



**NAMIBIA UNIVERSITY
OF SCIENCE AND TECHNOLOGY**

Effect of agricultural financial credit on investment and productivity in Namibia

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Definition of key words

Word	Definition
Agricultural productivity	Agricultural productivity refers to the quantity of produce by the farmers such as the number of livestock owned, and yield harvested measured before and after credit access.
Bidirectional causality	A two-way flow of causal exogenous influence.
Binary logistic:	A binary logistic model provides an efficient setting for assessing the impact of an endogenous binary regressor (treatment) on a binary outcome.
Credit access	In this study, credit access pertains to individual farmer's capability to secure financial loans or credit from lenders or financial institutions. It denotes the availability and opportunity for an individual farmer to borrow money or access credit facilities based on their financial situation, credit history, and other pertinent factors.
Credit	Credit refers to a financial instrument or arrangement that allows individuals or entities to borrow money or access funds on the condition that they will repay the amount borrowed.
Farm investment:	Farm investment refers to the physical infrastructure developed on the farm by the farmer, the capacity-building of farm employees, and investment in livestock production such as improved breeds procured by the farmer.

Multinomial regression:

Multinomial regression is a statistical method for modelling and analysing the correlation between categorical dependent variables with more than two outcomes or groups (such as a nominal or ordinal variable) with one or more independent variables (which could be binary, categorical, or continuous).

Simultaneous Equation Model (SEM):

SEM is a statistical model used to examine the relationships between multiple endogenous variables in an interdependent system. Each endogenous variable in an SEM is modelled as a function of one or more other endogenous variables, and the model includes a system of equations describing these relationships.

List of Acronyms

Acronyms	Meaning
AALS	Affirmative Action Loan Scheme
ACGSF	Agricultural Credit Guarantee Scheme Fund
AMTA	Agro-Marketing and Trade Agency
ATPI	Agricultural Trade Policy Institute
AU	African Union
ARDL	Autoregressive Distributed Lag
BOA	Bank of Agriculture
BoN	Bank of Namibia
BRAC	Bangladesh Rural and Advancement Committee
DAPAP	Draught Animal Power Acceleration Programme
ESRM	Endogenous Switching Regression Model
GIZ	German Development Agency
FAO	Food and Agriculture Organisation
FSAC	Food Security and Agricultural Credit
ESRP	Economic Stimulus and Relief Package
FAO	Food and Agriculture Organisation
GDP	Gross Domestic Product
MAWF	Ministry of Agriculture, Water and Forestry
MAWLR	Ministry of Agriculture, Water and Land Reform
MTEF	Medium-Term Expenditure Framework
MSP	Market Share Promotion
NAB	Namibian Agronomic Board
NACMS	Namibia Agricultural Credit and Marketing Scheme
NPC	National Planning Commission
NSA	Namibia Statistical Agency
NAU	Namibian Agricultural Union
NECFU	Namibia Emerging Commercial Farmers Union
NHDI	National Horticultural Development Initiative
NNFU	Namibia National Farmers Union

NRISAL	Nigeria Risk Incentive System for Agriculture Lending
IV	Instrumental Variable
SEM	SEM is a statistical model used to examine the relationships between multiple endogenous variables modelled as interdependent systems.
OLS	Ordinary Least Square
TIPEEG	Targeted Intervention Programme for Employment and Economics Growth
TFP	Total Factor Productivity
VECM	Vector Error Correction Model
ZTBL	Zarai Taraqiyati Bank Limited

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Dedication

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Abstract

Adequate access to farming resources such as credit enhance agricultural productivity and investment. However, the lack of it characterises the agricultural landscape of most developing nations. The study investigates the effect of credit on investment and productivity. Factors that enhance access to credit and determinants of loan default were assessed. Further, the study investigates the credit-investment-agricultural productivity nexus and their causal relationship in the study area.

A sample of 242 farmers across the country was used for the study. A semi-structured questionnaire was designed and administered to the farmers. In addition, an online link was created and shared with the farmers' unions, at livestock auctions, and with individual farmers throughout the country. The logistic regression model, multinomial regression, and simultaneous equation model were used to analyse the data. The descriptive statistics indicate a gender imbalance in access to credit. Farmers with tertiary education have a higher rate of credit access compared to farmers without tertiary education. The regions of Zambezi and Omusati have the most farmers without access to credit. Those with credit access have more land and livestock and make more investments. The repayment rate for long-term loans is higher than that for short- and medium-term loans. However, there has been an increase in loan defaults among farmers with short- and medium-term loans. The logit model shows that farm size, farm income, farm yield, herd size, number of investments, and tertiary education enhance credit access. In terms of default, the multinomial model shows that income from farming, farm size, and the number of acquired loans increased the probability of farmers defaulting. The simultaneous equation model results show that there is a bidirectional causality between investment and credit while investment and productivity reveal inconclusive results.

The study recommends that farmers should be provided with credit to enable them to purchase land for maximum farm income. Farm investment must be promoted as it enhances productivity, which in turn increases farm inputs. To minimise default, lenders should consider the magnitude of loans issued to farmers based on farm income and farm size. One of the limitations of the study is that most farmers do not keep farm records. Therefore, some vital financial information was not provided.

Keywords: Credit, Investment, Productivity, Multinomial Regression, Simultaneous Equation

Chapter 1 General Introduction

1.1 Background

In 2003, the African heads of state met in Maputo during the African Union Summit and agreed to increase financial resources to the agricultural sector, aiming to achieve a 6 per cent annual agricultural growth by allocating 10 per cent of the state's national budget to the sector (African Union [AU], 2014). In 2014, the heads of state and Governments in Malabo, Equatorial Guinea, recommitted to increasing agricultural investment financing by maintaining a 10 per cent public spending target aimed at increasing productivity and reducing hunger (African Union [AU], 2016). Institutional intervention through budget allocation and financial credit system reform is critical for accelerating investments in agriculture (Mishra & Mohapatra, 2017). Agricultural financial credit is important for risk mitigation, especially during drought and disease outbreaks. This may result in an increased capacity for investment spending by farmers and enhance productivity. Developing countries, including Namibia, have embraced this initiative because it can unlock the economic and productive potential of the highly important agricultural sector.

Namibia's agricultural sector is among the country's most important industries, and employs one-third of the total workforce, according to the National Planning Commission [NPC], 2020). The sector's contribution to foreign exchange, employment creation, and general national income should not be underestimated. However, its potential to immensely contribute to the national economy has declined over the years (Schlettwein, 2024). For instance, the percentage of Gross Domestic Product (GDP) that it contributes has reduced from 8 per cent in 1981 to 3.4 per cent in 2015 and 2016, respectively. Sixty per cent of this was attributed to livestock production and 40 per cent to the crop and forestry subsectors (National Planning Commission [NPC], 2018). The agricultural sector contributed 6.5 per cent of GDP from 1981 to 2016. During the year 2018, the GDP declined from 7.06 per cent to 6.96 per cent, and 6.61 per cent in 2019 (Mwinga et al., 2020). Currently, the sector's contribution to GDP increased to 8.3 per cent during the first quarter of 2021 compared to 6.6 per cent recorded during the first quarter of 2020 (Namibia Statistics Agency [NSA], 2021). The country's commercial farming sector, primarily concentrated in the central and southern regions, produces high-value crops and livestock. Meanwhile, the subsistence farming sector, common in the northern part of the country, serves as the primary source of food and income for rural households. In addition, agriculture is crucial for food security in Namibia, as a large portion of the population relies on locally grown crops, such as millet, maize, and sorghum, alongside livestock products (Gross, 2022). Nevertheless, the sector faces numerous challenges, such as low productivity, climatic uncertainty, tenure insecurity, high transaction costs, and limited financing.

Government initiatives and agricultural policies have aimed at improving productivity through technological innovations, irrigation schemes, and improving access to markets (Bank of Namibia, 2022). However, these efforts have not yet led to significant improvements across all regions, especially in rural, small-scale, and communal farming areas, where production levels remain relatively low. In this study, agricultural productivity refers to the quantity of produce by the farmers such as the number of livestock owned, and yield harvested measured before and after credit access.

1.2 Problem Statement

Farmers in Namibia encounter a considerable hurdle due to their restricted access to credit. Credit has been suggested as a potential remedy to enhance investment and agricultural productivity. Yet, the extent to which credit effectively leverages productivity notably among farmers in developing nations, remains only partially addressed. Perhaps the dual nature of the agricultural landscape in Namibia is a matter of concern. The dual land system in the country contributes to the uneven distribution of land resources. The interventions aimed at developing the agricultural sector were adopted after independence thus, introducing different financial products, which are unevenly distributed to both communal and commercial sectors (Bank of Namibia [BoN], 2020). As a result, agricultural productivity has been declining over the years (Bank of Namibia [BoN], 2020). For instance, Namibia's controlled agronomy production in the third quarter of 2023 was 19,940 tons, in contrast to 35,614 tons in the same quarter of 2022, representing a 44.0 per cent reduction. White maize accounted for the biggest per cent, totalling 19,343 tons which translates to a share of 97.0 per cent of the total agronomy production. In the third quarter of 2023, the import bill for agronomic products was N\$415.5 million, down from N\$438.0 million recorded in the third quarter of 2022 (Namibia Statistics Agency, 2023a). Likewise, livestock exported on hoof recorded a decline of 3.9 per cent relative to the 19.6 per cent growth recorded during the same quarter of 2022 (Namibia Statistics Agency, 2023c). In terms of GDP contribution, during quarter two of 2023, agriculture contributed a negative 2.4 per cent which translates to a decline of 0.2 per cent when compared to the same quarter of 2022 (Namibia Statistics Agency, 2023c). The general decline of agriculture contribution to GDP from 2017 shows a decline from 4 per cent to 3 per cent in 2020 (Helmke, 2022).

Trade investment and growth in the sector by farmers have been declining due to numerous constraints experienced by farmers. In terms of real value-added, from 2021, the sector recorded a negative growth

of 3.6 and a positive growth of 1.9 while in 2022, the agricultural sector accounted for improved growth rates of 1.2 per cent and 2.3 per cent mainly in the livestock subsector. The crop subsector recorded 5.5 per cent growth rates in 2021 compared to a slower growth rate of 4.3 per cent recorded during 2022 (Namibia Statistics Agency, 2023b). The total export revenue accounted for approximately 5 per cent, mostly due to the export of live animals. Over the past thirty years, agricultural trade has been slow and continues to decline (Namibia Statistics Agency [NSA], 2020).

Based on Agribank financial transactions, in 2021, the bank disbursed N\$217 million to 1301 clients which translated to 37,784 employment and a client base of 4,723. However, during the year under review, the bank incurred losses of N\$25.5 million (Agribank, 2021). In 2022, the bank disbursed N\$194 million to 481 clients which translates to 35,736 jobs and a client base of 4,467. Unfortunately, the bank loses 46.6 million during the 2022 financial year (Agribank, 2022). During 2023, the bank disbursed N\$285 million to 1026 clients resulting in 49,224 jobs and a client base of 6,153. Regardless of an increase in the disbursed loan and an increase in the jobs created, the bank recorded a loss of N\$2.8 million as a result of client defaulting (Agribank, 2023a).

Despite these investments, the bank encountered difficulties in loan recoveries because of high default, prompting the bank to implement risk mitigation measures such as the requirement of 100 per cent collateral as a requirement for the client to qualify for credit, credit loss provisioning as well as debt recovery mechanisms which resulted in the bank recovering N\$0.2 million loan from clients (Agribank, 2023a).

As mentioned earlier, records from Agribank clearly show that farmers' credit servicing has affected banking institutions' ability to provide long-term agri-finance. It may deter lenders from re-financing farmers who have defaulted on their loans. As a result, there is a concern that such a scenario may limit farmers' capacity to invest and improve their agricultural output in Namibia. This study aims to bridge these gaps by examining the role of credit in enabling farm investments and its subsequent impact on productivity, highlighting how limited access to credit undermines both farm growth and overall agricultural development in Namibia. Addressing these gaps is critical to developing effective policy interventions that can enhance credit accessibility and stimulate investment in agriculture, ultimately boosting productivity and improving food security.

Given the significance of this sector (agriculture) to the Namibian economy and current trends, the sector's contribution to GDP could be increased by addressing issues affecting Namibian farmers such as insufficient funding, low investment, high transaction costs, risk status of farmers and, credit-constraint induced collateral security.

To boost investment and agricultural productivity, agricultural credit is vital. However, the effectiveness of credit in achieving these outcomes, particularly in the context of farmers in developing countries, is not widely understood and most farmers spend their earnings on consumption instead of investing in agriculture (Amanullah et al., 2020). The issue of sufficient credit provision or its adequacy to farmers is believed to affect agricultural productivity (Mumararungu et al., 2024). Hence, this research evaluates the effect of agricultural credit on farmers' investment and productivity and identifies the relevant determinants.

1.3 Research Objectives

The primary objective of the study is to measure the effect of agricultural financial credit on investment and productivity in Namibia.

The specific objectives are.

1. To identify factors that enhance access to credit.
2. To identify factors that influence agricultural loan default in Namibia.
3. Analyse the effect of credit on agribusiness investment and agricultural productivity.

1.4 Research Hypothesis

Hypothesis testing is a statistical method of analysis used to test statistical assumptions. Consequently, to test the null (H_0) and alternative hypothesis (H_a), it is necessary to determine if the sample information supports the null hypothesis or otherwise. However, if the acquired data does not confirm the null hypothesis, it is rejected with the assumption that the evidence proves that it is true. The null hypothesis of this study is that there is no difference or relationship between credit, investment, and agricultural productivity. The hypotheses are summarised below as

- There is no adequate financial support for farmers in the study area.
- There is no significant level of loan default amongst farmers in Namibia.

- There is no significant relationship between agricultural financial credit, investment, and productivity in Namibia.

1.5 Significance of the study

The realisation of growth, development, and productivity of any sector is a function of the amount of investment channelled towards that sector. Therefore, sustainable financing is crucial. Loan access and repayment performance are essential to maintain and determine agricultural credit delivery and to ensure the sustainability of lending institutions. Additionally, poor loan repayment to the lending institutions affects the institutions' profitability and growth, as indicated in the literature. Therefore, examining the factors that affect loan repayment will assist immensely in designing appropriate loan products and could inform policymakers as well as advance appropriate policy interventions that could reduce default rates among borrowers. A high loan repayment rate has an advantage for both the borrower and the lending institutions. Agriculture is the main sector of the Namibian economy. The agricultural sector is poorly financed, and this has resulted in low productivity and dependence on imports rather than exports recorded over the years. The financing of the agriculture sector is crucial for Namibia to become self-reliant in terms of food security.

The study highlights challenges to sustainable credit access and agri-financing policy development in Namibia. It will be vital in the development of a sustainable and innovative credit provision, investment opportunities and interventions aimed at increasing agricultural productivity based on factual and evidence-based findings. Such findings could enhance the development of agri-financial systems, and farm investment aimed at reforming the agrarian sector and boosting agricultural productivity. The findings would guide policymakers, especially those in the financial institution and the ministry responsible for agrarian reform in the country, and managers to nurture the management and administration of the agricultural sector and agrarian reform. This research is crucial because it will give more evidence and contribute to the body of literature. This could assist the farmers in making informed decisions and the government to develop proper policies and to develop infrastructure for farmers. Additionally, the research is beneficial to other researchers because the findings will be made available through publishing to form a benchmark for future studies.

1.6 Limitations of the study

The effects of credit, investment, and agricultural productivity are complex. It involves various factors, and this study experienced several limitations. One of the limitations was collecting data using online links. The data were collected using blended methods to minimise potential bias towards participants with no internet access. To mitigate this effect, diverse sampling was undertaken by combining online methods with offline approaches. The survey link was shared extensively with the farmers through WhatsApp groups, the Farmers Union newsletters, and livestock auctions. The questionnaire was also self-administered to the farmers in the regions.

The study relied on farmer's recall of past events. Farmers could either under or overstate relevant data, especially financial, investment, and productivity data. To minimise bias, the data was validated. Further, anonymity or confidentiality technique was used to encourage honest and unbiased responses from the farmers. Clear instructions, simple language and translation of the survey questionnaire were used to help minimise response bias. Other external factors such as climate uncertainty contribute to the limitation of the study. The country has experienced severe droughts over the years. Therefore, climatic factors affected farmers' productivity, as indicated by the challenges experienced by them. Because of the unavailability of time series data, primary data was collected over six months.

1.7 Outline

The thesis starts with Chapter 1 which includes a general introduction, providing background information on the Namibian agricultural sector, the identified gaps, research hypotheses, the aim and objectives of the research, the study's significance, and encountered limitations. Chapter 2 provides historical facts on Namibian agriculture, an overview of the agriculture sector, and programmes to promote agricultural investments. Chapter 3 is a literature review, covering agricultural financing, the general basis for investigating the financing-investments-productivity nexus, and the Namibian banking and agricultural financial sectors. Chapter 4 is a review of the methods. The Chapter outlines the methodology for data collection and empirical analysis. The study area, population sampling, and data analysis are also covered in Chapter 4. The results are presented in Chapter 5, whereby descriptive statistics and econometric results of the study are highlighted. Chapter 6 concludes and provides recommendations.

Chapter 2: Sector overview

Chapter two presents the sector and literature review. A detailed overview of agricultural financing, productivity, and investment are presented in this chapter.

2.1 Overview of the agricultural sector

Namibia boasts a rich agricultural history that predates European colonization, with subsistence farming and pastoralism being the primary practices. However, European arrival significantly altered Namibian agriculture. The German colonizers, who arrived in the late 1800s, introduced commercial farming to the region, emphasizing exports rather than local food production (Eriksen & Moorsom, 1985).

Following Namibia's independence from South Africa in 1990, the government implemented a land reform program aimed at redistributing land from commercial farmers to historically disadvantaged Namibians (National Planning Commission [NPC], 2018). This initiative also included land registration and formalization in informal settlements, addressing historical imbalances in land access and ownership while encouraging small-scale agricultural production. Although the land reform scheme succeeded in providing land access to many previously disadvantaged Namibians, challenges such as insufficient funding and limited technical support hindered its effectiveness.

Despite these challenges, agriculture remains crucial to Namibia's economy, employing about 30 per cent of the workforce and contributing approximately 5 per cent to the GDP (World Bank Group, 2017). Despite the arid climate posing challenges to agricultural production, Namibia has made efforts to promote small-scale farming, increase productivity, and facilitate access to markets for locally produced food. Initiatives like protecting infant industries and market share promotion have been instrumental in these endeavours.

2.1.1 The agricultural landscape

Namibia's arid to semi-arid climate, characterized by sporadic rainfall with only 8 per cent of the country receiving above 500 millimetres annually, presents challenges to agriculture. Factors such as significant variations in annual precipitation, increased evaporation rates, spatial differences in water availability, and erratic rainfall influence dryland cropping and farming conditions (FAO, 2015). Despite these challenges and the relatively low agricultural potential, agriculture remains crucial to the livelihoods of many Namibians, with approximately 70 per cent relying on it directly or indirectly. Furthermore, the

agricultural sector contributes a significant portion of Namibia's Gross Domestic Product (GDP). However, farming faces hurdles, including limited crop diversity due to the arid environment, with sorghum, millet, and maize being major crops (FAO, 2015).

Given the country's arid climate and limited water resources, livestock farming dominates the agricultural sector, primarily focusing on cattle, goats, and sheep, while crop farming is limited. Namibia's agricultural system is divided into communal (mainly for subsistence) and commercial (for profit) categories. Subsistence farming, aimed at personal consumption without surplus for sale, is prevalent, especially among small-scale farmers relying on rainfall for production. These farmers typically engage in low-skilled, labour-intensive practices, primarily in communal regions, where cattle are raised and crops are grown for domestic use. Subsistence farming often involves minimal agricultural technology, with modest outputs mainly for personal consumption, prevalent among impoverished communities.

In contrast, the commercial sector, covering 44 per cent of Namibia's land area but housing only 10 per cent of its population, is highly developed, investment-driven, and market-oriented, primarily in the southern two-thirds of the country. About 4,500 commercial landowners hold title-deed lands, with historically disadvantaged individuals and the government owning 25 per cent of the land as of 2012 (Namibia Statistics Agency, 2018). Commercial farming involves organized production for profit, with farmers holding title certificates, investing more capital, and utilizing advanced machinery for higher productivity.

Despite government efforts to promote sustainable agricultural development through access to credit, financial support, infrastructure investment, and research, the sector faces challenges associated with climate variability, water scarcity, and limited market access (FAO, 2020). Commercial farming requires substantial capital investment, effective strategies, and access to viable markets to thrive in Namibia's agricultural landscape.

2.1.2 Institutional development

To unlock the economic potential of Namibia's agricultural sector, the government has embarked on various programs aimed at promoting investments in agriculture. Notable initiatives include the National Horticultural Development Initiative (NHDI), which develops Namibia's horticulture sector by offering technical support, training, and assistance to small-scale farmers. Additionally, the National Agricultural

Mechanisation and Seed Improvement Programme (NAMSIP) aims to boost agricultural productivity by providing farmers with farm implements and improved seed cultivars (FAO, 2019).

The Namibia Agricultural Credit and Marketing Scheme (NACMS) offers farmers credit for agricultural production and marketing operations. Similarly, the Agro-Marketing and Trade Agency (AMTA), a government entity, assists with agricultural marketing and trade. AMTA's goal is to develop irrigation systems and encourage the cultivation of special crops such as vegetables, berries, and flowers in Namibia's arid regions. These programs aim to encourage agricultural investment, increase productivity, and improve farmers' livelihoods (MAWF, 2019).

Various land reform programs also promote agricultural investments, such as the Affirmative Action Loan Scheme (AALS) (FAO, 2019). This program provides loans to previously disadvantaged Namibians, assisting farmers in purchasing farms, livestock, and equipment. These loans feature lower interest rates and longer repayment terms than traditional commercial loans. The National Resettlement Programme ensures the equitable distribution of land resources by reallocating commercial land from large commercial farms to previously deprived Namibians. The program offers resettled farmers training, technical assistance, and credit (MAWF, 2019; MAWLR, 2023).

2.1.3 Farming systems

The two major farming systems are crop cultivation and livestock farming. These types of farming are described below.

2.1.4 Livestock farming

Livestock farming in Namibia includes cattle, goats, sheep, ostriches, pigs, game farming, and trophy hunting. This sector remains dominant, contributing around two-thirds of the industry's output. The commercial cattle farming industry is well-established, capital-intensive, and export-oriented. Cattle farming is prevalent in the middle and northern regions, while goat and sheep husbandry dominate the arid southern regions. The poultry sub-sector, once minor, has experienced rapid growth in recent years, with annual sales of 1.05 billion Namibian dollars, making it the second-most significant sub-sector. The country permits the importation of only 1,500 tonnes of frozen chicken pieces each month, while local production meets approximately 1,900 tonnes of the monthly demand of 2,500 tonnes of broilers. Ostrich

farming is common in the arid regions of Namibia. Other notable agricultural sub-sectors include pig farming, dairy farming, game farming, and trophy hunting (FAO, 2019).

2.1.5 Agronomy and Horticulture

Namibia cultivates a diverse range of crops, including fruits, grains, and horticultural goods, despite its predominantly arid and semi-arid environment. Horticulture in Namibia focuses on the irrigation-based production of high-value crops such as dates, grapes, watermelons, melons, citrus fruits, and various fresh produce items like potatoes, tomatoes, carrots, beans, cabbage, groundnuts, and butternuts. The primary cereal crops include maize, wheat, sunflower, and pearl millet (mahangu). Onions, a major export vegetable, are primarily shipped to Angola and South Africa. However, Namibia only produces about 35 per cent of its vegetable requirements domestically. This limited production is mainly attributed to the seasonality of crops, despite significant growth in the sector over the past decade. Furthermore, less than 4 per cent of the 730 tonnes of fruits needed annually are produced locally (Namibia Agronomic Board [NAB], 2020).

In response to these challenges, Namibia implemented a market share promotion (MSP) policy in 2018. The Namibian Agronomic Board (NAB) increased the MSP from 44 per cent to 47 per cent, requiring fresh produce traders to source 47 per cent of their products from local producers before importing the remaining 53 per cent, contingent on a license. This initiative bolstered local production, adding approximately 20 million Namibian dollars to the local agricultural economy (Namibia Agronomic Board [NAB], 2020).

