Quality?	What mechanism do you use for lighting solution?	How do you keep Feed and water in good condition?
1.Generators	1. Insulation	1. Battery operated fans	1.Battery powered lights	1.Manual feeding
2.Solar panels	2. Alternative heating, i.e., wood	2. Poultry houses with adjustable windows and roof	2. rechargeable LED light	2.Emergency storage
3.Battery system	3.Battery operated temperature monitor		3. Solar Powered lights	

F: Alternative mechanism for coping with extreme weather conditions

F1	**F2**	**F3**	**F4**	**F5**	**F6**

How do you deal with extreme weather conditions?	Which health measures do you use to prevent diseases	Which Financial aid and operational planning do you use during rolling blackouts and extreme weather conditions?	What do you think needs to be done to reduce negative effects of extreme weather conditions on business firms?	When last did you have to make extra provision for heat?	Has there been a death due to extreme weather conditions? Yes/ NO
1.Poultry houses with durable material	1. Enhancing biosecurity practices to prevent disease outbreaks,	1.Emergency funds	1. Shared Resources**: Collaborating with neighbouring farmers to share backup power solutions or resources.	1.Day before	1.Yes
2.Windbreaks and shade to protect poultry houses from strong winds and provide shade during extreme heat.	2. Health Monitoring: Regularly checking the health of the poultry and having a plan for quick intervention if problems arise due to environmental stress.	2. Insurance	2. Sharing of loadshedding schedules	2. A week before	2.No
3. Installing proper drainage	3.None	3.None	3. Sharing weather information updates	3. Last month	

G: Effect of rolling blackouts on profit and production

G1	G2
Has rolling blackouts led to a reduction in profits? Yes/ No (specify – frequency)	Has the extreme weather conditions led to a reduction in profits? Yes/ No (specify– frequency)
1.Yes	**1.Yes**
2.No	**2.No**

Appendix B: Ethical Clearance Certificate

UNIVERSITY OF

MPUMALANGA

Creating Opportunities

B Maoneke (PhD)

School of Computing and Mathematical Sciences Mbombela
Campus.
Dear Fortunate Nelisiwe Tshabalala

Protocol Reference Number: UMP/TSHABALALA201911248/SAS/MSC/2024/01

Project Title: Effects of Rolling Blackouts and Extreme Weather Conditions on Smallholder Poultry Farmer's Profitability: Nkomazi Municipality.

Approval Notification: In response to your application received on 15/03/2024, the Research Ethics Committee: Faculty Research Ethics Committee has considered the above-mentioned application and the protocol has been granted FULL APPROVAL.

Any alteration/s to the approved research protocol, i.e., Questionnaire/lnterviews Schedule, Informed Consent form, Title of the project, Location of the study, Research Approach and methods must be reviewed and approved through the amendment/ modification prior to its implementation. In case you have further queries, please quote the above reference number.

PLEASE NOTE: Research data should be stored securely in the School/ division for a period of 5 years.

The Ethical Clearance certificate is only valid for a period of 3 years from date of issue. Thereafter, Recertification must be applied for on an annual basis.

Wishing you the best with your study.

Yours faithfully,

....

B Maoneke (Chair)

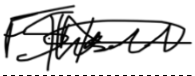
Cc: Faculty Research & Innovation Committee Chair

.... 14/06/2024

M. Bembe

DECLARATION OF INVESTIGATOR(S)

I/We fully understand the conditions under which I am/we are authorised to carry out the abovementioned research and guarantee to ensure compliance with these conditions. I agree to completion of a yearly progress report.



14/06/2024

Signature Date

Appendix C Language Editing Certificate

Independent Editor

kufazano@gmail.com
+27631434276

SATI
SOUTH AFRICAN TRANSLATORS' INSTITUTE

CERTIFICATE OF EDITING

This confirms that I edited substantively the document below, including a Reference list. The document was returned to the author with various tracked changes to correct errors and clarify meaning.

TITLE: **Effects of rolling blackouts and extreme weather conditions on smallholder poultry farmers' profitability in selected areas of Nkomazi Municipality**

AUTHOR : **Tshabalala Fortunate Nelisiwe**

STUDENT NUMBER : **201911248**

Note: The edited work described here may not be identical to that submitted. The authors, at their sole discretion, have the prerogative to accept, delete, or change amendments made by the editor before submission.

DATE: **17 December 2025**

EDITOR'S COMMENT

The author was advised to effect suggested corrections regarding subject-verb agreement, punctuation and overall academic writing style, to name a few.

Signature

Dr Kufakunesu Zano, PhD in English. A member of the South African Translators' Institute, Ref 1000686, South Africa 2025