Agriculture in Namibia presents numerous opportunities for economic development, job creation, food security, and poverty reduction. However, the sector faces significant challenges that must be addressed to fully realize its potential. Namibia's agriculture is heavily impacted by sporadic rainfall and frequent droughts, which adversely affect both the livestock industry and crop productivity. The over-reliance on livestock production, coupled with the limited diversification of agricultural activities, underscores the urgent need to optimize both livestock and crop production (FAO, 2019).

Climatic conditions have had a profound impact on the agricultural sector. Severe and prolonged droughts, along with periodic floods, have led to fluctuating agricultural performance over the years. These adverse weather events have resulted in decreased crop and livestock production, subsequently

reducing overall agricultural output. Despite these challenges, agriculture remains a cornerstone of Namibia's economy and a vital source of livelihood for many Namibians. The sector continues to play a pivotal role, even though its contribution to the gross domestic product (GDP) has been declining.

To enhance the resilience and productivity of Namibia's agricultural sector, it is imperative to adopt innovative strategies and advanced agricultural practices. This includes improving water management systems, promoting drought-resistant crop varieties, and enhancing soil fertility through sustainable farming techniques. Furthermore, strengthening the financial infrastructure to support farmers, especially smallholders, through accessible and affordable credit facilities is crucial for fostering agricultural development.

In summary, while Namibia's agricultural sector faces significant climatic and structural challenges, strategic interventions and policies aimed at improving local production, enhancing financial access, and adopting resilient agricultural practices can unlock its full potential, contributing to economic stability, food security, and poverty alleviation in the country.

2.1.6 Agricultural financing

Financial institutions play a critical role in providing credit to various sectors of the economy, including agriculture, making them indispensable components of a country's financial system. Agricultural financing by banks involves extending credit to support investments in agriculture. While financial credit is essential for the sector's sustainability and development, its availability, accessibility, repayment, and performance are key issues that need to be addressed.

Research conducted in Malawi sheds light on the significance of credit management programs in improving loan repayment rates among farmers. Among interviewed farmers, 36 per cent who participated in such programs were subsequently removed from default rolls. However, challenges persist, particularly in the context of maize farming, where the loan repayment rate stands at 54 per cent. This lower rate is attributed to various factors, including risks associated with currency fluctuations and the removal of agricultural input subsidies like fertiliser subsidies for hybrid maize (Diagne & Zeller, 2001).

Furthermore, access to credit remains a concern, especially among rural Malawian households. The study reveals that 28 per cent of households that have never participated in credit provision programs face

limited credit access. While 64 per cent of subsistence farmers resort to informal credit sources, only 8 per cent have access to formal credit (Diagne & Zeller, 2001). These findings underscore the importance of addressing barriers to credit access and enhancing the performance of credit programs to support agricultural development effectively.

2.2 Namibian government expenditure on agriculture

The Namibian government has been actively funding agriculture since independence. According to the medium-term expenditure framework (MTEF) over the past six years, the government has implemented various programs aimed at achieving sustainable improvements in household agricultural production, stimulating and diversifying rural income-generating activities, encouraging private sector investment in agro-processing companies, improving animal health and productivity, boosting income, and reducing poverty. These objectives are being pursued through initiatives in animal veterinary services, agricultural engineering, agricultural development, extension services, and agricultural research. Over the past seven years, the Namibian government's expenditures on these programs totalled N\$6,053,158,694 billion.

The MTEF report shows that over the past seven years, the development budget for specific agricultural programs fluctuated between 10 per cent and 20 per cent of the total budget (Figure 1). In the 2016/17 financial year, the total development budget for agriculture was 19 per cent. During 2017/18 and 2018/19, the budget decreased by 12 per cent, but in the 2018/19 financial year, an increase of 15 per cent was observed. The development budget rose from 15 per cent in 2018/19 to 19 per cent during the 2019/20 financial year. However, in 2020/21 and 2021/22, the development budget was only 12 per cent, with a subsequent increase to 14 per cent in the 2022/23 financial year (Figure 1) (MOF, 2017; MOF, 2018; MOF, 2019; MOF, 2020; MOF, 2021; MOF, 2022). The budget increase in the 2019/20 financial year can be attributed to the construction of the Necktal Dam. These investments highlight the importance placed on the agricultural sector by the government and its significance to the Namibian economy.

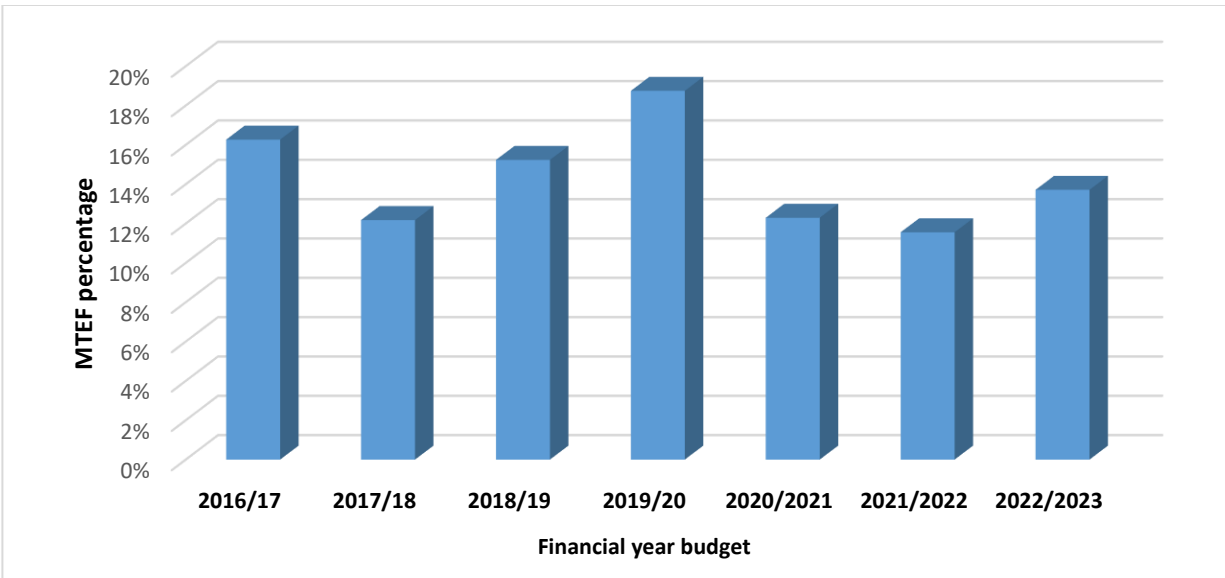


Figure 1: Namibian Government MTEF for specific agricultural programmes (2016 - 2023 financial year)

Source: GRN MTEF report ((MOF, 2017 - MOF, 2022).

2.3 Namibia banking sector

Namibia's financial sector is a crucial part of the nation's monetary system, offering various services to individuals, businesses, and state agencies. The country's banking system is known for being well-functioning and one of the most advanced on the African continent, with strong ties to South Africa's extensive and liquid financial markets. Despite this strength, Namibia faces structural issues that weaken the system and hinder the financial sector's ability to advance society economically (Bank of Namibia [BoN], 2022).

Access to financial services is seen as essential for increasing household welfare. Greater credit availability can address historic financial exclusions and help smooth consumption during difficult economic times (Kavari, 2020). Financial inclusion is defined as ensuring that underprivileged groups, especially small and medium enterprises and low-income groups, have timely access to financial products and services, including sufficient credit at reasonable and affordable prices (Ministry of Finance [MoF], 2011).

The Bank of Namibia regulates the sector, maintaining financial stability and enhancing the effectiveness and efficiency of the banking industry (Bank of Namibia [BoN], 2022). Namibia's banking sector comprises both domestic and foreign-owned institutions, including Bank Windhoek, Nedbank Namibia, FNB, and Standard Bank of Namibia. These banks provide services such as investment banking, trade finance, retail

banking, and corporate banking. Some commercial banks have created special units to serve specific sectors, such as Bank Windhoek's dedicated agricultural financing unit and Standard Bank Namibia's unit for small and medium enterprises (Bank of Namibia [BoN], 2022).

Advancements in technology have enabled financial intermediaries to perform vital functions in the agricultural sector. However, the instability of bank loan portfolios and reduced interest rates mean that the portion reserved for emerging farmers is small. The Agricultural Bank of Namibia (Agribank) implemented a reform to offer different financial products designed for both communal and commercial farmers. Established under the Agribank Act No. 5 of 2003 (as amended), Agribank's mandate is to disburse credit and encourage financial intermediaries to support advanced agriculture and related agribusiness ventures. The bank offers unique credit programs for sustainable energy and agricultural development, including loans for labourers' homes, solar farm systems, bush encroachment management, horticultural production, aquaculture, animal power programs, agricultural infrastructure and equipment, biomass projects, loan consolidation, and livestock farming (Agribank, 2023b).

Namibia's banking sector has remained stable in recent years, with financial institutions maintaining good capital adequacy ratios and balance sheets. However, the sector faced challenges due to the COVID-19 pandemic, which caused a downturn in economic activity and a rise in non-performing loans (Bank of Namibia [BoN], 2022). Overall, Namibia's financial banking segment plays a vital role in the country's economic and financial systems. The well-regulated financial market enables various financial institutions and banks to provide diverse services to individuals, corporate entities, and public agencies.

Many commercial banks in Namibia provide financial services to the agricultural sector, but collateral requirements pose a challenge. Mubita et al. (2018) indicated that collateral is required to recover loans in case of default. Despite the challenge of loan defaults due to collateral issues, the sector needs investments to ensure value addition, employment creation, and unlocking economic potential (Ministry of Agriculture, Water and Forestry [MOAWF], 2011).

Farmers' access to credit and loan repayment poses significant challenges. Agribank employs several options to provide credit to farmers in communal areas. One option is a no-collateral loan secured by monthly deductions from the client's payslip for 54 months. For example, a loan amount of N\$350,175.00 to drill and install a borehole in the Ohangwena region would result in a monthly instalment of N\$8,939.62

deducted from the client's payslip. Another option splits the loan into two parts: a long-term loan paid over 15 years and a short-term loan repaid over 54 months with monthly salary deductions. Alternatively, clients must provide additional collateral, such as fixed property or investments, to cover any shortfall.

In recent years, Agribank implemented a moratorium on no-collateral loans for clients without full-time employment due to non-payment issues. The bank offers a no-collateral product for women and youth, such as agricultural graduates, but the requirements are stringent. To qualify, clients must provide a signed off-take agreement for three years, ensuring Agribank recovers its investment from loan disbursements. This requirement makes it difficult for emerging farmers and agricultural entrepreneurs to acquire credit without contractual obligations.

Farmers' owner equity is often insufficient, highlighting the importance of sustainable and affordable agricultural financing for new investment ventures to enhance productivity. Investing in the sector will mitigate problems and boost agricultural production Cloete (2013) identified factors such as ineffective institutional structures, lack of finance, market access, and inadequate production inputs as limiting agricultural development. Traditional credit institutions are unable to provide adequate financial support to small-scale farmers. Vasilchenko & Derunova (2020) proposed the need for innovative financing approaches for agriculture investment, suggesting an alternative financial system through innovation and institutional reform.

It is essential to assess the current performance of commercial banks to evaluate strategies to minimize credit default and asset repossession and to identify less risky agricultural ventures. The following studies highlighted notable findings on the effect of credit on investment and productivity.

2.3.1 Agricultural financing and productivity

The link between credit and productivity is that agricultural credit is believed to increase agricultural productivity. Credit is an important input in agriculture, enabling farmers to boost their productivity. Farmers with access to finance can procure inputs such as pesticides, fertilizers, and seeds, which can increase crop productivity and improve produce quality (Adebayo et al., 2019). However, many farmers frequently depend on unregulated credit sources, such as traders and moneylenders, who charge significantly high interest rates and provide few repayment options. This reliance makes it difficult for farmers to invest in their farms and boost productivity, resulting in low agricultural yields and limited

incomes. Credit can also be used by farmers as a risk-management tool, helping them deal with unexpected events such as floods, droughts, and market volatility. Access to credit allows farmers to build up savings and buffer securities that can be utilized to handle shocks and optimize their production. Consequently, credit can improve the resilience of farming and empower farmers to maintain their livelihoods in difficult circumstances (World Bank Group, 2017).

A study by Asante-Addo et al. (2017) found that the key motive for most participants in credit programs is better access to savings services. Microfinance institutions (MFIs) often require clients to save a portion of their income before qualifying for credit. Another common reason for joining credit programs is to access credit for agribusiness purposes, as farming is the main source of income for many participants. Additionally, many individuals participate in credit provision programs to grow their existing business ventures or pursue new ones. Awotide et al. (2015) conducted a similar study in Nigeria, finding that financial access positively affects the adoption of modern farming techniques, such as improved seeds and fertilizers, which increase yields and, eventually, agricultural productivity. Moreover, Gebeyehu et al. (2020) conducted a study in Ethiopia and discovered that the availability of finance to household farmers had a positive impact on the magnitude of fertilizer utilization and the number of contracted labourers, resulting in greater crop yields and increased agricultural productivity. In summary, the studies indicate that credit access is a critical factor in increasing productivity and managing risks. Credit enables farmers to increase yields, improve farming produce quality, and ultimately help reduce poverty and enhance food security in rural areas by providing them with the capital they need to invest in their farms.

2.3.2 Credit and transaction costs

For Namibian farmers to invest in their operations, purchase farming inputs, and increase productivity, they must have access to credit. Unfortunately, obtaining credit is extremely difficult for many farmers in Namibia due to high transaction costs. These expenses, incurred when applying for credit, include application fees, appraisal fees, legal fees, and other costs imposed by lenders.

Amadhila & Ikhide (2016) noted that credit demand constraints are associated with risk rationing and transaction costs. High risk may discourage farmers from applying for loans because of risk rationing, while transaction costs may deter farmers from applying and accessing loans due to the associated costs. Transaction costs are frequently high in Namibia for several reasons. a) lack of collateral - many farmers in Namibia lack sufficient collateral to secure loans (National Planning Commission [NPC], 2018).

Borrowers must provide security for credit, known as collateral or loan security. In cases of default, the lender may seize the collateral to recoup the loan. In the absence of collateral, lenders may demand higher transaction costs to balance the default risk, b) limited credit histories - it is difficult for lenders to evaluate the creditworthiness of many farmers in Namibia because they lack a credit history. To offset the risk of lending to an unidentified borrower, lenders may demand higher transaction costs in the absence of a credit history (Claessens, 2006), c) distance from financial institutions - many farmers reside in rural areas far from financial institutions such as micro-finance institutions and commercial banks. Due to this distance, it may be expensive for lenders to contact these farmers and evaluate their creditworthiness, which raises transaction costs (Mukasa et al., 2017), d) administrative expenses - processing loan applications, checking borrower information, and disbursing funds can be expensive for Namibian lenders. Borrowers may be charged more for transactions due to these costs, e) interest rates - farmers may be challenged to repay acquired loans in Namibia because of inflation and high interest rates, which also raise transaction costs.

In general, Namibia's high transaction costs for credit access can be a major barrier for farmers, particularly small-scale and subsistence farmers, who might not have the necessary collateral or credit history to be approved for loans (Bank of Namibia [BoN], 2001). To overcome these obstacles, actions must be taken to increase financial access, lower administrative expenses, and create innovative financing models specifically tailored to the requirements of Namibian farmers

3.1 Introduction

The relationship between credit, investment and productivity is widely studied, however, with mixed results. This chapter discusses the challenges that arise when modelling the credit effect on investments and productivity. The aim is to provide a summary of the various approaches used in the literature to determine how credit affects investments and agricultural productivity and to analyse their unique merits and drawbacks. In the end, the assessment helped to determine the methodology that is best suited for assessing the credit effect on investments and productivity in Namibia.

The structure of this chapter is as follows. A discussion of the conceptual issues surrounding the assessment methodology for credit, the assessment methodology for investments, and agricultural outputs are presented. Different methodological approaches to assess credit, investment, and productivity are examined through empirical studies. Finally, the variables used in different empirical studies are listed.

The literature on the effect of credit on investment and agricultural productivity has evolved significantly, with a growing body of research focusing on how access to credit influences both capital formation and productivity in the agricultural sector. Early studies, such as the study conducted by Gadgil (1986) in India focused on farm credit policy from 1951, the development of financial institutions, the performance of credit provision to farmers and the viability of agricultural credit. Gadgil's (1986) study identified key issues which were left hanging and needed further research and discussion. These issues were; the need for future agricultural credit policy, credit access by farmers, impact of credit on agricultural yield and loan performance. Adam & Von Pischke's (1991) study conducted in the United States highlighted that credit provision to small farmers has failed and it must be discouraged to avoid already experienced problems. Later research expanded this understanding by examining the role of financial institutions in agricultural investment, revealing that access to credit reduces the capital constraints faced by farmers, which, in turn, increases their ability to invest in technology and improved farming practices (Balana & Oyeyemi, 2022). This body of work emphasised the positive relationship between credit and agricultural output, particularly in developing economies where farmers often face significant barriers to accessing formal financial services.

More recent studies have focused on the broader mechanisms through which credit influences agricultural productivity (Adebayo et al., 2019; Adewale, et al. 2022; Assouto & Houngbeme, 2023; Gana et al. 2024; Orji et al. 2021). For example, research by Assifuah-Nunoo, (2023); Czech et al. (2024)); Mapanje et al. (2023) and others has pointed out that the type of credit (e.g., short-term vs. long-term loans), the terms and conditions associated with the credit, and the institutional environment (e.g., interest rates, financial literacy) play significant roles in determining the success of credit access in improving productivity. Furthermore, a growing body of literature has explored the constraints that limit credit access, including high collateral requirements, interest rates, and farmers' risk aversion, all of which can undermine the effectiveness of credit in driving agricultural investment and productivity (Kapoor, 2024; Rehman et al., 2017; Usman et al., 2023).

While much of the existing literature explores these general relationships, there is a notable gap in research on how credit systems, particularly in specific regions such as sub-Saharan Africa, affect agricultural productivity in the context of rapidly changing agricultural technologies, climate change, and evolving market dynamics. Additionally, there is limited exploration of the interplay between different forms of agricultural credit (e.g., microcredit, government-backed loans, and commercial loans) and the specific types of investments that lead to tangible increases in agricultural productivity.

This study is pushing the frontier forward by focusing on the nuanced relationship between credit, investment, and agricultural productivity, specifically within the context of Namibia. The study addresses the existing gaps in the literature by examining how different types of credit impact not only capital investment but also the adoption of the research provides a more comprehensive understanding of the role of credit in enhancing agricultural productivity. Additionally, the study focuses on specific challenges faced by farmers in Namibia which allows for a more context-specific analysis, offering policy recommendations that are tailored to local needs. Through this approach, the study will contribute new insights into the design of more effective credit systems that can support sustainable agricultural development in the face of current and future challenges.

3.2 Modelling credit, investment, and productivity

The approach in the literature to model the relationship between credit, investment and productivity differs and often with mixed results. Some of these approaches are listed in Tables 1 to 4. The concept is that access to credit can facilitate investment in the accumulation of productive assets, which can in turn

boost productivity. This relationship is well-studied in the economic literature, with studies highlighting the important role of credit in promoting economic growth and development (Rajan & Zingales, 1996; Demirgunes, 2016).

Investment is a critical driver of productivity growth, as it enables firms to acquire new technologies, expand operations, and improve efficiency (Vasilchenko & Derunova, 2020). However, investment often requires significant financing, which may not be readily available to all firms. Credit can play an important role in bridging this gap, providing firms with the funds needed to make productive investments (Rajan & Zingales, 1996).

On the other hand, productive efficiency and effectiveness can result in scale economics thus increasing the capacity of the firms to invest. It is, therefore, intuitively challenging to find out the causal link between credit, investment and productivity. By quantifying the link between credit, investment, and productivity, economists can identify the most effective policies for promoting growth and development. This type of modelling can also help policymakers assess the potential impact of diverse policy interventions, such as changes in interest rates or financial regulation (Demirgunes, 2016).

One econometric model used to analyse the link between credit, investment, and productivity is the Cobb-Douglas production function. This model relates output (productivity) to inputs such as labour, capital, land, credit, and investment. Kudadze et al. (2016) used this method to analyse agricultural credit access and rice production in Ghana. Another econometric model that can be utilised to analyse the link between credit, investment, and productivity is the Vector Error Correction Model (VECM). The model permits the examination of short- and long-run relationships among variables. Chisasa & Makina (2015) used the error correction model to assess bank credit and agricultural output in South Africa.

Ahmad et al. (2018) used autoregressive lag (ARDL) and the bound testing method to assess the effect of formal credit on the farming output in Pakistan. Balana et al. (2022) used a two-step hurdle econometric model and Tobit to investigate supply and demand constraints of agricultural credit in Tanzania and Ethiopia. Agbeno (2021) used the endogenous switching regression model (ESRM) to assess the effect of credit access on productivity in Togo. Wang et al. (2023) used a panel vector autoregressive (PVAR) model to assess the link between fiscal support, agricultural credit, and income from farmers in China. Lemecha (2023) conducted a study on credit restriction and the use of technology in Ethiopia. The study results

indicate that being credit-constrained can discourage farmers from adopting and efficiently utilising farm technology, thus perpetuating poverty.

Lemecha (2023) modelled credit rationing using credit as a dependent variable, while livestock, extension, labour, land size, and education are predictors. The results revealed that 54 per cent of the farmers face credit rationing. Saleem (2011) evaluated the effect of credit on GDP. Using secondary data between 1990 and 2008, credit increased the contribution of agriculture to GDP in Pakistan. Chandio et al. (2017) used the stochastic production frontier technique to study the credit effect on productivity. Results indicate that agricultural credit was used to procure fertilizer, farm size, and labour-enhanced rice productivity. In Ghana, Wongnaa & Awunyo-Vitor (2013), assessed factors that affect loan repayment. Using a probit model with a sample of 100 farmers, results indicate that off-farm income, education, age, profit, experience, and supervision have positive effects on loan repayment performance. Taremwa et al. (2021) in Rwanda used the propensity score matching technique to assess credit impact on 422 farmers. The findings indicate that productivity was 44 per cent higher for farmers with credit.

In Ethiopia, Tesfaye & Worku (2019), using logistic regression, studied the factors that affect credit access using Technology factors—cost, risk, income, lending procedures, repayment period, farmer age, and livestock—enhanced access to credit as regressors. In Zimbabwe, thematic analysis was used on 12 commercial banks to assess factors that enhance applicant access to credit. Results indicate that on- and off-farm physical investments enhance loan repayment. Investments provide collateral to banks. Social capital formation activities enhance credit access. A study conducted in South Africa by Henning et al. (2019) reveals that farmer experience, collateral, credit history, and small loans enhance successful loan applications with financial institutions. In Nigeria, an endogenous switching regression model and propensity score matching were used to examine the credit effect on productivity. Results revealed that credit positively enhances agricultural productivity. Tables 1, 2, 3, and 4 provide a detailed methodology and the results obtained from these studies.

Credit is a mechanism that enables the temporary transfer of purchasing power between individuals or organisations. It serves as the foundation for enhanced production and efficiency by promoting the division of labour and the specialisation of tasks (Purokayo & Yohanna, 2024). Adegeye & Ditto (1985) define credit as the process of acquiring control over the use of money, goods, and services in return for a commitment to repay at a future date. It also denotes the capacity to obtain borrowed funds (Adewale,

et al., 2022). In this context, the term "credit" specifically pertains to the loans secured by farmers to initiate or expand their agricultural enterprises. Credit can be categorised into three types namely: short-term, medium-term, and long-term.

Access to credit is critical for agricultural development because lack of access to credit limits agricultural investment and productivity which affect farmer's livelihood and profitability (Purokayo & Yohanna, 2024). Recall that 70 per cent of the Namibian population depend directly and indirectly on agriculture for their livelihood and the importance of credit for the farmers to invest and enhance their productivity cannot be underestimated. However, access to finance, particularly for investment in agriculture, remains severely restricted (Khandker, 2021). Investment in agriculture has not been fulfilled by farmers as expected due to various reasons. For instance, financial institutions are hesitant to provide financial services for agriculture due to several factors, including production risks such as drought and excessive rainfall, the absence of physical collateral due to a lack of title to cultivated land, and price volatility resulting from global climate changes. Similarly, the hectares of cultivated land have increased but not the harvested yield as observed by (Fortunato & Enciso, 2023).

In terms of agricultural investments, Balana & Oyeyemi (2022) and Boucher et al. (2009) opined that with a perfect credit market, farmers will make desirable investments. In the context of Namibia, communal farmers typically utilise credit to meet immediate, day-to-day expenses rather than capital investments or other expenditures aimed at boosting productivity. The primary use of credit is for purchasing livestock and addressing cash requirements for labour, seeds, and fertilisers, rather than investing in physical capital or other productive assets. This approach is in stark contrast to that of commercial farmers, who generally allocate credit towards long-term investments in infrastructure and machinery to enhance their productivity, Fortunato & Enciso, (2023); Singh & Langyan (2024) opined that large and medium-scale farmers, who typically possess greater assets and collateral, generally enjoy easier access to credit, enabling them to invest in high-yield and high-value agricultural practices. In contrast, the reduced access to credit among marginal farmers is a matter of concern, as it may indicate underlying challenges such as the absence of collateral, a higher perceived risk by lenders, or insufficient financial literacy. These factors restrict their capacity to invest in inputs that could enhance productivity (Singh & Langyan, 2024). In this study, investment refers to capital investment made by the farmers to enhance production.

Agricultural productivity can be either total or partial. When total, the estimated return is assessed concerning all inputs contributing to production growth, such as capital, labour, materials, and land. This estimate is referred to as "total factor productivity." In the case of partial productivity, it is measured by the return on a single factor of production, comparing the volume of output to the quantity of that specific factor. The level of productivity can be influenced by various factors, including economic conditions, the social environment, and the institutional framework (Louyindoula et al., 2023). In this study, productivity is measured based on the agricultural output/yield before credit access and after credit access. This is because access to credit can enable farmers to invest, capital investment in facilities and technologies is believed to enhance agricultural productivity (Fortunato & Enciso, 2023; Louyindoula et al., 2023).

The theoretical framework for this study on the "Effect of Credit on Investment and Agricultural Productivity" is grounded in the concept of credit as a critical determinant of investment decisions and productivity outcomes in agriculture. On the other hand, the supply theory as accepted by McKinnon, (1973) and the demand theory developed by Patrick (1966) are incorporated to guide the access of credit and supply of credit by the farmers. Applying the supply theory to agricultural credit, a well-developed financial sector can significantly enhance the supply of credit to farmers. By reducing transaction, information, and monitoring costs, financial intermediaries can efficiently channel funds to the agricultural sector. This improved access to credit allows farmers to invest in productivity-enhancing technologies, manage risks, and increase output. As a result, a robust financial system facilitates agricultural development, stimulates economic growth, and ensures that farmers can secure the necessary resources to expand their operations (Manasseh et al., 2024).

In terms of the demand theory, the theory developed by Patrick (1966) forms the basis for the demand for credit. The demand for agricultural credit by farmers is driven by broader economic growth. As the economy develops, particularly through commercialisation and agricultural monetisation, the need for financial services increases. This heightened demand for credit leads to the establishment of new financial institutions and markets tailored to support agricultural activities (Louyindoula et al., 2023). Consequently, farmers seek financial resources to expand their operations, as internally generated funds are often inadequate. In this framework, economic progress indirectly stimulates the growth of agricultural credit, with financial intermediaries playing a key role in supporting farmers' needs (Manasseh et al., 2024).

In addition to the demand and supply theories, the rational choice theory described below demonstrates the link among the above-mentioned theories. Rational choice theory, advocated by neo-classical economists, focuses on the decision-making behaviour of individual farmers. It posits that each decision-maker represents a broader group, such as farmers in a financial market (Gyong & Ahmed, 2024). The theory examines the demand for financial services, which includes savings, credit, and money transfer services, considering the nature of these services and the conditions under which they are offered (Purokayo & Yohanna, 2024). The theory assumes that individuals make choices that best help them achieve their goals, given uncontrollable factors. It uses a utility function to assign values to choices (Purokayo & Yohanna, 2024). However, the theory has faced criticism for neglecting external factors that influence decision outcomes (Herfeld, 2022; Kaiser & Leeson, 2023; Krstić, 2022). Despite this, it remains useful in explaining how personal attributes impact economic decisions, particularly concerning access to financial services. The relevance of rational choice theory in this study is affirmed, especially in understanding how individual characteristics affect both demand and supply in financial services.

According to economic theory, credit provides farmers with the financial resources necessary to invest in productive assets, such as improved seeds, modern machinery, and infrastructure, which are essential for enhancing agricultural productivity (Adewale, et al., 2022; Balana & Oyeyemi, 2022; Louyindoula et al., 2023). The availability of credit helps overcome liquidity constraints, enabling farmers to make investments that would otherwise be unattainable. The relationship between credit and investment is further supported by the theory of capital formation, which suggests that access to financial resources facilitates the accumulation of physical and human capital, thereby contributing to increased productivity (Manasseh et al., 2024). In this context, credit acts as an essential enabler for adopting new technologies and practices that boost agricultural output.

Furthermore, the role of credit in agricultural productivity can be understood through the lens of the productivity function, which posits that productivity is a function of both the quality and quantity of inputs used in production (Louyindoula et al., 2023). The infusion of credit allows for a higher investment in productivity-enhancing inputs which directly impact the efficiency of agricultural operations. However, the effectiveness of credit in enhancing productivity depends on several factors, including the type of credit, the terms of repayment such as medium, short-term and long-term, and the borrower's ability to manage and utilise the funds effectively. The limitations faced by smallholder and marginal farmers, such

as lack of collateral and financial illiteracy, may restrict their ability to benefit fully from credit, thus affecting the overall impact on agricultural productivity (Balana & Oyeyemi, 2022).

Keynesian theory argued that rural financing policies depended on state intervention, highlighting the importance of rural credit for groups without collateral or the means to afford high interest rates (Louyindoula et al., 2023). It viewed rural underdevelopment as a result of poor peasants' inability to save, invest, or provide collateral for credit access (Gana et al., 2024; Olawale, 2024). The theory stresses public financing as a means to foster technical change, encourage innovation, and enhance agricultural production, particularly for the disadvantaged (Carvalho et al., 2024). Ultimately, it concluded that state-backed agricultural credit could improve the traditional system and enable broader access for the rural population.

Private-sector financing theory emphasises the role of banks, microfinance institutions, NGOs, and international organisations in providing credit for agriculture. Neoclassical economics advocates for liberalising financial systems and creating rural markets to improve access to financial services and boost agricultural productivity (Louyindoula et al., 2023). Agricultural credit, particularly through microfinance, fosters development by supporting income growth, capital accumulation, and technological advancement. Theories such as rational choice theory, change theory, agricultural surplus, and human capital theory highlight how credit influences productivity, with education and technical support further enhancing agricultural outcomes (Louyindoula et al., 2023).

Diagne and Zeller (2001) indicated that credit access is often mistaken for involvement in formal credit programs, with many studies using these concepts interchangeably. This study focuses on farmers who have acquired formal credit from financial institutions. Socioeconomic and credit constraints affecting credit servicing need to be incorporated into the model to better understand the concept. Borrowing from a credit source refers to credit market participation, while those unable to borrow the desired amount are credit-constrained. These distinctions are vital in the study of financial credit. Additionally, issues such as technology, collateral security, and underdeveloped credit markets must be examined to ensure successful agricultural financing. Bell et al. (1997) identified market imperfections, such as monopoly dominance in credit markets by informal lenders and found that contractual provisions tying loans to output marketing enhanced informal lenders' ability to provide more loans.

The World Bank Group (2017) found that digital technologies globally enhance inclusive and equitable access to agricultural finance. Services such as loan disbursements, credit servicing, savings, and credit scoring were enhanced using digital technologies. In Tanzania, a data analytics company assessed the risk of farmers for banks and agricultural input suppliers who had no credit scores or bank accounts. The company processed 350,000 loan applications, mainly from subsistence farmers. Financial institutions in other African countries such as Senegal, Albania, and Malawi have utilized mobile banking services to provide financial services to farmers using biometric technology, such as fingerprinting. In Malawi, the biometric system decreases loan defaults and reduces transaction costs through digital financial services (Tinsley & Agapitova, 2018).

Ghana implemented a successful program aimed at reaching farmers for crowdfunding, payment, and digital data collection. The Farmable platform allows investors to finance small-scale entrepreneurs, enabling more farmers to access financial services at low opportunity costs and receive agricultural information quickly (Tinsley & Agapitova, 2018). Furthermore, research findings for Ghanaian cocoa farmers revealed that 54.8 per cent of the farmers preferred to receive payment for their crops via mobile transactions (World Bank Group, 2017). Such successful findings indicate the importance of technologies in agri-finance. Enu (2014) found that agricultural productivity significantly affects Ghana's economic growth, with a percentage increase in productivity resulting in a 0.35 per cent increase in GDP.

The Nigeria Risk Incentive System for Agriculture Lending (NRISAL) enabled farmers to access credit at single-digit interest rates using innovative methods such as borrowing funds based on trade history and stock as collateral. This approach has been successful, with about USD 122 million in loans injected into the program by the government for the benefit of key agricultural sectors. From 2011 to 2013, the number of subsistence farmers benefiting from digital financial services increased from 800,000 to 4.3 million. Digital financial services in Nigeria have been effective and efficient in the disbursement of loans and agricultural inputs (Tinsley & Agapitova, 2018).

A study by Orok (2017) used Ordinary Least Squares (OLS) regression to establish the link between the Agricultural Credit Guarantee Scheme Fund (ACGSF) and livestock production, crop, and fishery sectors. The research found that ACGSF positively impacts the growth of the Nigerian agricultural sector. A unit change in loan guarantees for cash crops results in a 14 per cent change in the crop sector's GDP. The study indicates that a percentage change in loan guarantees to cattle, poultry, sheep, or goat farmers

enhances production by up to 21.3 per cent for cattle, 46 per cent for poultry, and 20.4 per cent for sheep or goats, resulting in a GDP change for the livestock sector.

The South African Land Bank supports agrarian reform initiatives in the country's agricultural sector. Like other African countries, loan defaults, transaction costs, macroeconomic factors, and information asymmetry hamper the sector, particularly in production, processing, and farm household income. Mmbengwa et al. (2015) examined the determinants of the success and failure of the Land Bank. The findings revealed that farmers' perceptions indicate a lack of skills and knowledge in business planning and extension services. Farmers were unable to identify the main sources of their success. The study further reveals that a lack of access to extension support, business plans, and sole ownership are factors that negatively affect farmers' productivity.

Petrick (2004) found that between 1997 and 1999, 80 per cent of farmers acquired credit, while 40 per cent of practising agriculturalists were credit rationed, meaning they were unable to obtain desired loans or any loans at all. Of those who acquired loans, 79.5 per cent made positive investments. Additionally, subsidized credit for farmers significantly influenced their investment behaviour. The average marginal effect of credit on investment was found to be less than one, indicating that some credit was used for purposes other than productive investment. The factors influencing the credit servicing of financial institutions show mixed results (Aruppillai & Godwin Phillip, 2015; Aruppillai & Godwin Phillip, 2015; Nawai & Shariff, 2010; Onyeagocha et al., 2012; Tundui & Tundui, 2013).

Reyes et al. (2012) evaluated the determinants influencing the productivity of vegetable and fruit growers in central Chile. Using switching regression models and panel data of 177 farmers from surveys conducted in 2006 and 2008, the study indicated that short-term loans did not significantly affect agricultural productivity. However, the research did not assess the effect of agricultural finance on investment.

Mehmood et al. (2012) investigated the external and internal determinants of agricultural loan repayment in the Kasur Punjab district. Using purposive sampling, the study revealed that 78 per cent of farmers defaulted due to high interest rates. Additionally, sudden increases in input prices resulted in 68 per cent of farmers defaulting, with 57 per cent citing delays in credit disbursement, 36 per cent citing insufficient credit disbursement by banks, and 23 per cent citing long distances to the bank. Other contributing factors included follow-up by bank employees (18 per cent), climatic conditions (12 per cent), credit over-

disbursement and corruption (5 per cent). Records from financial institutions indicated that 60 per cent of defaulters misused the acquired credit by diverting loans to non-agricultural activities, while 13.3 per cent defaulted due to a change of address, 11 per cent were wilful defaulters, 10 per cent defaulted due to political interference, and 5 per cent were deceased.

Chandio et al. (2017) conducted a study in Sindh, Pakistan, and found that high-income farmers were more likely to service their acquired credit from financial intermediaries. Smaller farmers, with lower incomes, smaller landholdings, and lack of collateral, were less likely to access formal credit compared to larger, well-established farmers. However, the study did not investigate the performance of acquired loans and their effect on agricultural productivity.

Wongnaa & Awunyo-Vitor (2013) investigated the determinants of credit servicing ability among yam farmers in the Sene district of Ghana. Using random sampling techniques and a probit model, they discovered that 41 per cent of district farmers were unable to service their loans. Factors such as years of farming experience, educational level, profitability, access to off-farm income, farmer age, and supervisory visits positively impacted Yam farmers' ability to service loans. In contrast, marriage and gender negatively impacted credit servicing, while larger household sizes significantly hindered farmers' capacity to service their credit.

Sakhno et al. (2019) assessed the impact of external financial assistance in the form of loans and investments on agricultural production and the risk of loan repayment delays. The study found that financing and agricultural investment increased sales volumes and revenue from agricultural commodities, promoting the development of agrarian firms. However, there was significant regional differentiation in technological efficiency, indicating substantial growth potential. The study also noted a significant risk of loan default and investment loss, with a lower correlation coefficient of 0.06 for revenue from sales of agricultural products between 2013 and 2016, indicating minimal impact on lending and investment. The study proposed increasing the volume of external financing and strengthening the relationship between credit, investment, production, and sales parameters to improve the situation.

Ali et al. (2017) examined the potential for lending by exploring the impact of various factors on farmers' borrowing behaviours. The study employed panel data techniques to analyse secondary data extracted from commercial bank financial reports in Pakistan from 2007 to 2014. Explanatory variables included

management efficiency, adequacy of capital, asset quality, liquidity, loan-to-asset and deposit-to-asset ratios, and investment-to-asset ratios. The findings indicate a significant relationship between the lending rate and the loan-to-asset ratio, liquidity ratio, investment-to-asset ratio, and deposit-to-asset ratio. Specifically, the investment-to-asset and liquidity ratios were positively related to the lending rate, while the deposit-to-asset and loan-to-asset ratios were negatively correlated with the lending rate. The study did not explore the effect of farmers' socio-economic characteristics and macroeconomic factors such as GDP and interest rates.

Chandio et al. (2018) examined the effect of the credit period (short-term credit versus long-term credit) on the agricultural output of 180 wheat farmers. Using cross-sectional data, the Two-Stage Least Squares model, and the Cobb-Douglas production function, the results showed that credit provision had a positive effect on wheat productivity. The analysis further revealed that the provision of credit had a statistically significant influence on wheat productivity. Regarding the credit availability period, the coefficient of the short-term loan was 0.12, indicating that wheat productivity would increase by 0.12 per cent when the short-term loan unit is improved by 1 per cent. The long-term coefficient was recorded at 0.079, indicating that wheat productivity would increase by 0.07 per cent when the long-term loan unit is improved by 1 per cent. These results suggest that short-term credit is more effective than long-term loans in terms of its effect on wheat output in the studied area.

Rahman et al. (2014) assessed the effect of credit provision by Zarai Taraqiati Bank on farmer productivity using logit regression. Primary data gathered through field interviews were analyzed, and the logit regression results showed that the education of the farmers, household income, household size, agricultural loan, and loan period (short-term and long-term) significantly affected agricultural yield per hectare. This indicates a positive relationship between agricultural production and credit provision to farmers.

Adeyinka et al. (2015) assessed the contribution of Nigerian commercial banks towards providing finance to agriculture. Based on the OLS results obtained from secondary data between 2002 and 2014, the study showed that the provision of credit by commercial banks to the sector during the period did not have a statistically positive effect on productivity. However, the assessment did not investigate the rate of loan defaults by farmers or identify factors that may have limited the efficient and effective use of credit.

Additionally, the study did not explore the monitoring of loan utilization by farmers to improve loan performance.

Ogbonnia (2013) assessed the effect of commercial bank credit lending on agricultural performance and the Nigerian economy. Secondary data were obtained from the Central Bank of Nigeria's statistical bulletin between 2004 and 2011. Bivariate linear regression was modelled on the data. The findings revealed that lending to agriculture by commercial banks had a positive influence on both productivity and the Nigerian economy, as evidenced by the aggregate gross domestic product (GDP). Specifically, a one-unit increase in the commercial bank's percentage lending to agriculture resulted in a 47 per cent increase in agricultural productivity contributing to the GDP.

Seven & Tumen (2020) assessed the effect of agricultural financing on productivity in Turkey. According to the study, doubling agricultural credit provision could result in a 4 to 5 per cent increase in productivity, demonstrating the importance of agricultural financing in enhancing agricultural productivity.

3.6 Farmer's socio-economic characteristics

3.6.1 Education

Gaining knowledge through education could improve farmers' understanding of the importance of their commitment under a loan agreement, ultimately decreasing default. Consequently, education is expected to diminish the likelihood of farmer loan defaults if all other factors remain constant. Wongnaa & Awunyo-Vitor (2013) found that farmers with a higher level of education are more likely to have better loan repayment ability, whereas those with a lower level of education are likely to have a lower loan repayment ability. Additionally, single farmers have a higher likelihood of having better loan servicing than married farmers. Ojiako and Ogbukwa (2012) found similar results whereby the education level and farmer's marital status had a correspondingly significant and positive effect on loan servicing.

3.6.2 Age

With time household heads tend to acquire experience and skills in the agricultural sector and/or in managing credit. Moreover, older farmers may be more endowed than their younger counterparts due to longer years of practice. Therefore, experience/age is anticipated to have a favourable effect on the borrowers' loan servicing performances. On the other hand, older household heads are more physically constrained than their younger counterparts resulting in impaired productive activities. Consequently,

farmers' ages may have either a beneficial or a harmful impact on loan repayment. A study by Tesfaye & Worku (2019) found that the age of the farm household is statistically significant at a 5 per cent level. Prior expectations show that older farmers may have greater access to formal sources of credit. Asom & Ijirshar (2017) found that the age of rural farmers is one of several social characteristics that significantly influence their access to credit facilities.

3.6.3 Gender

In general, male farmers are more risk-seeking than their females thus, tend to be more likely to seek credit than their female counterparts. This indicates that there is a positive correlation between farmers' gender and their use of loans. As a result, men are more resourceful and successful farmers than women. Wongnaa & Awunyo-Vitor (2013) found that 93 per cent of farmers sampled in the Sene District were males while only 7 per cent were females. The finding reveals that more male farmers are involved in farming than females. Also, Asom & Ijirshar (2017) found that gender significantly enhanced farmers' access to credit facilities.

3.6.4 Marital status

The assumption is that married farmers are more capable of regulating and organising their entire lifestyle, including social responsibilities and agricultural operations. This, in turn, enables them to produce more and earn higher incomes than single-parent, divorced, or widowed households. Consequently, married households are expected to have a better loan servicing rate than the other household types mentioned. Wongnaa & Awunyo-Vitor (2013) discovered that for farmers in the Sene District, only a small percentage (9 per cent) are not married, while the majority (91 per cent) are married. This implies that most farmers in the study area are married and have a high probability of allocating a significant portion of their proceeds to their families. On the other hand, married farmers typically have bigger family sizes, their expenses tend to be higher than those of unmarried farmers. Consequently, single farmers are more likely to have better repayment capabilities than their married counterparts. A study by Asom & Ijirshar (2017) revealed that access of rural farmers to credit facilities is significantly enhanced by their marital status.

3.6.5 Family size

The more family members available, the greater the number of labour accessible for production. Based on this, it is expected that families with a larger labour force will be less likely to default on loans. However,

as the number of family members increases, more produce is consumed to meet the household's food needs, especially if the number of adult equivalents in the household increases. Consequently, it is predicted that farmers' loan repayment capacity will decline as their families grow. Olagunju et al. (2023) found that more than half (52.92 per cent) of the beneficiaries have households consisting of six to eight members, indicating that a large proportion of respondents have large household sizes which may lead to higher living expenses. However, larger households can also act as the labour source, which can raise farm output, reduce costs, and ultimately increase income levels. The extent of involvement in farm work, however, depends on the age distribution of household members.

A study by Silong & Gadanakis (2019) using logit and multinomial regression found that household size is one of the factors that significantly enhances credit demand. Households are increasingly using debt to supplement their consumption expenditures because of rising living expenses and easier access to credit. There are concerns that as household debt rises, more people may be in danger of financial instability and are likely to use additional credit to pay off debt obligations when it is due (Kavari, 2020). Furthermore, a study by Kassegn & Endris (2022) in Ethiopia found that family size was among the factors that negatively and significantly affected loan servicing in Habru District, Amhara Regional State, Ethiopia.

3.6.6 On-farm income

On-farm income is the money a farmer receives from the sale of agricultural products during a specific year or period, expressed in Namibian dollars. The farmers' inability to repay the loan and the likelihood of defaulting increase with lower on-farm income. Tesfaye & Worku (2019) found that income from irrigation was a variable found to be significantly linked to credit. This variable was found to be statistically significant at the 1 per cent level with a negative sign. The result is not consistent with expectations.

3.6.7 Off-farm income

Money earned from sources other than farming is referred to as off-farm income. They include salaries and earnings from non-agricultural sources, among other things. These additional sources of income would help farmers pay off debts even in years with poor harvests and when the relationship between payback time and agricultural prices is unfavourable. Loan repayments will probably begin right after a season of abundant harvest, which usually coincides with a considerable drop in agricultural commodity prices. Farmers who are involved in non-agricultural business ventures or activities during this time are expected to have a higher likelihood of repaying their loans promptly compared to farmers who do not

engage in non-agricultural activities. Consequently, farmers are highly dependent on non-agricultural income as a means of financing, and therefore, off-farm revenue has a beneficial outcome on the repayment of loans. Key (2020) studied challenges associated with credit, the effect of off-farm revenue, and farm investment in the United States of America. Results indicate that borrowing restrictions that are based on household income and net worth apply to many farmers. Another study by Dubale & Beshir (2020) found that off-farm income extremely influenced loan repayment performance. Findings demonstrate that more off-farm revenue increases the farm output, income from farming, productivity and credit accesses, capital expenditures, and capital input intensity.

3.6.8 Land size

It is assumed that the magnitude of the farmer's operation determines the amount of income. Thus, the enterprise size is anticipated to impact the farmer loan performance, Anigbogu et al. (2014) found that farm size positively enhanced loan repayment. Kassegn & Endris (2022) investigated the factors that affected the repayment rate of loans by smallholder farmers in the Habru district of Ethiopia who borrowed money from the Amhara Credit and Saving Institution. Tobit model was used to analyse the data, and the results showed that land size was one of the factors that positively and significantly influenced the loan servicing of smallholder borrowers in the study area.

3.6.9 The number of livestock owned

The number of animals owned may affect farmers' incomes. The probability of repaying bank loans increases with income and the livestock herd size. Tesfaye & Worku (2019) found that the possession of livestock in communal areas serves as a form of wealth accumulation, a means of security during emergencies, and a cultural symbol of status. Their logit model results indicate a positive correlation between the number of livestock owned by farmers and credit availability. Farmers who own many animals tend to use formal credit compared with those with fewer animals.

3.6.10 Experience

The ability of farmers to use acquired loans is directly related to their farming experience. Jumpah et al. (2019) found that one more year of farming experience increases the likelihood of the farmer partaking in microcredit programmes by 25 per cent. An individual with a history of farming and loan utilisation may have a higher likelihood of being approved for credit, as the lending institutions may have a better record of the farmer's credit history, making them less risky borrowers. Furthermore, farmers with more

experience may be better equipped to manage credit and may be more willing to engage in such programmes.

3.7 Summary of empirical studies and methodologies

Table 1: Empirical studies conducted in Ethiopia and Pakistan using panel selection, Cobb-Douglass and OLS and the stochastic production frontier technique.

Authors and Year	Study Area /Country	Method /Model	Sample Size	Dependent Variable	Independent Variables	Findings /Results
Lemecha (2023)	Ethiopia	Panel selection model	962	Credit	Livestock, extension, labour, land size, education	54 per cent of households face credit rationing, predominantly on the demand side
Saleem (2011)	Pakistan	linear regression model on The Cobb-Douglass	1990-2008 data	Agricultural GDP	Credit was used to purchase seeds, tractors, fertilisers, pesticides, and irrigation.	Credit strongly correlated to GDP; hence, credit increased agricultural production.
Chandio et al. (2017)	Pakistan	stochastic production frontier technique	180	Rice output	Size of the farm, labour, seed, fertiliser, credit, age, education and experience.	Farm size of the farm, credit, labour, and fertiliser enhance the productivity of rice.

Source: Own computation

Table 2: Empirical studies conducted in Ghana, Rwanda, and Ethiopia use probit, propensity scores matching technique, and logistic regression

Authors and Year	Study Area / Country	Method /Model	Sample Size	Dependent Variable	Independent Variables	Findings /Results
Wongnaa & Awunyo-Vitor, (2013)	Ghana	Probit model	100	Credit payment	Off-farm revenue, age, education, profit, experience, gender and marriage, household size and supervision.	Off-farm revenue, age, education, profit, experience, and supervision have positive effects on the performance of loan repayment.
Taremwa et al. (2021)	Rwanda	Propensity score matching technique	422	Credit	Agricultural productivity, land area, types of loans, repayment terms, interest rates, and demographic and socioeconomic characteristics.	Productivity increased by 44 per cent for farmers with credit access.
Tesfaye & Worku (2019)	Ethiopia	Logistic regression	329	Access to credit	Livestock, Age, cost, income, lending procedures, repayment period.	Technology cost, risk, income, lending procedures, repayment period, age, and livestock enhanced access to credit.

Source: Own computation

Table 3: Empirical studies conducted in Zimbabwe and South Africa using thematic analysis and logistic regression.

Authors and Year	Study Area /Country	Method /Model	Sample Size	Dependent Variable	Independent Variables	Findings /Results
Chigunhah et al. (2020)	Zimbabwe	thematic analysis	12 registered commercial banks	Credit	Human capital, social capital formation, and business management knowledge.	Off and on-farm investments in physical assets enhance loan repayment. The investment provides collateral to banks. Social capital formation activities enhance credit access.
Henning et al. (2019)	South Africa	Principal component logistic regression	128 farmers	Credit	Financial characteristics, Loan characteristics, personal characteristics, and farm characteristics.	Farmer experience, collateral, credit history, and small loans enhance successful loan applications with financial institutions.

Source: Own computation

Table 4: Empirical studies conducted in Nigeria and South Africa use propensity score matching, endogenous switching regression model and OLS

Authors and Year	Study Area /Country	Method /Model	Sample Size	Dependent Variable	Independent Variables	Findings /Results
Osabohien et al. (2020)	Nigeria	Propensity Score Matching	4210	Agricultural credit	Land, health, information, labour, capital, education, household head and access to credit.	The yield of credit households with credit was higher compared to the yield of farmers without credit.
Awotide et al. (2015)	Nigeria	Endogenous Switching Regression Model	856	Credit	Farmer's age, farming area, livestock number, household size, education, asset value, off-farm income, television, gender, rented land, and cassava output.	Livestock numbers and farming areas enhanced farmers' access to credit. Access to credit enhances cassava productivity.
Chisasa (2014)	South Africa	Ordinary Least Squares	362	Agricultural output	Land, bank credit, rainfall, and labour.	Credit- enhanced agricultural output.

Source: Own computation

Introduction

This section provides detailed information about the empirical models used to analyse the data. It also highlights the source of the primary and secondary data used in the study. The adopted sampling procedures, data analysis methods and the motivation for the statistical analysis methods used are also discussed.

4.1 Study area

The study was conducted in the Republic of Namibia. Namibia is located in the southwestern portion of the African continent, with the Atlantic Ocean forming its western border. The country's coastline stretches over 1,570 kilometres which separates the ocean from the land, providing access to important sea trade routes and valuable marine resources (Mendelsohn et al., 2003). It is situated on the Atlantic coast and shares borders with Angola to the north, Zambia and Botswana to the northeast, and South Africa to the south and southeast. The country also has a small strip of land along the Caprivi Strip, which is a link to Zimbabwe and narrow access to the Zambezi River. Geographically, Namibia is positioned between latitudes 17° and 29° South and longitudes 11° and 26° East (Mendelsohn et al., 2003). It spans an area of approximately 824 000 square kilometres (Namibia Statistics Agency [NSA], 2018).

17 per cent of Namibia's land is national parks and 1 per cent is declared urban areas, while 44 per cent is freehold or commercial farmland, and 38 per cent is communal land (National Planning Commission [NPC], 2020). According to the survey conducted among communal and commercial farmers, the agricultural production in the communal area is mainly subsistence production while in commercial areas, agricultural production is for commercial purposes (Namibia Statistics Agency [NSA], 2019).

inappropriate, inadequate or excessive sample size influences the precision and quality of the research. It is also argued that adequate sample and quality data collection will provide results which are more generalizable (Ahmad & Halim, 2017). Following Yamane (1967), the sample size of this study was calculated as illustrated below;

$$S = \frac{N}{1+N(e)^2}$$

Where, S = the required sample size, N = Population size (193,412), e = is the margin of error (0.06429). The sample size was then calculated as follows; $S = 242$. Based on the above equation, the data were analysed using the logit, multinomial regression and simultaneous equation models to enhance result robustness. Lakens (2022) opined that the value of the data collected depends on the degree which could enable the goals of the study to be achieved and not necessarily on the sample size.

In the study, a stratified random sampling technique was used. Due to resource constraints and the size of Namibia, which is vast, this study used multiple response methods at once to boost response rates and eliminate non-response and coverage presumptions. For diversity and variety, survey researchers frequently employ multiple survey techniques (De Leeuw, 2005). To collect data, a web-based questionnaire was designed. A web survey was created and promoted via several platforms, including the newsletter of the Namibian Agricultural Union, the Agriforum Facebook page, the websites of farmers' unions, emails, and WhatsApp messages. Farmers were also contacted through the Namibia National Farmers Union (NNFU) and Namibia Emerging Commercial Farmers Union (NECFU), and the survey URL link was distributed to farmers through WhatsApp and emails. In addition, farmers without electronic communication devices, those without access to social networking sites, and those who indicated a willingness to participate in telephone interviews were also contacted. To be inclusive, a structured questionnaire was translated into Afrikaans and administered to farmers at different livestock auctions. All responses from the respondents were kept anonymous, and all information was handled confidentially. The survey covered all 14 political regions of Namibia. The survey had a positive response from 242 respondents and was conducted from 15 June to 30 December 2022. The data were analysed using multiple models to ensure robustness of the results by applying three models to the data namely the logistic regression model, the multinomial model and the simultaneous equation.

4.3 Empirical analysis: The Logistic regression

The first objective of the study was achieved by using a logistic regression approach. The model was used because it is effective for analysing choice sets with non-linear binary outcomes. It is suited to measure the probability of events such as investment decisions, credit and productivity performances. Therefore, a non-linear binary logistic regression model was fit. The dependent variable has a probability value of one if the event occurred and a value of zero, otherwise. In this study, the dependent variable is the probability that an individual has access to credit (i.e., a binary variable). The goal of logistic regression is to model the probability of the binary outcome variable as a function of the independent variables (Studenmund, 2014). The model estimates the coefficients of the independent variables, which represent the degree to which they influence the probability of having access to credit.

To begin the analysis, data on a set of independent variables were collected that are thought to be related to credit access, such as farming system, farming experience, household size, farm size, herd size, yield, number of investments, income, education level, types of farming, age, gender, and employment status. These variables were used to estimate the probability of having access to credit (See Table 5). The logistic regression model assumes that the log odds of the dependent variable (having access to credit) is a linear combination of the independent variables. The log odds can then be transformed into probabilities using the logistic function (Gujarati, 2003).

The logistic regression model provides several metrics to assess the quality of the model fit, such as the overall significance of the model, the significance of individual coefficients, and measures of model accuracy and goodness of fit (Gujarati, 2003). Overall, logistic regression is a useful tool for identifying factors that enhance credit access, allowing policymakers and financial institutions to better understand the factors that influence credit access and take appropriate measures to promote financial inclusion. The credit model in this case has a dependent variable of one if credit was accessed, otherwise zero. The model assumes for the binary response of y , the likely value of y , $E(y) = \pi$, where π denotes $P(y=1)$. Generally, the regression determines the likelihood of the events occurring.

4.4 Estimation procedures

The basic model of logit estimation as defined by Gujarati (2003) is as follows:

$$p_i = \text{prob}(y_i = 1) = \frac{1}{1 + e^{-(\beta_0 + \beta_1 X_{1i} + \dots + \beta_k X_{ki})}} = \frac{e^{\beta_0 + \beta_1 X_{1i} + \dots + \beta_k X_{ki}}}{1 + e^{-(\beta_0 + \beta_1 X_{1i} + \dots + \beta_k X_{ki})}} \dots \dots \dots (4.1)$$

Moreover,

$$p_i = \text{prob}(Y_i = 0) = 1 - \text{prob}(Y_i = 1) = \frac{1}{1 + e^{(\beta_0 + \beta_1 X_{1i} + \dots + \beta_k X_{ki})}} \dots \dots \dots (4.2)$$

Equation (4.1) and equation (4.2) are then divided from each other. This resulted in the following equation (Equation 4.3).

$$\frac{\text{Prob}(Y_i = 1)}{\text{Prob}(Y_i = 0)} = \frac{p_i}{1 - p_i} = e^{\beta_0 + \beta_1 X_{1i} + \dots + \beta_k X_{ki}} \dots \dots \dots (4.3)$$

Where P_i denotes that there is a positive probability that the farmer will access agricultural finance, and $(1 - P_i)$ denotes that an individual farmer has no credit access, and e denotes the exponential constant. Additionally, the natural logarithms were considered in equation 4.3, resulting in the logit model as stated by (Hosmer & Lemeshow, 1989). The logit model was then expressed as indicated by the equation below:

$$z_i = \ln\left(\frac{p_i}{1 - p_i}\right) = a + \beta_1 X_1 + \beta_2 X_2 + \beta_n X_n \dots \dots \dots (4.4)$$

In addition to equation (4.4) above, as the value moves between 0 and 1, the logit transitions from lemniscates or negative infinity to positive infinity ($-\infty$ to ∞). This indicates that although the probabilities of choices are constrained between 0 and 1, the logit is not bound by such limitations as explained by (Gujarati, 2003). Hence, the disturbance term is considered and equation 4.5 is formulated as follows:

$$z_i = a + \sum_{j=1}^m \beta_j X_j + \mu_i \dots \dots \dots (4.5)$$

Table 5: Dependent and predictor variables used in the logit model.

Variables	Coding	Type	Expectation effect (+-)
Dependent variables			
Credit access (yes = 1; 0 otherwise)	Credit	Binary	+/-
Independent variables			
Farming system (communal =1 commercial = 0)	Farmsys	Binary	+/-
Farming experience	Farmexp	Continuous	+
Household size	Hhsize	Continuous	+
Farm size	Lnfarmsize	Continuous	+
Total income	Ln totinc	Continuous	+
Farm yield	Ln yield	Continuous	+
Herd size	Ln herdsiz	Continuous	+
Number of investments	no_invest	Continuous	+
Education: Secondary (yes = 1; 0 otherwise)	Edusec	Binary	+
Education: tertiary (yes = 1; 0 otherwise)	Edutert	Binary	+
Employed fulltime (yes = 1; 0 otherwise)	Empfulltime	Binary	+/-
Employed part-time (yes = 1; 0 otherwise)	Empparttime	Binary	+/-
Crop farming (yes = 1; 0 otherwise)	Crop farm	Binary	+
Livestock farming (yes = 1; 0 otherwise)	Livefarm	Binary	+

Source: Own computation

4.5 Multinomial regression

The multinomial probability regression method was used to analyse the data to achieve objective two. The model is used because it provides a comprehensive method to handle multiple categories of outcomes, account for non-linear relationships, and offer clear insights into how credit influences different levels of investment and productivity. It allows for more nuanced interpretations and can provide insights that ordinary least square (OLS) models may not capture (Green, 2012).

The objective is to identify factors that affect agricultural loan default. It is assumed that access to a financial instrument such as credit is a function of availability, accessibility, and some macroeconomic variables. Other factors include credit rationing and fiscal money supply restriction. Financial institutions

may ration the allocation of credit due to many reasons some of which are, the risk profile of borrowers, adverse selection, and the moral hazard of farmers. Farmers with little investment and production capacity are high-risk clients. Moreover, farmers are likely to borrow funds for a different reason – moral hazard hence, the default in loan servicing is high. Thus, banks embark on strict assessments for financial credit disbursements - collateral. The measure for financial credit creates a constraint for farmers leading to credit market imperfection and loan default – thus a reduction in farm investment and productivity. Nevertheless, certain social-economic features of the farmer may result in default. These include a lack of adequate landed property and insurance to lock in the credit leverage, others are age, academic level, and risk status. Farmers with little capacity are more risk-averse than more resourceful ones. Risk-seeking farmers may over-commit and borrow more than they can service. Also, asymmetric information contributes to limiting their knowledge about the type of credit suitable for them. Consequently, poor loan choices may eventually result in bad debts.

The variable of interest is the ability to service a loan. Therefore, the amount paid (unpaid) is a function of the factors explained prior. Therefore, the study applied a multinomial probability choice model to analyse the relationship between default and a vector of variables that affect loan servicing. The response variable has three outcome levels, active payment, partial payment, and default - payment ceased. Therefore, a multinomial logit probability model is fit to analyse default. The relationship between the response variable in this case (repayment) and the predictors can be represented in a multinomial logit model.

In probability choice modelling, when there are more than two outcomes, a multinomial logit regression model could be used (Greene, 2012). Nominal categories are easily modelled with multinomial regression. The assumption is that the response variable (repayment status) has three outcome levels namely, active payment, partial payment, and default payment (denoted as dependent variables/endogenic variables in the model). Again, the effect on repayment of a loan by the farmers has the following exogenous (independent) variables, credit accessibility, and socioeconomic characteristics of the farmer among others (See Table 6).

Assume that the probability of the above-mentioned three outcomes is

$$y_j = \begin{cases} 1 & \text{if } y = j \\ 0 & \text{if } y \neq j \end{cases}, j = 1, 2 \dots k$$

$y_j = 1$ if the alternative j is the observed outcome while the remaining $y_k = 0$. In this case, for each observation, $y_1, y_2 \dots y_x$ will be non-zero and the rest will be equal to zero.

The probability that an individual farmer falls into one of the three outcomes j^{th} an alternative is denoted by equation (4.6)

$$P_{ij} = \Pr[y_i = j] = F_j(x_i, \beta) \dots \dots \dots (4.6)$$

Note that the functional form of F_j will be selected to enable the probability to be between 0 and 1 and sum over j to one (meaning that the probability for outcomes variables; active payment, partial payment, and default payment will be equal to one). The functional form of F_j will then lead to a multinomial model.

P_{ij} = Probability

w_i = regressor (independent variables)

F_j = alternative

i = individual

y_i = dependent variables

Using the alternative invariant regressor, the multinomial logit model is then denoted in the following equation. The probability for the three outcomes is

$$P_{ij} = P(y_1 = j) = \frac{\exp(w_i y_j)}{\sum_{k=1}^m \exp[w_i y_k]} \dots \dots \dots (4.7)$$

The above equation indicates a generalised binary logit model as denoted by equation (4.7). Therefore, the probability of each alternative outcome occurring as indicated below, adds up to **one** as indicated below.

$$\sum_{j=1}^m p_{ij} = 1 \dots \dots \dots (4.8)$$

To estimate the model accurately, one set of coefficients shall be normalised to zero ($y_1 = 0$ ending up with $(j - 1)$ set of coefficient estimates. Other alternatives are referenced to the base outcome. Therefore, the alternative j coefficient, when compared to the base alternative, will indicate an increase in the independent variables, credit accessibility (CA), and socioeconomic characteristics (SEC) will make the selection of the alternative j more or less likely to happen.

Table 6: Dependent and predictor variables used in the multinomial model.

Variables	Coding	Type	Expected sign
Dependent variable*			
Predictors			
Farming system	Farmsys	Binary	+/-
Number of investments	no_invest	Continuous	+
Total farm income	Lntotinc	Continuous	+
Total herd size	Lntoherdsize	Continuous	+
Farm size	Lnfarmsize	Continuous	+
Total loan	Lntotloan	Continuous	+
Gender	Gender	Binary	+

*Dependent variables are: (Paid-up, Active and default). Source: Own computation

4.6 Data analysis

Logistic regression, Multinomial probability regression, and simultaneous equation model (SEM) were used to analyse the data. These models are explained in detail below.

4.7 Simultaneous equation model (SEM)

Simultaneous equation modelling is a method used in the literature to develop models for the estimation of the link among credit, land rights, agricultural investment, and agricultural productivity. Simultaneous Equation Models (SEMs) are frequently employed to develop optimisation problems related to farm investments and production choices, regardless of the existence of credit. Examples include Feder & Onchan (1987); Place & Hazell (1993); Place & Migot-Adholla (1998), and Uchezuba et al. (2019).

To examine credit access, investment, and productivity while addressing endogeneity concerns, the models described earlier include specific variables. To simplify these models, reduced-form equations (4.18), (4.19) and 4.20 are estimated. These equations assume that credit can be expressed as a function of investment and productivity, as found in previous studies such as Place & Migot-Adholla (1998) and Dube & Guveya (2013). Some studies use a reduced-form recursive regression of the models, where the residuals or fitted, values are recursively added to Equations (4.19) and (4.20) instead of actual credit (C) and investment (I) variables, as demonstrated in Dlamini & Masuku (2011). A treatment effect and instrumental variable two-stage least square (2SLS) approach was used to create a link and address

endogeneity concerns. Using a valid instrument ensures that the IV estimator produces consistent estimates.

Instrumental variables (IVs) are statistical techniques used to estimate causal relationships between variables when traditional regression analysis may produce biased or inconsistent results. It is commonly used in econometrics and social sciences to address endogeneity, which occurs once a variable correlates with the error term in a regression model. IV seeks to find an external variable, known as an instrument that correlates with the variable being studied but not with the error term. The instrument is then used to calculate the impact of the variable of interest on the result. The use of IV requires assumptions that the instrument is significant, indicating a correlation with the factor of interest, and not associated with the error term, making it exogenous. If these assumptions are held, IV can provide unbiased and consistent estimates of the cause-and-effect relationship between the variable of interest and the ultimate result or consequence being studied. The use of IV methods has been used by Das et al. (2009); Chandio et al. (2018) Nakano & Magezi (2020); Shuaibu & Nchake (2021); Li et al. (2022); Jing et al. (2022); and Toure (2021).

Objective three examined the effect of credit on agribusiness investment and productivity. This objective was achieved using the simultaneous equation model (SEM). Simultaneous equations are estimated when two or more variables are jointly determined (Having more than one equation that is related to each other (Wooldridge, 2016). SEM was used because it is assumed that there is a two-way influence whereby one variable affects other variables. That is, credit can affect investment and investment can affect credit. Hence, there is a need to consider three equations in the form of SEM. The result of SEM could be biased; hence, the bias must be solved first by using two-stage least squares and instrument variables to correct the endogeneity bias. Consider equations (4.9) and (4.10) below.

$$Y_1 = \beta_0 + \beta_1 Y_2 + \beta_2 z_1 + \mu_1 \dots \dots \dots (4.9)$$

$$Y_2 = a_0 + a_1 y_1 + a_2 z_2 + \mu_2 \dots \dots \dots (4.10)$$

From the above equation, one can detect that the two endogenous variables appear as a dependent variable and an independent variable, Y_1 in equation (4.9) and Y_1 existing as an independent variable in equation (4.10). The same applies to the dependent variable Y_2 in equation (4.10) existing as an

independent variable in equation (4.9). Furthermore, there are two exogenous variables z_1 and z_2 while Y_2 appear as an endogenous variable in equation (4.9) and Y_1 in equation (4.10). To show simultaneity bias, equation (4.9) is inserted in equation (4.10) with the following expression.

$$Y_2 = a_0 + a_1(\beta_0 + \beta_1 y_2 + \beta_2 z_1 + \mu_1) + a_2 z_2 + \mu_2 \dots \dots \dots (4.11)$$

$$Y_2(1 - a_1 \beta_1) = a_0 + a_1 \beta_0 + a_1 \beta_2 z_1 + a_2 z_2 + a_1 \mu_1 + \mu_2 \dots \dots \dots (4.12)$$

$$Y_2 = (a_0 + a_1 \beta_0)/(1 - a_1 \beta_1) + a_1 \beta_2/(1 - a_1 \beta_1) z_1 + a_2/(1 - a_1 \beta_1) z_2 + (a_1 \mu_1 + \mu_2)/(1 - a_1 \beta_1) \dots \dots \dots (4.13)$$

Now, equation (4.11) is the expression for Y_1 and putting Y_2 on the other side of the equation from equation (4.11) to equation (4.12). Equation 4.12 indicates that y_2 is correlating with the error term μ_1 . This means that y_2 is endogenous in the equation for y_1 (simultaneity).

The next step is to formulate the reduced-form equation for Y_2 as depicted below.

$$Y_2 = \hat{\beta}_0 + \hat{\beta}_1 z_1 + \hat{\beta}_2 z_2 + e_1 \dots \dots \dots (4.14)$$

At this stage, the biased and inconsistent estimator posed by the structural equation is solved through Equation (4.14), which will provide an unbiased and consistent estimator because z_1 and z_2 are not associated with the error term. This same procedure will be used for the other equation to solve the simultaneity bias.

Next, it is important to explain that simultaneous equations can be constantly estimated by two-stage least squares (2SLS). To analyse the effect of finance on agribusiness investment and agricultural productivity.

Consider structural equations (4.15), (4.16) and (4.17) denoted below.

$$Y_1 = \beta_0 + \beta_1 Y_2 + \beta_2 z_1 + \mu_1 \dots \dots \dots (4.15)$$

$$Y_2 = a_0 + a_1 y_1 + a_2 z_2 + \mu_2 \dots \dots \dots (4.16)$$

$$Y_3 = a_0 + a_1 y_2 + a_2 z_2 + \mu_2 \dots \dots \dots (4.17)$$

Where;

Y_1 = credit

Y_2 = investment

Y_3 = productivity

$$Credit = \beta_0 + \beta_1 investment + \beta_2 Age + \beta_3 education + \beta_4 x_1 + \mu_1 \dots \dots \dots (4.18)$$

$$investment = a_0 + a_1 credit + a_2 age + a_3 education + a_3 x + \mu_2 \dots \dots \dots (4.19)$$

$$Productivity = a_0 + a_1 credit + investments + a_2 age + a_3 education + a_3 x + \mu_2 \dots \dots \dots (4.20)$$

From the three structural equations, credit appears as endogenous in equation (4.18), and investment and productivity in equations (4.19) and 4.20.

In summary- and for simplicity, the credit, investment, and productivity models are presented below.

$$\text{Credit based model } (C) = f(TTL, FS, ED, FE, FS) \dots \dots \dots (4.21)$$

$$\text{Investment based model } (I) = f(TTL, FS, ED, FE, FS, C) \dots \dots \dots (4.22)$$

$$\text{Productivity based model } (Y) = f(TTL, FS, ED, FE, FS, I, C) \dots \dots \dots (4.23)$$

Where; TTL denotes total loan; FS- denotes farming system; ED denotes the farmer's education level; FE denotes farming experience; FS denotes farming size; C denotes credit, I denote investment and Y denote productivity.

4.8 Causality test on credit, investment and productivity: SEM model

The magnitude of agricultural investment and productivity is heavily associated with access to agricultural credit. According to Agbeno (2021); Chisasa & Makina (2015); Gebeyehu et al. (2020); Falola et al. (2022), Kudadze et al. (2016); Lam et al. (2019); credit-enhanced agricultural investment and agricultural productivity.

However, analysts find mixed results. Agbodji & Johnson (2021); Bidisha et al. (2018); Ngong et al. (2021); and Rehman et al. (2017) used the Engle-Granger two-step cointegration and autoregressive distributed lag technique to analyse the correlation of the expansion of financial services and the level of agricultural efficiency in the manufacturing sector of Cameroon. According to the results, trade openness was found to impair the production sector's productivity in the short run. The study found that providing finance to the private sector and increasing funding had a favourable impact on the manufacturing sector's productivity in the short term. Several researchers also examined the cause-and-effect association between finance and productivity.

Nakano & Magezi (2020) assessed how microcredit affects technology adoption and rice farming productivity in Tanzania. The study shows that using credit does not increase borrowers' household incomes, paddy yields, or rice farming profits. Using a Pairwise Granger causality test, Orji et al. (2021) assessed the causal link between financing and agricultural output in Nigeria. The findings reveal the absence of a link between agricultural credit and farm output. Ngong & Thaddeus (2020) assessed the development of the financial services industry and property developments in Nigeria. Based on a null hypothesis, the study calculates the long-term cause-and-effect association between the growth of the banking sector and that of the real estate market in Nigeria's emerging economy from 1990 to 2018. The

study establishes a link between Nigeria's banking sector growth and property growth using autoregressive distributed lag (ARDL) and vector error correction (VEC) modelling techniques. This implies that there exists a lasting correlation between the growth of Nigeria's banking sector and the development of its real estate industry. The results show that there is no cause-and-effect association between the growth of Nigeria's banking sector and the development of its real estate industry. Anh et al. (2020) used an autoregressive distributed lag bounds test, the Toda-Yamamoto Granger causality test, and the indicator saturation break test. The aim was to investigate the effect of bank financial service provision on agricultural output in Vietnam during the period 2004 to 2016. The results show that agricultural credit has a favourable effect on agricultural production in the short and long run. Moreover, the study found a unidirectional cause-and-effect association between credit and output.

Ozdemir (2022) examined the effects of agricultural financing on agriculture value added in the short- and long-term, while also considering other factors such as foreign direct investments and government expenses. The study utilises a mixed autoregressive distributed lag (ARDL) panel technique and Dumitrescu-Hurlin Panel Causality tests using worldwide data spanning from 2000 to 2018. The results indicate that credits eventually have a beneficial effect on agricultural productivity. This shows that boosting agricultural credits leads to a significant rise in improved agricultural output, whereas both FDI and public sector scale lead to a decrease in agricultural productivity in different countries. The pairwise causation test confirms the presence of bidirectional causal relationships among nearly all variables, indicating an interdependent relationship between farm output, agricultural credit, foreign direct investment (FDI), government spending, and price levels.

Given the mixed results, an essential inquiry to be addressed in this investigation is whether there exists a cause-and-effect relationship between access to finance, investment, and agricultural production. To put it differently, does guarantee credit access have a positive effect on farm investment and productivity? Or is there a bi-directional relationship among these variables? A Durbin-Wu-Hausman endogeneity test was used for this test. If the null hypothesis of exogeneity is not rejected, the variable is exogenous, therefore, the variable Granger causes the other, otherwise, it is endogenous. The result could be bi-directional.

Chapter 5: Results

This chapter presents the results of the study. The empirical analysis focused on the three objectives of the study. A descriptive analysis of preliminary findings is given. Followed by the presentation of empirical results obtained with a probability (choice) model and structural equation specification.

5.1 Descriptive statistics

Descriptive statistics includes the summary of the distribution of the data including visual display. The data was displayed using various graphs including histograms and pie charts, among others. Frequency and percentage were calculated to interpret and summarise the data. This was performed to organise the data and produce a descriptive summary that is easy to visualise and interpret the results.

The survey assessed three categories of farmers according to their credit profiles. The credit-seeking, credit-served and credit-constrained farmers. Credit-seeking farmers are those who have applied for credit but whose application was unsuccessful. Credit-served are the successful applicants whereas, credit-constrained farmers are those who need credits but never applied. Tables 8, 10 and 11 depict shows the three categories of farmers.

5.1.1 Acquired credit

Ninety-eight farmers indicate that they have acquired credit. However, 7 per cent, representing seven farmers, did not indicate the amount that was disbursed to them. Only 91 of the farmers indicated the amount disbursed to them by the financial institution, as depicted in Table 7. Credit access is a crucial source of revenue for farmers to fulfil their farming operation needs. Farmers indicated how the loan was used as per the application. These needs include the drilling of boreholes, the purchasing of livestock, game, and production inputs, the purchasing of fencing materials, and the purchasing of farms. Table 7 depicts the distribution of loans acquired by the farmers. Twenty-three per cent of the farmers acquired loans ranging between 151,000.00 and 200,000.00 Namibian dollars, while a small proportion of 4 per cent received between 301,000.00 and 400,000.00 Namibian dollars, most of which were aimed at improving the farming operation and enhancing production.

The findings indicate that most farmers have access to credit, a vital resource for financing farming operations. Credit is predominantly used for specific needs like purchasing livestock, drilling boreholes, and acquiring production inputs or infrastructure, which are essential for improving agricultural productivity. The variation in loan amounts—ranging from 151,000 to 400,000 Namibian dollars—reflects diverse financial needs and capacities among farmers. However, the 7 per cent of respondents who did not disclose their credit amounts suggest gaps in reporting or awareness of credit allocation.

These results align with broader literature highlighting the role of credit in enabling farmers to invest in inputs, infrastructure, and farm expansion. Similar studies, such as those by Bhaumik (2023) and Geda et al. (2024), emphasize credit's impact on improving productivity through investments in modern tools, livestock, irrigation, and soil fertility. However, the relatively smaller loan amounts in this study may limit opportunities for larger-scale improvements, contrasting with findings in other regions where higher loan amounts facilitate more substantial productivity gains.

Table 7: Distribution of the amount of credit obtained from farmers.

Amount	Frequency	Percentage (%)
1600 – 59000	8	8.79%
60000 - 100000	10	10.99%
101000 - 150000	8	8.79%
151000 - 200000	21	23.08%
201000 - 250000	13	14.29%
251000 - 300000	10	10.99%
301000 - 350000	4	4.40%
351000 - 400000	4	4.40%
> 401000	13	14.29%
Total	91	100%

Source: Own computation

Ninety-five farmers indicate that they have acquired credit. However, 3 per cent, representing three farmers, did not indicate the reasons or purpose of the loan that was disbursed to them. Only 95 of the

farmers indicated the purpose of the loan (Table 8). The results indicated that 71 per cent was for livestock production. Twelve per cent was used for drilling boreholes and rehabilitation of water infrastructure, 8 per cent for farm purchases, and 4 per cent for fencing materials and fencing rehabilitation.

Table 8: Purpose of acquired loan.

Use of credit	Frequency	Percentage
Farm purchase	8	8%
Fence	4	4%
Game	1	1%
Irrigation pipes	2	2%
Livestock	67	71%
Poultry production facilities	1	1%
Tractor	1	1%
Water (borehole)	11	12%
Total	95	100%

Source: Own computation

5.1.2 Credit-constrained farmers

Farmers were also assessed to see whether they had applied for credit and if their applications had been unsuccessful; they were requested to provide the reasons for rejection. Among the respondents, twenty-one farmers applied for credit, but their applications were unsuccessful. Agribank rejected 71 per cent of the applications, while First National Bank and the Development Bank of Namibia rejected 5 per cent and 1 per cent, respectively (Table 9). The reason for the rejection of the farmer's applications is depicted in Table 10. The results indicate that 48 per cent of the farmers did not qualify, 33 per cent had no collateral, 14 per cent did not indicate the reason for rejection, and 5 per cent indicated high farmer's debt profile was the main reason for the rejection of their application.

The findings reveal significant barriers to credit access for farmers, with 71 per cent of Agribank applications rejected due to insufficient collateral, lack of qualifications, and high debt profiles. These constraints hinder farmers' ability to invest in agricultural ventures, limiting productivity and growth. This aligns with the broader literature on credit constraints in agriculture, such as Chanda (2024), but highlights stricter conditions and higher rejection rates compared to regions with more inclusive financial systems,

as noted by Christodoulou-Volos (2024). The study underscores the pressing challenges farmers face in accessing finance in this context.

Table 9: Name of financial institutions

Bank name	Frequency	Percentage
Agribank Development Bank	15	71%
Bank	1	5%
FNB	5	24%
<hr/>		
Total	21	100%

Source: Own computation

Table 10: Reasons for not accessing credit

Reason for rejection	Frequency	Percentage
Not applicable	3	14%
Did not qualify	10	48%
Fear of debts	1	5%
Lack of collateral	7	33%
<hr/>		
Total	21	100%

Source: Own computation

The survey included farmers with credit access, those who applied for loans, but whose applications were unsuccessful, and those who never applied. Those who never applied for a loan were requested to indicate the main reasons why they had not applied for agricultural credit. Fifty-nine per cent of the farmers indicated a lack of credit information, 31 per cent stated that they did not apply because of the risk associated with a loan, and 7 per cent of the respondents were not interested in agricultural credit. Table 11 indicates the reasons given by the farmers who never applied for loans.

The findings emphasize significant barriers to credit access, including inadequate knowledge and fear of financial risk, which deter many farmers from seeking loans. These results highlight the role of information asymmetry and perceived financial risk as key obstacles to credit uptake. Compared to studies like Chanda (2024) and Louyindoula et al. (2023), which focus on collateral and qualifications, this research

underscores the importance of improving access to credit information and addressing risk concerns to enhance loan application rates in agricultural communities.

Table 11: Reasons given by farmers why they never applied for a loan

Reasons for not applying	Frequency	Percentage
Risk	9	31%
Cannot afford to pay back	1	3%
Lack of credit information	17	59%
Not interested	2	7%
Total	29	100%

Source: Own computation

Regarding gender, among the respondents who participated in the survey but did not have finance access, 67 per cent were men and 33 per cent were women. Second, among farmers who have accessed credit, 62 per cent of the farmers are male while 38 per cent of the farmers are female (Figure 3). This means that most farmers are predominantly men, which indicates that men are more involved in farming among the surveyed participants than women.

The findings highlight a gender disparity in agricultural credit access, with men more likely to engage in farming and secure credit. This imbalance reflects cultural and structural factors favoring male farmers, as noted in previous studies (Chanda, 2024; Lelisho & Lelisho, 2024). Compared to regions with more gender-inclusive credit policies (Perrin & Weill, 2022), these results underline significant gender inequities and the need for targeted interventions to improve credit access for women in agriculture.

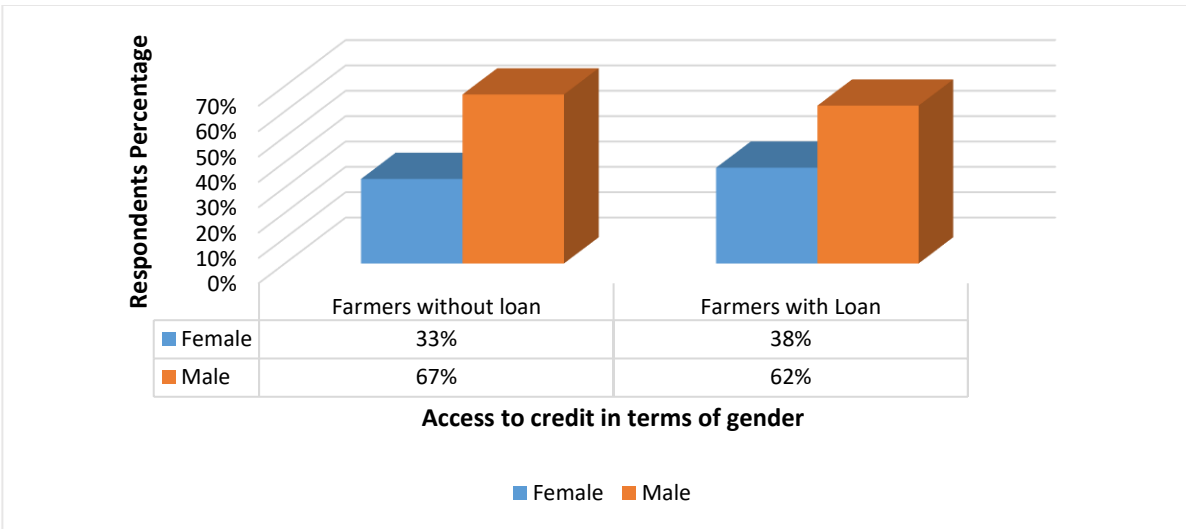


Figure 3: Distribution of respondents according to farmer gender. (Source: Own computation)

The education level of farmers was assessed. The ranking of education was assessed based on the farmers who had acquired loans and those without loan access. In addition, the farmer's education level was measured based on the categories for those without formal education, those who have formal education, primary education, secondary education, those who have attended tertiary education, and short courses. Figure 4 indicates that 54 per cent of the farmers with loan access have tertiary education, while only 33 per cent of the farmers without loans have tertiary education. Apart from tertiary education, 18 per cent of the farmers without loans have no access to formal education, compared to the farmers with loan access, who are only 15 per cent without formal education. Farmers without loans have a higher access level to primary and secondary education compared to farmers with credit.

The findings show that educational attainment significantly influences access to agricultural credit, with higher education levels, particularly tertiary education, associated with better loan approval rates. Farmers with lower education levels face greater challenges in securing loans, highlighting an educational gap in credit access. This aligns with studies like Chanda (2024), which show that more educated individuals are better equipped to meet credit requirements. The results suggest a need for further research into the specific barriers faced by farmers with primary and secondary education in accessing financial support.

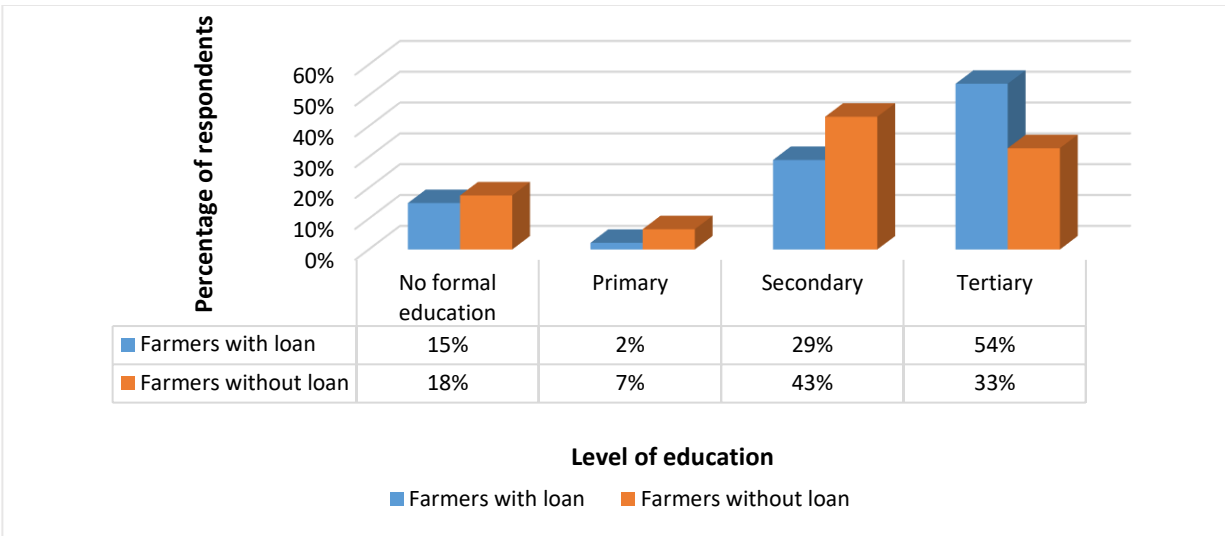


Figure 4: Access to credit and farmers' education

Source: Own computation

In addition, farmers were requested to specify if they have agricultural qualifications and to specify the types of agricultural qualifications. Figure 5 indicates that 87 per cent of farmers without loans and 72 per cent of farmers with loans do not have agricultural qualifications. The educational background of farmers who have taken credit is as follows: 13 per cent have a bachelor's degree qualification, 6 per cent have a master's degree qualification, 4 per cent have a diploma, and 2 per cent have a doctorate or certificate. It is noteworthy that farmers who have not taken credit have a lower proportion of agricultural qualifications, with the highest percentage being 6 per cent for those with a bachelor's degree, 4 per cent with a diploma, 3 per cent with a master's degree, and 1 per cent with a doctorate (as depicted in Figure 5).

The findings reveal that most farmers, regardless of credit access, lack agricultural qualifications, though those with loans are slightly more likely to hold higher education credentials. This highlights a correlation between agricultural education and credit access but also underscores the overall low level of qualifications among farmers. Consistent with studies like Moahid & Maharjan (2020) and Tabe-Ojong et al. (2023), which link formal agricultural education to improved credit access, these results suggest that limited qualifications may hinder farmers from meeting loan requirements. Targeted education and qualification programs are needed to enhance farmers' ability to secure financial support.

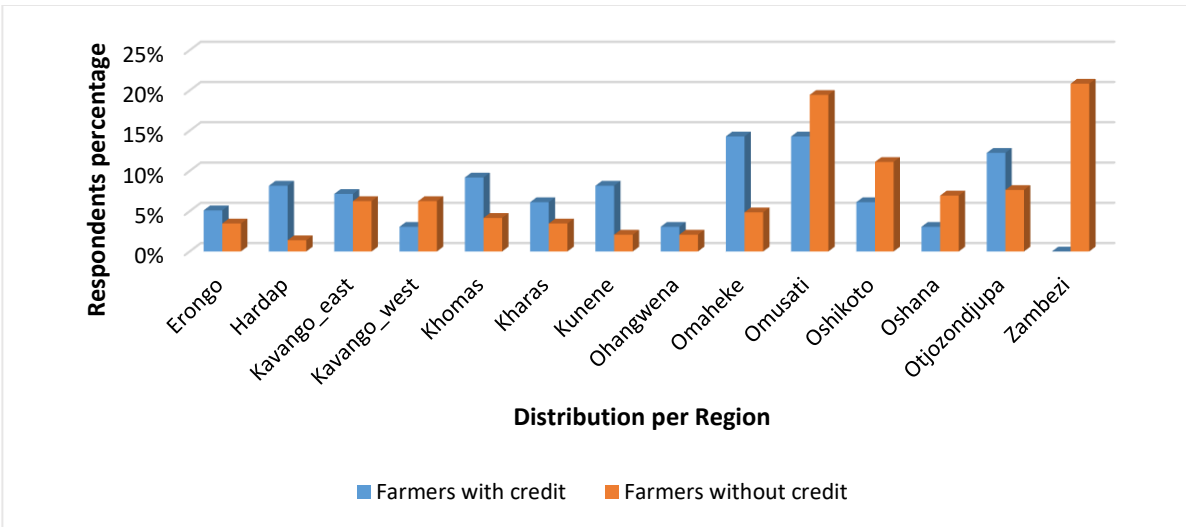


Figure 6: Farmers’ access to credit per region

Source: Own computation

5.1.3 Age

Figure 7 indicates that most of the respondents are young farmers, ranging in age from 46 to 55 years and 36 to 45 years. In terms of gender, 41 per cent of males fall between the age categories of 36 and 45 years. Female farmers dominate the age category of 46 to 55 years with 41 per cent compared to male farmers with 34 per cent under the same age category. There is equal credit access by farmers between the age categories of 36 to 45 years and 46 to 55 years, as illustrated in Figure 7.

The findings contribute to the literature on age and agricultural credit access, indicating that both younger and mid-aged farmers have similar opportunities for financial support, aligning with studies by Manzilati et al. (2022) and Men et al. (2024). This is consistent with Atakli & Agbenyo (2020), who found that age positively influences credit access, which in turn enhances agricultural productivity. The equal access observed in this study suggests a more inclusive credit environment for these age groups in the surveyed areas.

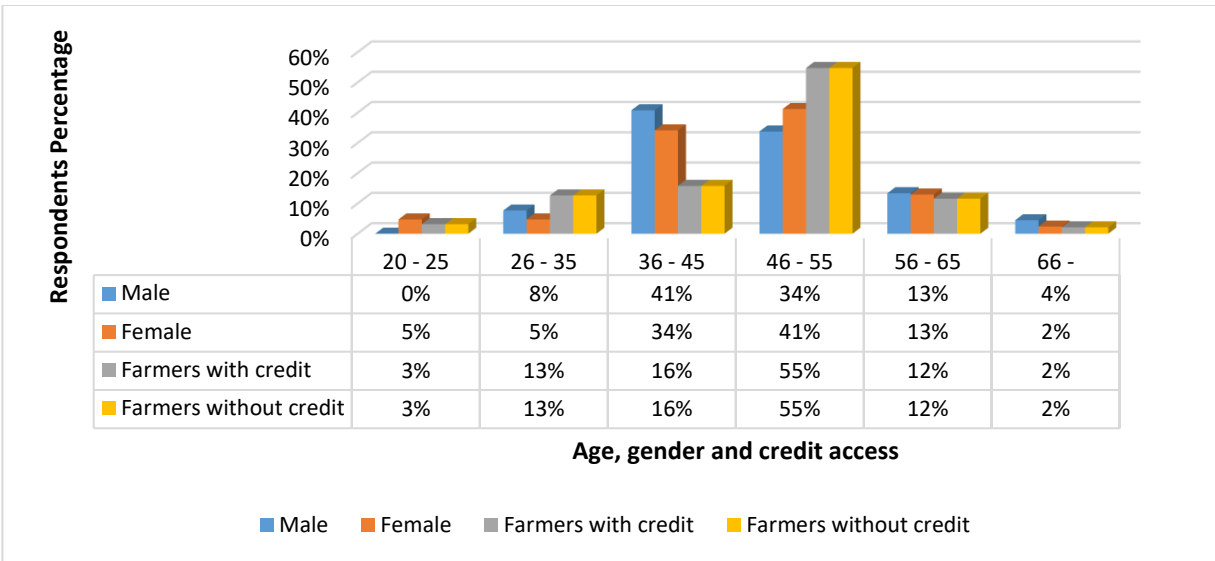


Figure 7: Respondents in terms of age, gender and access to credit

Source: Own computation

Farmers with credit have more land than farmers without credit. Sixty-three per cent of the land area belongs to farmers with credit access, while 37 per cent is owned by farmers without credit access (Figure 8). This indicates that the more land owned by the farmers, the better chance they had of accessing credit. Farming land size may provide a crucial role for farmers to access credit because more livestock could be accommodated in the farming units and more hectares may produce a higher crop yield.

The findings reveal that farmers with credit access tend to own larger land areas, suggesting that land size is a key factor in securing agricultural credit, which in turn enhances investment and productivity. Larger land holdings enable farmers to manage more livestock and cultivate larger crop yields, improving their chances of obtaining financial support. This study adds to the literature by emphasizing land size as an important factor in credit access, supporting existing research that links credit availability to tangible assets like land, which can serve as collateral. Compared to studies such as Atakli & Agbenyo (2020), this research highlights the need for financial institutions to consider land size when evaluating loan applications. It also suggests that policies focused on increasing land access or offering alternative collateral could improve credit access for smaller farmers with limited landholdings.

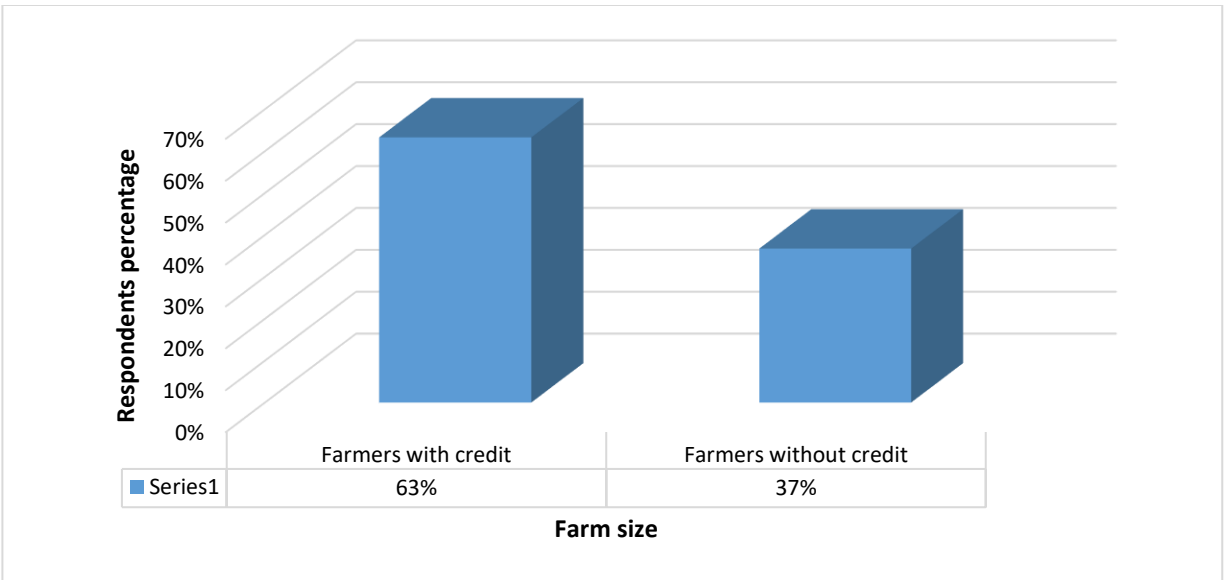


Figure 8: Land size for farmers with credit and farmers without credit

Source: Own computation

5.1.4 Loan performance

Farmers acquired credit from different service providers. The credit was acquired from financial institutions, of which Agribank provided 78 per cent of the loan, First National Bank advanced 14 per cent of the loan, Bank Windhoek advanced 4 per cent of the loan, and the Development Bank of Namibia disbursed 1 per cent. Non-financial institutions such as the Regional Council, the Ministry of Trade and Industrialisation, and Small and Medium Enterprises disbursed 2 and 1 per cent, respectively. The Agricultural Bank of Namibia was the largest provider of agricultural loans (Figure 9).

The findings reveal that Agribank is the dominant source of agricultural credit, with smaller contributions from other financial institutions such as First National Bank, Bank Windhoek, and the Development Bank of Namibia. Non-financial institutions like regional councils, the Ministry of Trade and Industrialisation, and small and medium enterprises also provide a minor share of loans. This highlights Agribank's central role in agricultural financing, in contrast to studies that emphasize a broader range of financial institutions (Kambali & Panakaje, 2022; Kapoor, 2024). The findings suggest that, while national banks dominate, there is potential for expanding the involvement of other institutions to improve farmers' access to financial resources, especially in regions with more diversified credit systems.

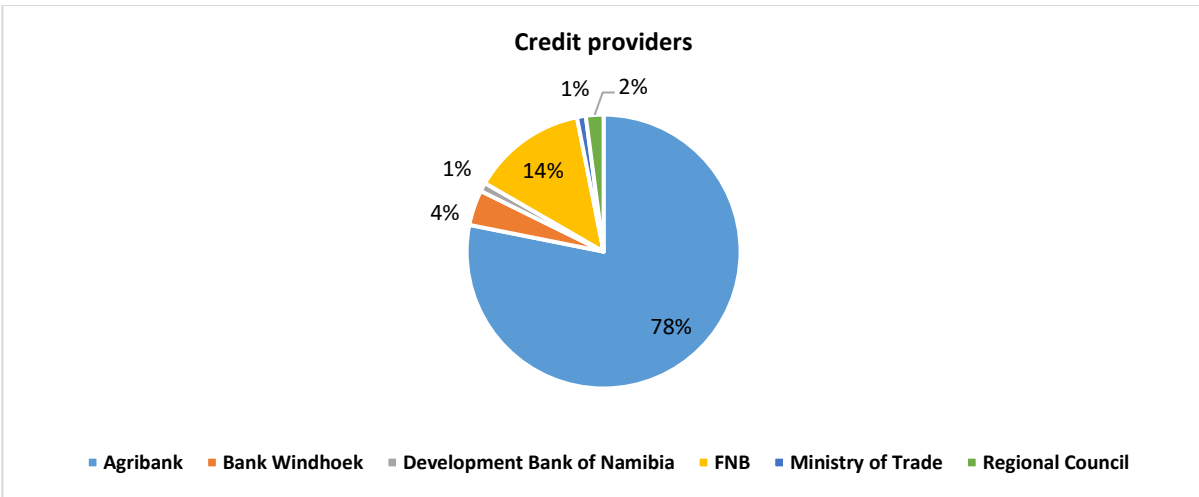


Figure 9: Providers of financial loans to farmers

Source: Own computation

Credit is issued on different categories and terms. Farmers could opt for short-, medium-, or long-term periods. Short-term loans are issued for a period between zero and five years. Medium-term loans range from six to ten years, while Long-term loans range from six to eleven years. Figure 10 shows the performance of the acquired credit per loan term. In terms of loan outstanding, short-term loans perform poorly compared with medium- and long-term loans. As the term increases (period), the outstanding loan decreases. This indicates that farmers service long- and medium-term loans better than short-term loans. This could be attributed to the fact that long-term loans are cheaper in the short run compared to short-term loans, although in the long run, long-term loans are more expensive.

The study highlights credit performance across different loan categories and terms, contributing to the understanding of repayment patterns in agricultural financing. It suggests that farmers are more likely to repay longer-term loans due to lower immediate financial burdens. The findings align with existing research indicating the importance of loan term length in repayment performance. However, it uniquely emphasizes the cost-effectiveness of loan terms, adding a nuanced perspective to the literature on agricultural credit and farmers' financial strategies.

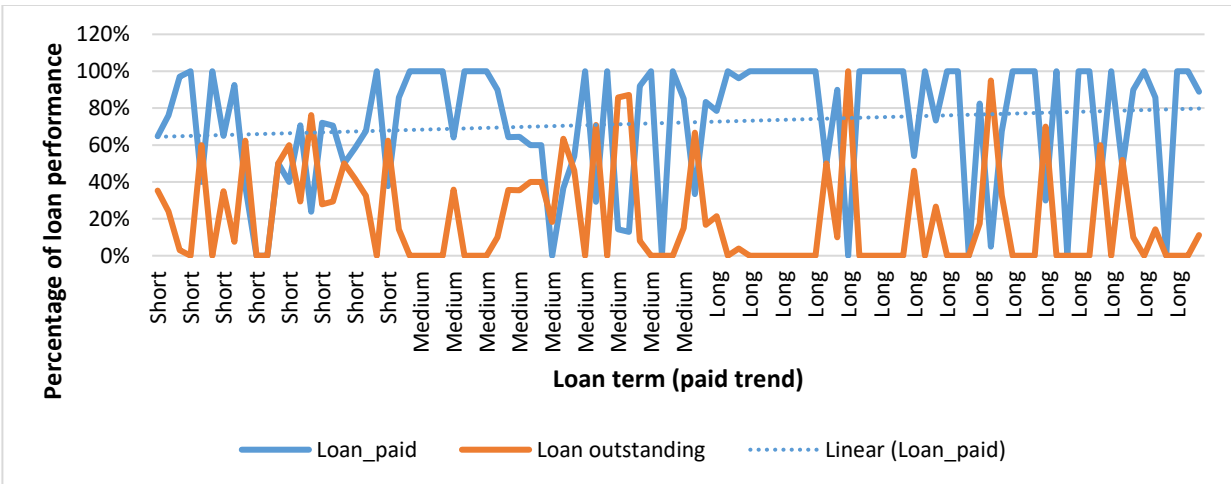


Figure 11: Loan period performance and loan-paid trend.

Source: Own computation

5.1.5 Loan defaulter

Loan holders who failed to pay more than 50 per cent of their loan were classified as loan defaulters. Figure 12 shows the defaulter payment trend in terms of the loan period. The payment decreased tremendously from 40 per cent for a short-term loan to below 20 per cent for a medium-term loan to less than 5 per cent for a long-term loan. The results show that loan outstanding has increased from 50 per cent for short-term loans to 80 per cent for medium-term loans until it reaches 100 per cent for long-term loans. This indicates a decline in loan servicing by farmers, resulting in defaulting. The trend is that as the payment of loans decreases, the outstanding loan volume increases, which results in loan defaults and repossession of farmer assets. However, this trend is only applicable to default farmers because the general trend of loan servicing indicates a positive outlook (refer to Figures 11 and 12).

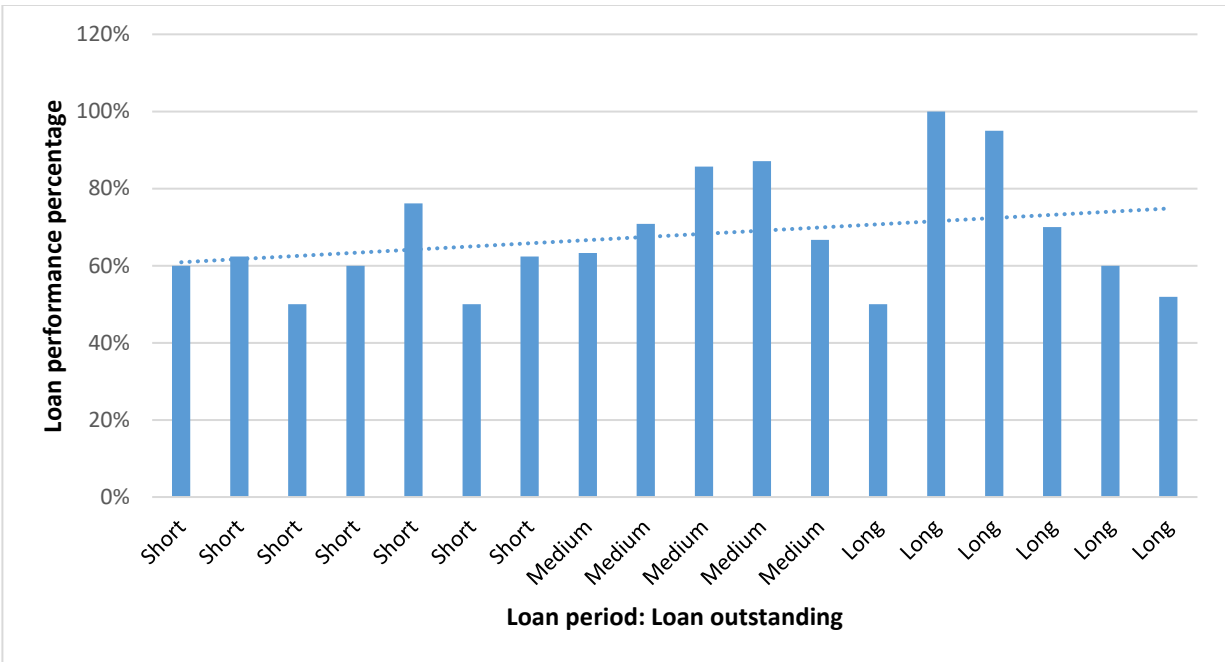


Figure 12: Defaulting farmers' loan performance

Source: Own computation

5.1.6 Infrastructures investments

In terms of infrastructure investment, farmers with credit have made more investments compared to those without credit. Farmers with access to credit invested in infrastructure at a rate of 56 per cent, whereas farmers without credit invested at a rate of 44 per cent. In terms of infrastructure costs, farmers with credit have made more investments than farmers without credit. These investments represented fifty-seven and 43 per cent of the farmers' infrastructure (Figure 13).

The findings show that farmers with access to credit are more likely to invest in infrastructure than those without credit, highlighting the significant role of credit in facilitating investments in essential infrastructure. This aligns with existing research, which demonstrates that access to financial resources can lead to increased agricultural investment, enhancing productivity and long-term sustainability. The current study builds on this by quantifying the difference in infrastructure investment between credit holders and non-holders, providing valuable evidence that financial support drives greater infrastructural development among farmers.

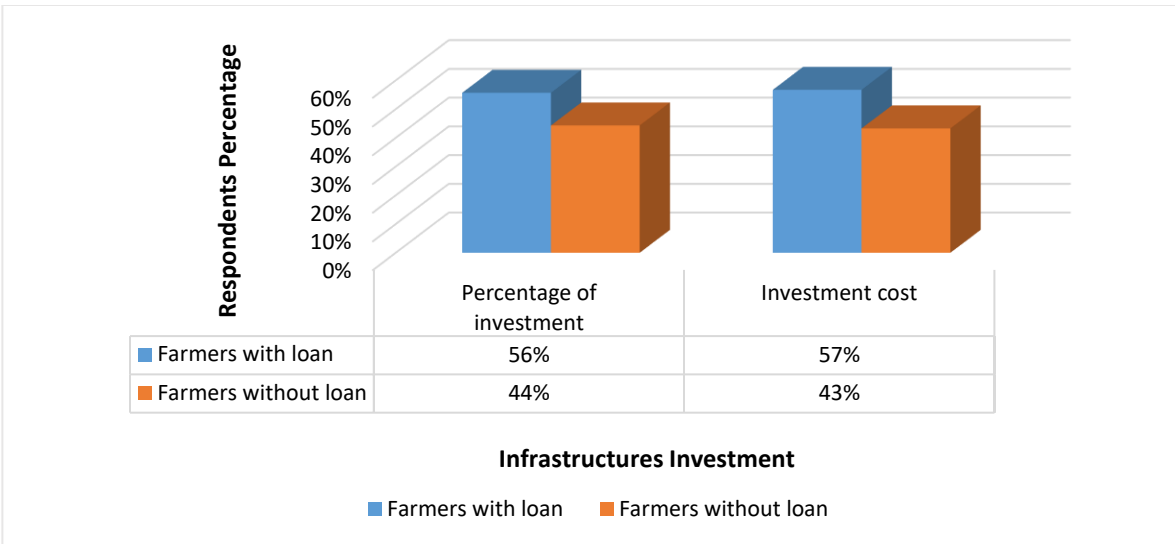


Figure 13: Access to credit and investment in infrastructure

Source: Own computation

In terms of costs, infrastructure investments were assessed per region. Farmers with access to credit have made more investments in the Erongo, Hardap, Khomas, Kharas, Kunene, Ohangwena, Omaheke, and Otjozondjupa regions. More infrastructure investment by farmers with credit was recorded in the Kunene region at 98 per cent, Ohangwena region at 96 per cent, Hardap region at 94 per cent, Kharas region at 85 per cent, Erongo region at 80 per cent, and Omaheke region at 74 per cent. Interestingly, farmers without credit have invested more in Omusati, at 78 per cent, Oshikoto, at 72 per cent, and Oshana, at 68 per cent (Figure 14).

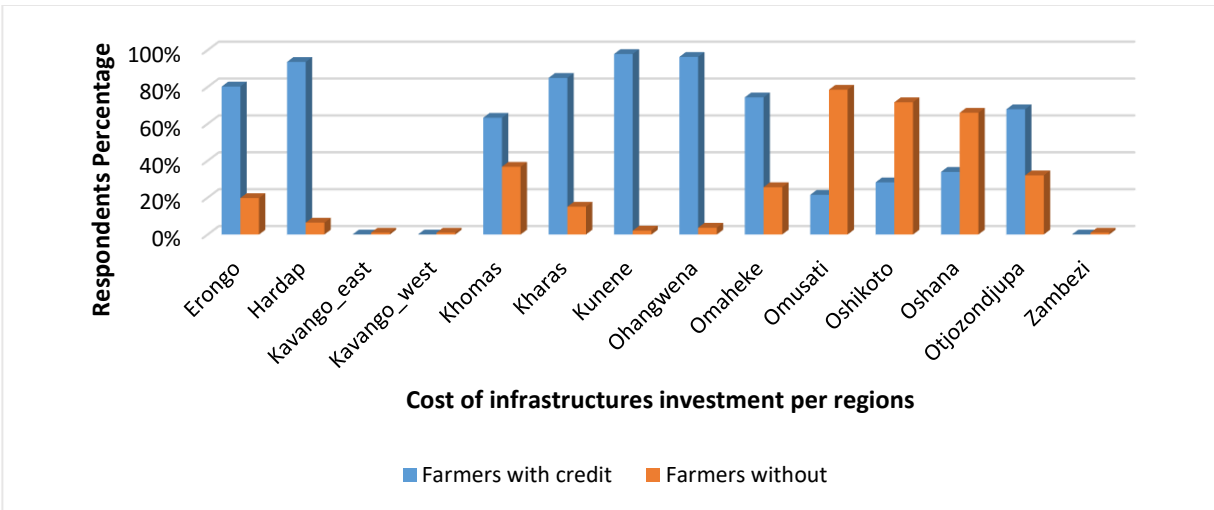


Figure 14: Distribution of infrastructure investment costs per region

Source: Own computation

5.1.7 Livestock production (productivity)

The productivity of the livestock farmers was assessed by examining the number of animals owned by the farmers and the number of offspring born per year. Figure 15 indicates the percentage of livestock for farmers with credit access and farmers without financial access. Farmers with financial access have more livestock than farmers without financial access. Those with financial access have 52 per cent of cattle, compared to 48 per cent of cattle for farmers without financial access. Farmers with financial access have 71 per cent of sheep and 69 per cent of goats compared to farmers without credit, who have 29 per cent of sheep and 31 per cent of goats, respectively.

The findings show that farmers with access to financial resources tend to own a larger proportion of livestock compared to those without credit, indicating that financial access significantly boosts their capacity to expand and manage livestock. This aligns with existing research, which underscores how credit access can enhance agricultural productivity, particularly in livestock farming. The study builds on previous literature by providing empirical evidence of the positive relationship between financial access and livestock ownership, highlighting the crucial role of credit in improving farmers' livelihoods and productivity, especially in resource-intensive sectors like livestock farming.

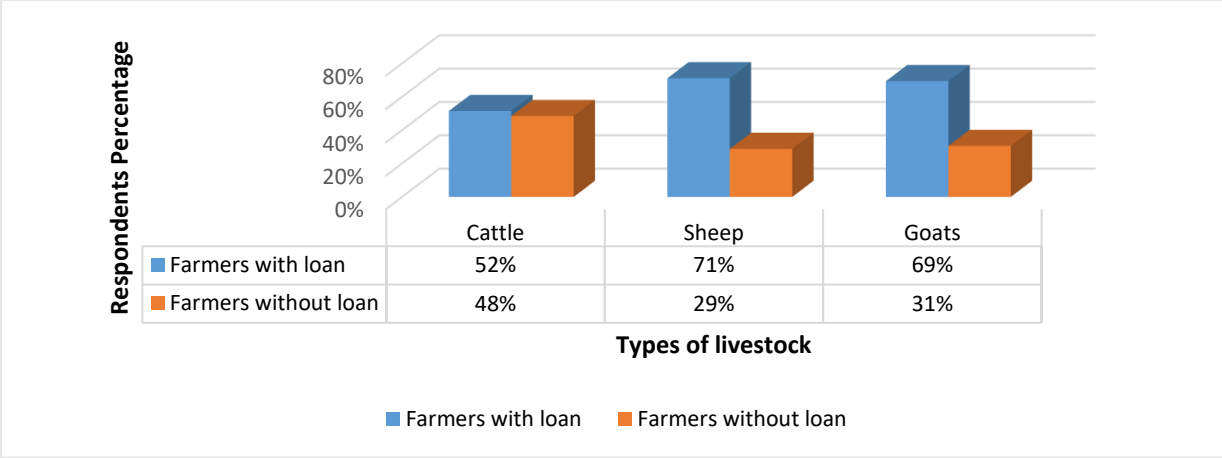


Figure 15: Quantity of livestock owned by the respondents.

Source: Own computation

In terms of calving, lambing, and kidding, farmers with loan access have more production in terms of offspring compared to farmers without financial access. Farmers with financial access recorded an 81 per cent calving and lambing rate while kidding amounted to 78 per cent. Farmers without credit recorded below-average calving rates of 19 per cent, 22 per cent kidding, and 1 per cent lambing. This indicates a positive production rate from the farmers who acquired credit (Figure 16).

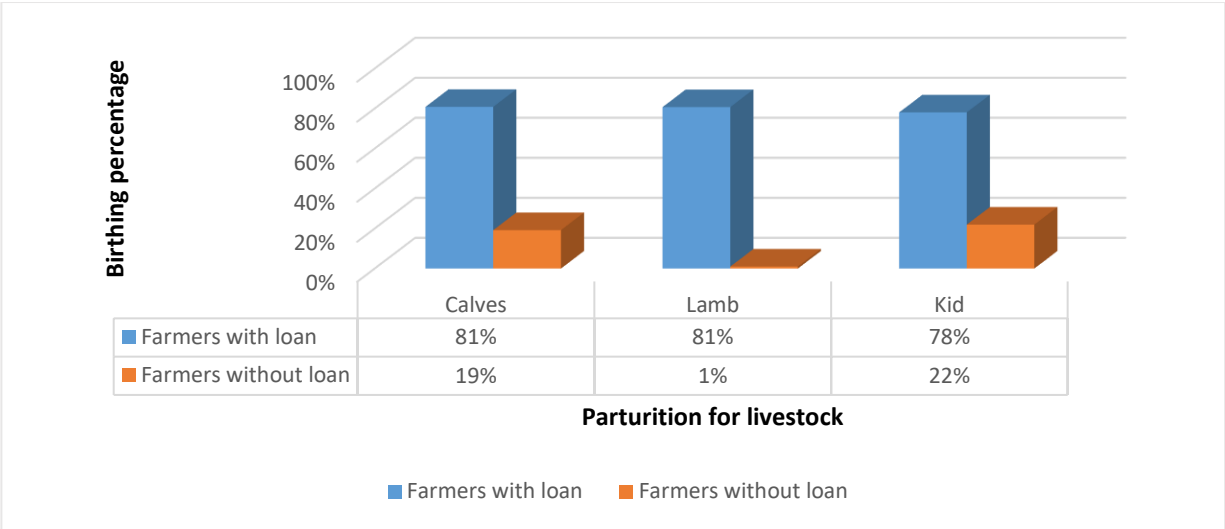


Figure 16: Percentage of livestock production rate (parturition)

Source: Own computation

Comparing the number of livestock owned and livestock parturition (offspring), the data show that farmers who have credit access have more livestock and have more livestock offspring compared to farmers without credit access. Farmers with credit have more cattle, sheep, goats, and other livestock, which include donkeys, horses, and chickens. The high number of livestock owned correlates with animal reproduction, and this indicates an investment in livestock and good management practices because of the high calving rate compared to the livestock number and calving rate for farmers without credit access. Figure 17 indicates the correlation between farmers with credit, farmers without credit access, and the livestock production rate.

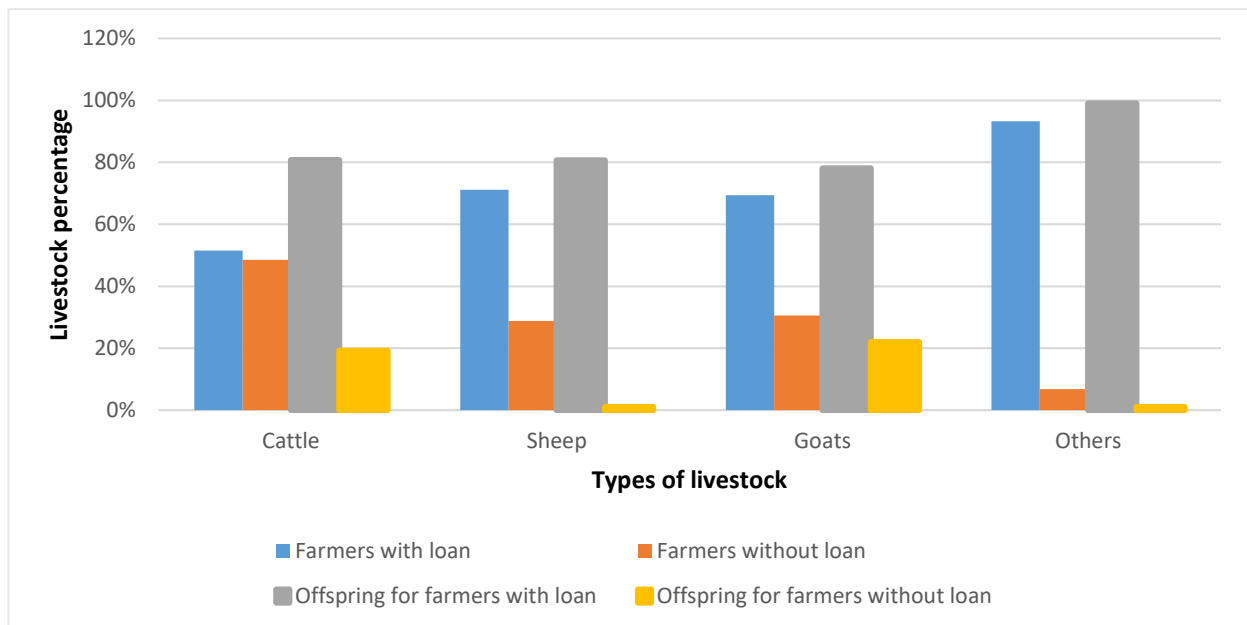


Figure 17: Number of livestock owned and livestock offspring.

Source: Own computation

5.1.8 Marketing

Marketing plays a significant and vital role in cash flow and farming operations. The findings indicate that farmers with credit market their livestock more than farmers without credit. Farmers with credit have a marketing percentage of 82 per cent for cattle, 80 per cent for sheep, and 76 per cent for goats, while for farmers without loan access, only 24 per cent of goats are marketed, 20 per cent of sheep, and 18 per cent of cattle, respectively (Figure 18). This signifies that farmers with credit have cash flow that will enable them to service the acquired loan.

The findings emphasize the importance of marketing in farm operations and cash flow, showing that farmers with access to credit are more likely to market their livestock than those without credit. This suggests that credit access improves cash flow management, essential for loan repayment and farm sustainability. The results align with previous research, which highlights how financial access boosts market participation and agricultural productivity. This study adds empirical evidence linking credit access with increased livestock marketing, supporting the view that credit is a key tool for enhancing farmers' financial stability and market engagement, ultimately improving farm operations.

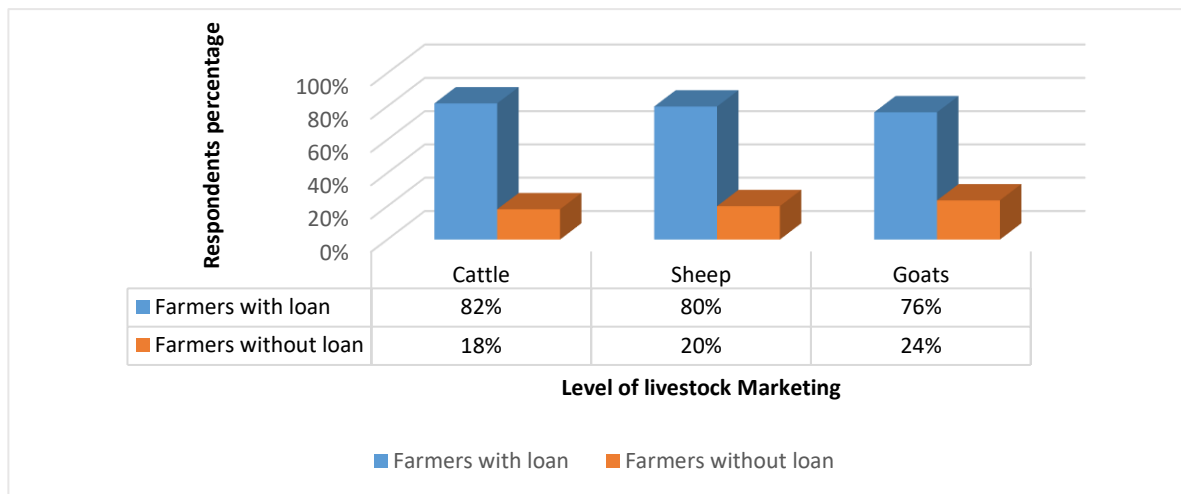


Figure 18: Percentage of livestock marketed by farmers.

Source: Own computation

5.1.9 Farming challenges

Farmers were asked to identify their farming challenges. They were also requested to indicate how these challenges affect their farming enterprise operation. The challenges range from a lack of finance to a lack of infrastructure and equipment such as boreholes, fencing, harvesters, tractors, threshing machines, storage facilities, and other farming implements. Twenty-one per cent of the respondents experienced infrastructure challenges. Farmers cited the lack of market access for livestock and crop products as another challenge they experienced. Twenty-five per cent of the farmers indicated that they experience challenges in marketing their produce due to long distances to the auction kraal, a lack of reliable market access, and the low price offered for their livestock and crop produce. Nineteen per cent of the farmers

indicated challenges with input costs. Input costs include high prices for vaccines and licks, fertilizers, chemicals, seeds, fuel costs, and labour. The challenges associated with climate accounted for 9 per cent, whereby flood and drought were cited as the main factors experienced by farmers and affecting their productivity. Other challenges include disease, which accounted for 6 per cent, while predation, poaching, which includes theft of agricultural produce and livestock and a lack of finance accounted for 5 per cent. Two per cent of the challenge was human-wildlife conflict, while theft of infrastructure, insufficient time to manage the farm successfully, an interest rate of less than 1 per cent, low production, and transaction costs accounted for 1 per cent each (Figure 19).

The result indicates key challenges faced by farmers. These findings align with existing literature highlighting the importance of infrastructure and market access for agricultural productivity (Suri & Udry, 2022; Men et al., 2024). By quantifying these challenges, the study provides valuable insights into the barriers farmers face and suggests that addressing these issues could improve farm operations and sustainability.

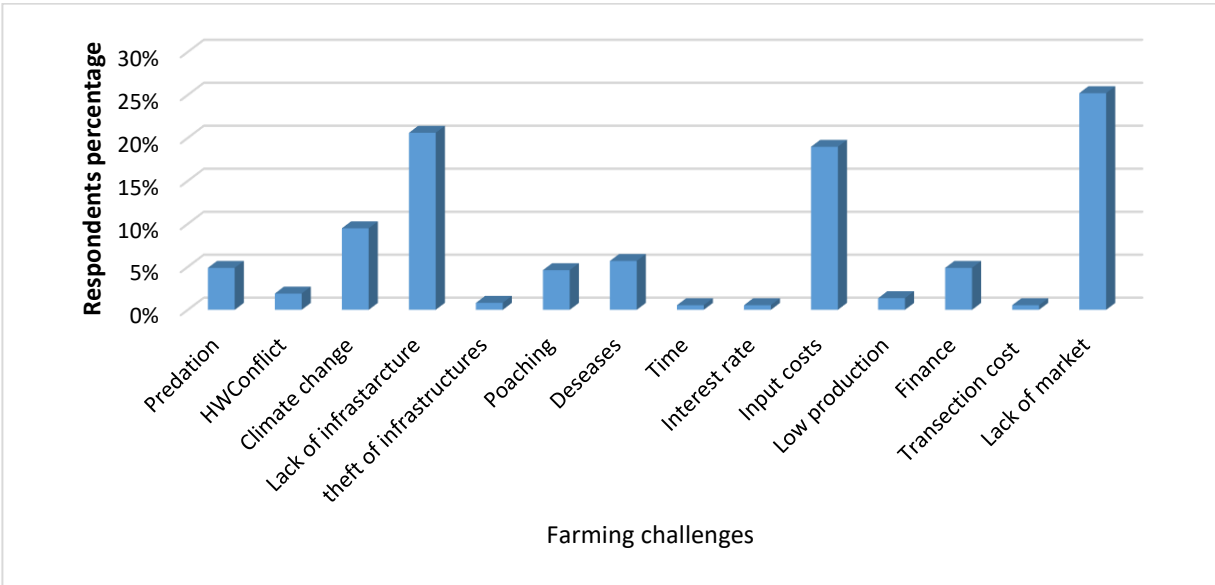


Figure 19: Overall challenges experienced by the farmers.

Source: Own computation

5.2 Logit regression

In the logistic regression model, the table provides descriptive statistics for various variables used to analyse the data. Each row represents a different variable, summarised by its mean, standard deviation,

minimum, and maximum values. These statistics are crucial for understanding the distribution of the data and identifying potential relationships between the variables in the logistic regression model, such as the effect of credit access on farm productivity and investment (table 12).

Table 12: Summary statistics of variables used in the logit model

Variables	Mean	Std dev	Min	Max
Credit	0.405	0.492	0	1
Farmsys	0.599	0.491	0	1
Age	47.23	9.478	23	72
Edunone	0.161	0.368	0	1
Eduprim	0.0579	0.234	0	1
Edusec	0.463	0.5	0	1
Edutert	0.322	0.468	0	1
Farmexp	16.36	9.304	1	50
Empfulltime	0.533	0.5	0	1
Emppartime	0.236	0.425	0	1
Hhsize	6.178	4.538	0	44
Cropfarm	0.74	0.44	0	1
Livfarm	0.636	0.482	0	1
Mixfarm	0.504	0.501	0	1
Totfarmcost	152,095	313,311	1	2914000
Lntotfarmcost	9.746	4.033	0	14.89
Farmsize	1,696	3,199	0.033	22,000
Lnfarmsize	3.479	3.486	-3.41	10
Totinc	951296	1823000	1	12600000
Lntotinc	9.142	5.773	0	16.35
Yield	90	240.7	0.1	1,800
Lnyield	2.049	2.324	-2.3	7.5
Herdsiz	343.9	785	1	10,028
Lnherdsiz	3.345	2.884	0	9.21
Livemkted	174.5	981.7	1	15,025
Lnlivemkted	2.12	2.593	0	9.62
Totinvtkost	174,668	320,356	1	2548000
Lntotinvtkost	7.224	5.707	0	14.75
no_invest	2.545	2.596	0	7
Observations	242			

Source: Own computation

5.2.1 Logistic Regression Output

Table 13 displays the logistic regression analysis output with a binary dependent variable (credit access) and a combination of continuous and categorical independent variables. The first table column contains the names of the model predictors, while the second and third columns contain the logit estimates and the corresponding marginal effects. The logit estimates represent the natural logarithm of the logistic odds linked to a one-unit change in the predictor while keeping other variables constant. In contrast, marginal effects represent a variation in the probability of the outcome variable linked with a one-unit variation in the predictor, while all other variables are kept constant. Additionally, the figures in parenthesis represent the coefficient estimate of the standard error, which is used to calculate the t-statistic and p-value of the coefficient. The marginal effects coefficients can be expressed as a percentage by multiplying by 100.

The variable farm size denoted as "Infarmsize" shows that a one-unit rise in "Infarmsize" results in the increase of the log odds of access to credit by 0.127. For a unit increase in "Infarmsize", the marginal effect on the probability of credit access increases by 0.0290. The results indicate that having access to agricultural land results in a positive relationship with access to credit. The marginal effect of land ownership was found to be 0.127, meaning that owning land raises the likelihood of partaking in microcredit programmes by 13 per cent. This could be because credit providers prefer clients (farmers) to invest the borrowed loan in their farming activities, which are the primary source of revenue in the area, so they can pay back the loan. Additionally, owning land can aid as collateral or guarantee for repayment of the loan. Furthermore, the larger the cultivated land, the more inputs such as labour, seeds, and fertiliser are needed, requiring additional capital from lenders as farm size increases (Jumpah et al., 2019). Another study investigated the ease with which rural farmers in Benue State could obtain credit, with a particular focus on the Bank of Agriculture (BOA). The study results indicated that having a larger land area is among the factors that facilitate credit accessibility (Asom & Ijirshar, 2017).

Total farm income denoted as "Intotinc" shows that a one-unit rise in "Intotinc" raises the log odds of credit access by 0.0857. For a unit rise in "Intotinc", the marginal effect on the likelihood of accessing credit increases by 0.0196. Farm yield denoted as "Inyield" shows that a one-unit rise in "Inyield" raises the log odds of access to credit by 0.321. For a unit rise in "Inyield", the marginal effect on the likelihood of accessing credit increases by 0.0736.

Yield is associated with the size of the land. For instance, the research conducted in Sindh, Pakistan, determined how effective rice farmers are in the area. The stochastic frontier model was utilised to analyse the results. The findings indicated that a rise in land size would cause a production rise of more than 80 per cent. The study resolved that ZaraiTaraqiyati Bank Limited (ZTBL) is successfully fulfilling its role of providing credit schemes to the sector in Pakistan. This, in turn, reduces poverty, enhances revenue, and enhances the living standards of the communal household (Chandio et al., 2019). It is therefore not surprising that yield and land size have positive coefficients, and they are one of the contributing factors that enhance farmers' credit access. Chaiya et al. (2023) investigated how credit use, credit misuse, and various factors impact the credit system in Pakistan. The findings indicate that the farm area and revenue are among the determinants that determine agricultural credit availability to farmers in the area. These studies are consistent with the findings in this research.

The number of livestock owned by farmers, denoted as "Inherdsize" indicates that a one-unit rise in "Inherdsize" raises the log odds of credit access by 0.118. For a unit increase in "Inherdsize", the marginal effect on the likelihood of credit access rises by 0.0271. The investment made by the farmers denoted as "no_invest", indicates that a one-unit rise in "no_invest" increases the log odds of accessing credit by 0.0415. For a unit rise in "no_invest", the marginal effect on the likelihood of credit access rises by 0.00950. This implies that farmers who make more investments have a high likelihood of having better access to loan facilities. The rationale behind this finding is that lenders perceive farmers who make multiple investments as being more creditworthy and financially stable, thereby making them more eligible for credit. However, this finding is very important because, after a thorough assessment, only a few literature have documented investment as a determinant of credit access.

Finally, farmers with tertiary education denoted as "edutert" indicate that a one-unit rise in "edutert" raises the log odds of credit access by 0.140. For a unit increase in "edutert", the marginal effect on the likelihood of credit access increases by 0.0319. Based on this, it does not seem like the education level, in terms of secondary education, of a farmer has a significant effect on their choice to apply for credit. However, farmers who have more education (tertiary education) may be more entrepreneurial or have improved information about the market and the procedures to apply for credit. Educated persons can increase their revenue, which can help them acquire the necessary assets for collateral, and they may also have a better understanding of the importance of credit. Additionally, they may face fewer entry barriers because they have an easier time collecting and evaluating the information required for loan applications

(Jumpah et al., 2019). Another study conducted in Pakistan using 168 subsistence farmers reveals that farmers who possess higher levels of education have greater access to credit. This could be ascribed to their improved technical knowledge, better comprehension of the credit markets system, superior farming skills, and familiarity with bureaucratic processes. The study found that farmers who have completed higher secondary education have a higher likelihood of obtaining credit compared with those with a lower education level (Saqib et al., 2018). Farmers with access to credit tend to be better educated, receive more advice and services, employ greater labour, and manage larger farms compared to those without such access (Louyindoula et al., 2023).

According to Table 13, the variable farming system denoted as "farmsys" shows that a one-unit rise in the variable "farmsys" decreases the log odds of access to finance. For a one-unit rise in "farmsys", the marginal effect on the likelihood of credit access decreases by 24 per cent. This means that farmers who are farming in the listed farming system (communal areas) have a lower likelihood of credit access than farmers in commercial areas, as depicted by negative logit estimates and a negative marginal effect. Farming experience denoted as "farmexp" shows that a one-unit rise in "farmexp" decreases the log odds of credit access. For a unit raise in "farmexp", the marginal effect on the likelihood of credit access decreases by 0.01 per cent. This means that the experience of farmers is not the main factor that enhances access to credit.

The variable household size denoted as "hhsz" shows that a one-unit rise in "hhsz" decreases the log odds of credit access. For a unit raise in "hhsz", the marginal effect on the likelihood of credit access decreases by 3.1 per cent. The household size predictor's negative logit estimates and negative marginal effect indicate that bigger households have a less likelihood to access credit compared to lower or smaller households. Perhaps the lenders perceive a larger household have higher cost of living which may limit the ability to repay a loan.

The variable "edusec" shows that a one-unit rise in secondary education decreases the log odds of accessing credit. For a unit increase in "edusec", the marginal effect on the likelihood of credit access decreases by 8.8 per cent. The variable denoted "empfulltime", shows that a one-unit rise in full-time employment decreases the log odds of accessing credit. For a unit rise in full-time employment, the marginal effect on the likelihood of credit access decreases by 16 per cent.

Table 13: Logistic regression estimates with access to credit as the dependent variable.

Variables	Logit estimates	Marginal effects
Farmsys	-1.065 (0.416)	-0.244* (0.0944)
Farmexp	-0.00372** (0.0208)	-0.000851*** (0.00475)
Hhsize	-0.137*** (0.0565)	-0.0313** (0.0126)
Lnfarmsize	0.127*** (0.0790)	0.0290** (0.0182)
Lntotinc	0.0857** (0.0448)	0.0196*** (0.0101)
Lnyield	0.321* (0.101)	0.0736** (0.0232)
Lnherdsize	0.118 (0.167)	0.0271 (0.0382)
no_invest	0.0415* (0.0848)	0.00950** (0.0194)
Edusec	-0.382 (0.376)	-0.0875* (0.0861)
Edutert	0.140 (0.387)	0.0319* (0.0884)
Empfulltime	-0.699* (0.398)	-0.160* (0.0908)
Emppartime	-0.451 (0.459)	-0.103 (0.105)
Cropfarm	-0.637 (0.486)	-0.146 (0.111)
Livefarm	-1.335* (0.765)	-0.306 (0.175)

Constant	0.493 (0.715)	
LR χ^2 (14)	97.91	
Prob > χ^2	0.0000	
R^2	0.2997	
Observations	242	242
Wald test:		
χ^2 (14)	60.73	
Prob > χ^2	0.000	

Source: Own computation. Note: The signs *, **, and ***, represent the 1%, 5% and 10% levels of significance. Figures in parentheses are standard errors.

5.2.2 Model goodness of fit

The LR statistic and p-value assess the overall fit of the model. A higher LR statistic suggests a good fit. In this case, the LR statistic is 97.91, which indicates a strong model fit, and the p-value is 0.00, signifying that the model provides a significant improvement in predicting the outcome. Additionally, the Wald test measures the significance of regression coefficients, with a larger test statistic indicating more significance. A p-value less than 0.05 suggests a coefficient significantly differs from zero. While the model fits well, not all coefficients are statistically significant, even though many of them are.

5.3 Multinomial regression

The multinomial logit model was applied to assess the variables that affect farmers' ability to repay a loan. Farmers were categorised as "paid" for those who paid up their loan, "active," for farmers who are still paying, and "default" for farmers who defaulted (have large outstanding amounts). The dependent variables (Paid, Active, and Default) were regressed against the predictors in the model.

The classification of farmers into "Paid," "Active," and "Default" categories is based on their loan repayment status, providing a clear distinction between those who have fully repaid their loan, those still making payments, and those with significant outstanding amounts. This classification allows for the

assessment of various factors that influence the ability to repay loans. While the repayment period and type of loan could play a role in loan performance, the classification mainly reflects the current status of the borrower. Government policies on repayment might also influence these outcomes, but the primary focus is on repayment behaviour, taking into account factors such as financial access, market conditions, and the individual circumstances of the farmers.

The variables, farming system, number of investments, total farm income, total held size, farm size, total loan acquired, gender, farm livestock production, farm income, farm investments, and the total loan acquired by the farmer were used as predictors to determine the farmer's probability to be paid-up loan recipients, active loan holders, or default farmers. The model goodness of fit was tested using the Wald test for joint significance. The significance of the chi-squared likelihood ratio (23.18) at the 0.05% level indicated that the multinomial model has a good data fit.

The regression-predicted probabilities represent the likelihood of each possible outcome of a dependent variable given the independent variable values. Table **14** indicates the summary statistics of the three dependent categories. In this case, there are 98 cases in the dataset. The average value for each variable across the observations is presented as the mean. For paid-up farmers, the average value is 0.4898; for active loan holders, the average value is 0.1531; and for default loan holders, the average value is 0.3571 across all 98 observations.

The standard deviation measures how much the values of each variable vary around the mean. In terms of paid-up loan beneficiaries, the standard deviation is 0.1470; for active loan beneficiaries, the standard deviation is 0.0764; and for default beneficiaries, the standard deviation is 0.2046 across all 98 observations. The minimum value is the lowest value observed in the dataset, while the maximum value indicates the highest value observed in the dataset. It is vital to observe that the mean value of Paid-up farmers is near or close to 0.5, indicating that it is roughly evenly split between the two possible values. Furthermore, the range values for Default are quite wide, with a minimum of 0.0374 and a maximum of 0.8556 values, respectively. This indicates that the variables might be more diverse or varied than the other two. In summary, the descriptive statistic provides insight into the distribution of each variable in the dataset.

Table 14: Paid, Active, and Default predicted probabilities.

Variable	Obs	Mean	Std.dev	Min	Max
Paid	98	0.4898	0.1470	0.1220	0.7220
Active	98	0.1531	0.0764	0.0224	0.4069
Default	98	0.3571	0.2046	0.0374	0.8556

Source: Own computation:

5.3.1 Loan categories: paid up, active and default

The coefficients of a multinomial regression model with several independent variables and observed marginal effects on paid-up, active, and default as dependent variables are shown in Table 15. The marginal effect shows the change in the likelihood of an event happening caused by a unit variation in the independent variable, whereas all other variables remain constant.

5.3.2 Paid-up farmers

The investments made by the farmers were quantified and modelled. The marginal effect for the variable "no invest", which represents the number of investments, is 0.0528, implying that a one-unit rise in "no invest" is associated with a 5.2 per cent rise in the probability of the dependent variable (Paid-up farmer). This suggests a positive relationship between the number of investments made by the farmer and the likelihood of successfully repaying the loan. The relationship may reflect that farmers who make more investments in their agricultural practices or businesses might be more financially stable and better equipped to manage their loan obligations. Investments, such as purchasing new equipment, seeds, or livestock, may increase productivity and income, thus improving the farmer's ability to repay debts (Assouto & Hougcheme, 2023; Fortunato & Enciso, 2023 and Kapoor, 2024). Higher investment could lead to better financial outcomes, such as increased profits or improved efficiency, which directly improves the farmer's ability to offset their loan. Farmers who are willing to invest more may have a greater focus on enhancing their farm's productivity, suggesting a higher commitment to ensuring financial stability, which translates into a higher probability of loan repayment.

However, the p-value is only marginally significant (0.067). The p-value of 0.067 suggests that the effect is marginally significant (close to the typical 0.05 threshold). This implies that while there is some evidence of a relationship between "no invest" and loan repayment, it is not very strong, and further research or a larger sample size may be needed to confirm the robustness of this result. The analysis revealed that the

total loan amount had a significant negative association with the likelihood of being a paid-up farmer. This suggests that as the total amount of loans increases, the probability of farmers fully repaying their loans decreases. This negative relationship may reflect the financial strain that larger loan amounts place on farmers, making it more difficult for them to meet repayment obligations. In cases where loans are substantial, farmers may struggle with the burden of high interest rates, repayment schedules, or even adverse economic conditions, which can hinder their ability to repay in full (Singh & Langyan, 2024).

Additionally, the negative association could be indicative of a financial distress cycle, where increased borrowing leads to a heavier debt burden, potentially affecting a farmer's cash flow and overall financial stability. Farmers with higher total loans prioritise repaying smaller, more immediate debts or face challenges in generating sufficient income to cover larger obligations (Zhao & Zou, 2021). This underscores the importance of managing loan sizes carefully and ensuring that farmers have the necessary support and resources to meet their financial commitments, particularly in the face of uncertain agricultural outcomes or market fluctuations

The marginal effect of income has the correct sign signifying that a unit rise in income increases the probability of offsetting a loan. However, the effect is not statistically significant. The literature indicates that credit enhances investment and productivity (Amanullah & Jing 2022; Taremwa et al., 2021; Chaiya et al.; 2023). Wongnaa & Awunyo-Vitor (2013); and Olagunju et al. (2023) state that farm profit has a positive impact on credit repayment. It is therefore assumed that when farmers invest, they can maximise their agricultural output and income. The income could then be used to service the acquired loan. This is because the positive marginal effects of the investments made by the farmers and the positive marginal effects on farm total income will increase the chance of farmers being in the paid-up category. Another study in Ghana found that farmers' ability to repay loans was higher when farm incomes were higher (Abankwah et al., 2016).

The result also shows that male farmers are more likely to pay up their loans compared to women. This could be attributed to various socio-economic factors, including differences in access to financial resources, decision-making power, and potential gender-based disparities in agricultural support systems. In many contexts, male farmers may have greater access to credit, higher levels of income, or more robust networks that facilitate loan repayment (Atakli & Agbenyo, 2020 and Christodoulou-Volos, 2024). Additionally, cultural and institutional factors could influence the financial stability and repayment

behaviours of male and female farmers differently. Further investigation into these gender-based differences could provide deeper insights into how gender impacts loan repayment patterns in agricultural settings.

If a farmer is a communal farmer, the probability of paying up a loan decreases. The result is as expected because communal farmers have a slim chance of servicing their credit. This aligns with expectations, as communal farmers often face limited access to resources, smaller landholdings, and fewer financial support mechanisms, making it more challenging for them to meet loan repayment obligations (Kapoor, 2024).

Ideally, larger farm size will boost production because more livestock can be reared. On the other hand, smaller farm size will decrease the farmer's chance of servicing the loan because less livestock or crop produce results in lower outputs and less income to service the loan. According to the findings, however, large farms may be inefficient in allocating resources thus resulting in low productivity. Additionally, the farmers might use the acquired loan to purchase the farm; hence, it will take time to get a return on investment. Hence, farmers may find it difficult to service the loan due to high farming input costs and high loan instalments. In terms of herd size, the farmer could have used the acquired loan to restock. Livestock production takes time, and it could be that farmers have not yet started recouping their investment, so they are either still servicing the loan or defaulting.

5.3.3 Active loan holders

The active loan holders are farmers who are still servicing their loans. Table 15 presents the marginal effects and the probability level of influence. The number of livestock owned by farmers, denoted as “Intothersize” impacts positively for farmers to be in the Active category. The marginal effect indicates that a one-unit rise in livestock number is linked with a 6.3 per cent rise in the probability of being an active loan holder, and it is statistically significant at $p = 0.032$. This means that most farmers may use their loans to restock; hence, they are servicing livestock loans.

Furthermore, herd size refers to the number of livestock a farmer manages, which can influence their financial stability and the ability to generate income. Larger herds often provide more opportunities for income generation, either through sales of animals or animal products, which can enhance a farmer's capacity to service loans. Therefore, a larger herd size may make farmers more likely to hold active loans, as they may require additional financing to expand or maintain their operations.

Literature shows that in some cases, the number of herd sizes and the total amount of loans acquired have a positive marginal effect on the likelihood of the farmer being an active loan holder. For instance, a study by Tesfaye & Worku (2019) found that, for smallholder dairy farmers in Ethiopia, herd size had a positive and significant effect on the probability of being an active loan holder. The authors argue that this could be because larger herds require more investment in inputs such as feed and medication, and thus farmers may need to access loans to finance these costs.

Total income, on the other hand, is a measure of the overall earnings a farmer generates from all sources, including agricultural sales, off-farm work, and other income streams. The significant association between total income and active loan holding suggests that farmers with higher overall earnings may be more likely to have an active loan. This could be due to their ability to access credit more readily or their intention to reinvest in their farming operations, seeking further financial support to expand their businesses. In this context, higher total income does not necessarily imply a higher repayment capacity, but rather a greater likelihood of engaging in active borrowing to facilitate business growth.

Several factors can influence the likelihood of a farmer being an active loan holder, and in some cases, the number of physical farm investments, farm size, and total farm income may have a negative marginal effect. Some borrowers might spend a larger portion of their loan balance clearing an excessively large land area, restocking, or purchasing inputs, which ultimately makes it harder for them to pay for other obligations or afford repayment instalments. Due to the low yield, especially during the initial stage of acquiring the loan and the increase in input costs, farmers with large farm sizes may also experience low income, resulting in being an active loan holder or defaulting (Wongnaa & Awunyo-Vitor, 2013a).

5.3.4 Defaulting farmers

The study found that the total loans acquired have a positive marginal effect of 15.67 per cent, this means that a one-unit rise in loans acquired increased the likelihood of a farmer being in the default category by 15.67 per cent. The results for income and farm size are not as expected because an increase in farm size was hypothesised to increase income and yield and the increase in income could allow farmers to service the loan. However, the coefficient is close to zero indicating minimal impact.

The number of investments is expected to decrease the probability of a default. The result shows that a one-unit rise in the number of investments decreases the predicted likelihood of being a default farmer.

This demonstrates the significance of investing in a farm because the more investments the farmer has, the likelihood of offsetting the loan is high. In other words, the negative association between the number of investments and the likelihood of default suggests that farmers who invest more are less likely to default on their loans. This could be because increased investment, whether in land, equipment, or livestock, typically reflects a commitment to enhancing farm productivity and long-term financial viability. By diversifying and strengthening their business, these farmers may improve their cash flow and financial resilience, making them more capable of meeting loan repayment obligations. Thus, investment activities can serve as a safeguard, reducing the likelihood of default by strengthening the farmer's overall economic position (Zhao & Zou, 2021).

In contrast, the positive association between the total loan amount and the probability of default can be attributed to the financial strain caused by larger debts (Balana & Oyeyemi, 2022). As the total loan amount increases, the repayment burden becomes heavier, particularly if a farmer's income does not grow proportionately. Farmers with larger loans may struggle to generate enough revenue to cover both their operational costs and loan repayments, especially if they face adverse weather conditions, market fluctuations, or other economic challenges. In such cases, the likelihood of default rises, as these farmers may prioritise other financial obligations or be unable to meet their debt commitments entirely.

In summary, these results imply that investment levels and the size of the loan have a more direct impact on the likelihood of loan repayment, while factors like farm size and income seem less influential. The strong influence of loan size on defaults suggests that higher loan amounts may create financial strain, making it harder for farmers to fully repay. Gender does not appear to significantly affect loan repayment, and farm systems ("Farmsys") and herd size ("Lntotherdsize") also show little to no impact on loan servicing in this model.

Table 15: Paid-up loan holders, Active loan holders' and defaulting loan holders' marginal effect at the sample mean of predictors.

Predictors / Variables	Paid-up farmers		Active loan holders		Defaulting loan holders	
	Marginal effect	P-value	Marginal effect	P-value	Marginal effect	P-value
Farmsys	-0.0478	0.737	0.129	0.2010	-0.0816	0.4070
no_invest	0.0528	0.067***	-0.005	0.8030	-0.0474	0.0260**
Lntotinc	0.0128	0.303	-0.020	0.0390**	0.0068	0.3940
Lntootherdsize	-0.0442	0.217	0.063	0.0320**	-0.0185	0.4210
Lnfarmsize	-0.0059	0.798	-0.018	0.2390	0.0234	0.2200
Lntotloan	-0.1915	0.001*	0.035	0.4610	0.1567	0.0000*
Gender	0.1058	0.344	-0.010	0.9200	-0.0962	0.1370

Source: Own computation: Note: The signs *, **, and ***, represent the 1%, 5% and 10% levels of significance.

5.4 Causality test on credit, investment, and productivity: SEM model

The structural equation model (SEM) specification in the literature assumes that access to credit (C) allows farmers to allocate resources for farming activities for investing (I) in farming activities, which will maximise productivity denoted as output (Y). Those engaged in farming activities are assumed to be cautious and conservative in their decision-making. Farmers maximise their earnings, production, and overall well-being while considering constraints such as credit accessibility. The models assume that credit (C) is exogenous to investments (I) and productivity (Y), as it is utilised to finance farm activities and subsequently enhance productivity.

Credit, investment, and yield are all exogenous to farm output. In situations where farmers are unable to obtain credit, this may result in producers refraining from investing and maximising their production, while farmers with access to credit may increase farm investments and maximise their productivity. The variables C, I, and Y are influenced by economic and social factors and farming attributes. The understanding of credit access may enhance investment decisions, with a lack of credit access leading to a lack of investment in movable assets and fixed investments due to a lack of finance.

To analyse the effect of credit on agribusiness investment and agricultural productivity, an instrumental variable two-stage least squares (IV 2SLS) and an ordinary least squares (OLS) model were fit. The OLS was fitted to compare results with the IV 2SLS. The investment model was fit with the credit variable as a

regressor. The instrument “*total farmers experience*” was used to instrument the investment model (Table 16).

The production variable was used as a predictor in the investment model. The aim is to assess the causal relationship between production and investment. The instrument was the *total farm yield* (Table 17). In the credit model, the production variable was used as a predictor. The instrument, *total yield* was used (Table 18). In Table 19, the investment variable was used in the credit model. The instrument *farm size* was used. In the production model, *credit* was used as a predictor. The instrument used was “*total farmers experience*” (Table 20). The investment was also used in the production model instrument with “*farm size*”. It should be noted that IV 2SLS and OLS were used jointly to justify the use of an instrument. If there is no significant difference between the coefficients, then an OLS regression will approximate an IV 2SLS, hence no need for instruments.

5.4.1 Investment model results

There is a marked significant difference between the coefficients of the IV2SL and the OLS estimators, therefore, the results of the IV2SL are interpreted in the following sections. For the investment model, the results show that communal farmers have a lower potential to invest in farm infrastructure due to a lack of financial capacity to do so. This is consistent with the results obtained earlier. The role of education though statistically significant plays a limited role in explaining investment decisions. However, farming experience statistically and significantly influences farm investment in the model, an indication that farmers in the study area learn by experience rather than through formal education.

The result also shows that larger farm size encourages farmers to invest more in farm infrastructure. Recall that credit was used in the investment model to assess its role in explaining investment decisions. A Durbin-Hu-Hausmann endogeneity test was carried out to investigate this. The null hypothesis is that the credit variable is exogenous in the investment model. The result shown in the lower panel of Table 16 shows that the null hypothesis was not rejected, an indication that credit is exogenous to investment in this study. Farmers require credit to make farm infrastructural investment decisions. In contrast, Table 17 shows that productivity, “*Intotinc*” is endogenous in the investment model. Production is endogenously determined when farmers make investment decisions.

5.4.2 Credit model results

Tables 18 and 19 show the results of production and investment in the credit model. The results show that the socio-economic characteristics of the farmer have little influence on farm credit. The Durbin-Hu-Hausmann endogeneity test shows that production is exogenous in the credit model. This means that a certain level of productivity is required by lenders to approve credit to farmers. On the other hand, investment was found to be exogenous to credit, meaning that farmers' investment in farm infrastructure can be used as collateral which increases their chances of acquiring credit from lenders. Recall that in the investment model, credit was also exogenous to investment therefore, the study found a bidirectional causality between farm investment and the ability to consume credit.

5.4.3 Production model results

The IV2SL model shows that socio-economic variables are important in making production decisions. According to the Durbin-Hu-Hausmann endogeneity test, credit is exogenous in the production model. Credit availability can influence the level of production. Recall that production was found to be exogenous in the credit model, therefore, it can be concluded that there is a bidirectional causality existing between credit and productivity in the study area. On the other hand, investment is endogenous in the production model. Recall that production was endogenous in the investment model, therefore, the results of the Durbin-Hu-Hausmann endogeneity test for investment - production nexus are mixed. Perhaps, there were no significant differences in the net investment/production in the data. Further studies are required to explore this in the study area.

The findings suggest a complex relationship between credit access, investment, and agricultural productivity in Namibia. Communal farmers face significant financial constraints, limiting their ability to invest in infrastructure, a challenge highlighted in the existing literature on financial access in developing countries (Assouto & Hougmbeme, 2023). The study shows that farm size and experience are key factors in investment decisions, with larger farms and more experienced farmers being better positioned to invest and improve productivity. However, credit alone does not guarantee increased productivity, pointing to the need for a more integrated approach to farmer support.

The study reveals bidirectional causality between credit and investment, where access to credit enables infrastructure investment, which in turn helps secure more credit. This challenges the traditional view that credit directly drives investment and productivity, highlighting a reinforcing cycle between credit and

investment decisions. Experience, rather than education, plays a more significant role in facilitating investment and securing credit.

These findings contribute to the literature by providing empirical evidence of the complex interactions between credit, investment, and productivity, underscoring the need for targeted financial interventions, infrastructure development, and farmer education. The study suggests that tailored financial products and support for farmers with larger farms and more experience could lead to increased productivity. Future research could explore ways to improve credit access and productivity, particularly for communal farmers facing barriers.

Table 16: Investment model with endogeneity test for credit in the investment model

Part 1: Credit variable in the Investment model				
	IV 2SLS		OLS	
No of Investment	Coeff	Robust Std Error	Coeff	Robust Std Error
Lntotloan	-0.3254	0.2842	-0.1140*	0.0701
-	-	-	-	-
Farmsys	1.7781***	0.6573	-1.6730**	0.6959
Eduone	-1.8503**	0.9068	-1.8374*	0.9359
-	-	-	-	-
Eduprim	3.5348***	1.0565	-3.6279***	1.0170
Edusec	-1.1962	0.8651	-0.7715	0.5804
Farmexp	0.0417*	0.0250	0.0412*	0.0254
Lnfarmsize	0.2915**	0.1228	0.2511**	0.0986
Constant	6.3176**	3.1954	3.9572***	1.2466
F(7, 90)			14.8	
Prob>F			0.0000	
Wald chi2(7)	91.56			
Prob>chi2	0.0000			
R2	0.3662		0.4113	
RMSE	2.3425		2.3559	
Obs	98		98	
Instrument	Total farm experience in the year			
Instrumented:	total loan			
Durbin-Wu-Hausman Endogeneity test				
Robust Score(Chi(1))	0.4673			
Prob	0.4942			
Robust Reg F(1, 89)	0.4549			
Prob	0.5018			
DWH Null hypothesis: Exogeneity - Credit is exogenous to Investment				

Source: Own computation. ***, **, * symbols represent 1, 5 & 10 % level of significance.

Table 17: Investment model with endogeneity test for production in the investment model

Part 2: Production variable in the investment model				
	IV 2SLS		OLS	
No_invest	Coeff	Robust Std Error	Coeff	Robust Std Error
Intotinc (total farm income)	0.5929***	0.1697	0.1989***	0.0473
	-		-	
farmsys (farming system)	2.6365***	0.6442	2.4475***	0.5408
edunone (no education)	-1.8423*	0.9925	-1.8608*	0.8589
			-	
eduprim (primary	-2.7530	1.9451	3.9127***	0.6770
Edusec	-1.2931*	0.7127	-1.0979*	0.5565
Farmexp	-0.0008	0.0380	0.0355	0.0242
_cons	-1.6814	2.1540	2.2022**	0.9213
F(6, 91)			25.19	
Prob>F			0.0000	
Wald chi2(7)	76.62			
Prob>chi2	0.0000			
R2	0.0421		0.4597	
RMSE	2.8798		2.2445	
Obs	98		98	
Instrument	Intotyield			
Instrumented:	Lntotinc			
Durbin-Wu-Hausman Endogeneity test				
Robust Score(Chi(1))	8.4976			
Prob	0.0036			
Robust Reg F(1, 90)	7.2207			
Prob	0.0086			
DWH Null hypothesis: Exogeneity - Productivity is exogenous to Investment				

Source: Own computation. ***, **, * symbols represent 1, 5 & 10 % level of significance.

Table 18: Credit model with endogeneity test for production in the credit model

Part 3: Production variable in the credit model				
	IV 2SLS		OLS	
Lntotloan	Coeff	Robust Std Error	Coeff	Robust Std Error
Lntotinc	0.0046	0.1240	0.0785*	0.0326
Farmsys	-1.1119	0.7311	-1.1474	0.7680
Eduone	-0.0941	0.3091	-0.0907	0.3251
Eduprim	-0.2287	0.5151	-0.0112	0.4992
Edusec	-2.3914***	0.8301	-2.4280***	0.8437
Farmexp	0.0132	0.0213	0.0064	0.0222
	12.3496**			
_cons	*	1.5672	11.6211***	0.7877
F(6, 91)			3.0400	
Prob>F			0.0093	
Wald chi2(6)	13.33			
Prob>chi2	0.0381			
R2	0.1917		0.2031	
RMSE	2.9964		3.0874	
Obs	98		98	
Instrument	Intotyield			
Instrumented:	Lntotinc			
Durbin-Wu-Hausman Endogeneity test				
Roust Score(Chi(1))	0.42860			
Prob	0.5127			
Roust Reg F(1, 90)	0.3919			
Prob	0.5329			
DWH Null hypothesis: Exogeneity - Productivity is exogenous to credit				

Source: Own computation. ***, **, * symbols represent 1, 5 & 10 % level of significance.

Table 19: Credit model with endogeneity test for investment in the credit model

Part 4: Investment variable in the credit model				
	IV 2SLS		OLS	
Lntotloan	Coeff	Robust Std Error	Coeff	Robust Std Error
no_invest	-0.0033	0.3087	-0.1909	0.1313
Farmsys	-0.5023	1.0250	-0.8055	0.8315
Eduone	-0.0672	0.6383	-0.4106	0.4231
Eduprim	0.4287	1.3540	-0.2613	0.9100
Edusec	-2.0104***	0.7823	-2.1122***	0.8050
Farmexp	0.0029	0.0194	0.0106	0.0225
Lnfarmsize	0.1918**	0.0939	0.2348**	0.1021
_cons	11.1726***	1.4583	11.6762***	0.9624
F(7, 90)			2.2800	
Prob>F			0.0350	
Wald chi2(6)	13.33			
Prob>chi2	0.0381			
R2	0.1917		0.2316	
RMSE	2.9964		3.0486	
Obs	98		98	
Instrument	lnfarmsize			
Instrumented:	No_Invest			
Durbin-Wu-Hausman Endogeneity test				
Roust Score(Chi(1))	0.4088			
Prob	0.5226			
Roust Reg F(1, 90)	0.3899			
Prob	0.5340			
DWH Null hypothesis: Exogeneity - Investment is exogenous to credit				

Source: Own computation. ***, **, * symbols represent 1, 5 & 10 % level of significance.

Table 20: Production model with endogeneity test for credit in the production model

Part 5: Credit variable in the production model				
	IV 2SLS		OLS	
		Robust Std		Robust Std
Lntotinc	Coeff	Error	Coeff	Error
Lntotloan	-0.0049	0.7715	0.0675	0.0700
Farmsys	3.2909***	1.2261	3.3269***	1.1521
Eduone	0.1048	1.2426	0.1092	1.2979
Eduprim	0.1952	2.7442	0.1633	2.8459
Edusec	2.2326	1.9614	2.3781**	1.0662
Farmexp	0.0425	0.0529	0.0423	0.0560
Lnfarmsize	0.8781***	0.2347	0.8642***	0.1887
_cons	4.2584	9.1291	3.4499*	1.9739
F(7, 90)			4.9400	
Prob>F			0.0001	
Wald chi2(7)	32.13			
Prob>chi2	0.0000			
R2	0.2679		0.2698	
RMSE	4.1956		4.3724	
Obs	98		98	
Instrument	Totalexpyr			
Instrumented:	Lntotloan			
Durbin-Wu-Hausman Endogeneity test				
Roust Score(Chi(1))	0.0094			
Prob	0.9226			
Roust Reg F(1, 90)	0.0083			
Prob	0.9274			
DWH Null hypothesis: Exogeneity - Credit is exogenous to productivity				

Source: Own computation. ***, **, * symbols represent 1, 5 & 10 % level of significance.

Table 21: Production model with endogeneity test for investment in the production model

Part 6: Investment variable in the production model				
	IV 2SLS		OLS	
		Robust Std		Robust Std
Lntotinc	Coeff	Error	Coeff	Error
no_invest	1.5937***	0.4651	0.6035***	0.1943
Farmsys	5.8694***	1.4393	4.2689***	1.1111
Eduone	3.0221*	1.7110	1.2097	1.1810
Eduprim	6.0550**	2.7234	2.4128	2.6149
Edusec	3.1071***	1.1325	2.5699**	1.0193
Farmexp	-0.0226	0.0575	0.0179	0.0550
Lnfarmsize	0.5116***	0.1816	0.7387***	0.1658
_cons	-0.0753	2.3214	2.5832	1.8378
F(7, 90)			8.4400	
Prob>F			0.0000	
Wald chi2(7)	53.90			
Prob>chi2	0.0000			
R2	0.1346		0.3471	
RMSE	4.5616		4.1346	
Obs	98		98	
Instrument	Lnfarmsize			
Instrumented:	No_Invest			
Durbin-Wu-Hausman Endogeneity test				
Roust Score(Chi(1))	4.09554			
Prob	0.043			
Roust Reg F(1, 90)	5.42278			
Prob	0.0221			
DWH Null hypothesis: Exogeneity - Investment is exogenous to productivity				

Source: Own computation. ***, **, * symbols represent 1, 5 & 10 % level of significance.

5.4.4 Model goodness of fit

The summary for investment, credit and productivity post-regression models are assessed to determine the model goodness of fit. The R-squared values, RMSE (Root Mean Squared Error), and the results of the Durbin-Wu-Hausman (DWH) endogeneity test are considered. The R-squared measures the proportion of variance in the dependent variable that is explained by the independent variables in the model. It is generally understood that a higher R-squared indicates a better fit of the model to the data. Regarding the RMSE, the RMSE measures the average magnitude of the residuals (prediction errors) in the model whereby smaller RMSE values indicate a better fit of the model to the data. Both the IV 2SLS and OLS models have a reasonably good fit as indicated by the R-squared values being moderately close to 1 and the RMSE values being relatively small. Therefore, both models indicate a good fit and the IV 2SLS model is preferred due to its ability to address potential endogeneity issues. The R-squared values, RMSE (Root Mean Squared Error), and the results of the Durbin-Wu-Hausman (DWH) endogeneity test for each model are presented in Table 16 to Table 21.

Chapter 6: Conclusions and Recommendations

6.1 Conclusions

The study findings suggest that there are complex relationships between credit, investment, and agricultural productivity. It highlights key factors influencing farmers' credit access, such as farm size, farm income, farm yield, herd size, number of investments, and tertiary education. In terms of credit performance, the study shows that the amount of acquired loans can impact farmers' ability to be in the category of paid-up loan holders. This is attributed to the fact that the amount of acquired loans can decrease the likelihood of farmers falling into the category of paid-up loan holders, possibly due to ongoing loan servicing and investment magnitude.

On the other hand, the farming system, herd size, and loan amount influence the likelihood of being an active loan holder. Farmers in communal areas are more likely to have longer loan repayment periods due to limited productivity. Additionally, the size of the acquired loan has a significant effect on farmers' chances of defaulting. The study reveals that total income and total loan, especially the loan amount acquired, have a positive effect on farmers being in the defaulting category. Higher loan instalments may deter interest in the use of financial instruments and may result in default.

The results of the Investment Model suggest that communal farmers have a lower tendency to invest in farm infrastructure due to a lack of financial capacity. In terms of education, although statistically significant, it plays a limited role in explaining farmer's investment decisions. Interestingly, farming experience is statistically and significantly correlated with farm investment, indicating that farmers in the study area learn more through experience than formal education. Farmers in commercial areas own larger farm sizes and larger farm size encourages farmers to invest more in farm infrastructures.

The results of the Durbin-Hu-Hausmann endogeneity test indicate that there is a bidirectional causality between credit and investment. This implies credit is needed for farm investment and investment in farm infrastructure serves as collateral for financial credit. Similarly, credit was found to influence production and as well the accumulation of productive assets such as income, influence farmer's ability to obtain financial credit. On the other hand, there were no direct causal effects between productivity and investment in the model. Therefore, it is concluded that production is endogenously determined when

farmers make investment decisions and vice versa. Therefore, further studies are suggested to explore this relationship in more detail in the study area.

These results suggest complex interactions between investment, credit, and production decisions among farmers in the study area. Factors such as financial capacity, education, farming experience, and farm size play roles in investment decisions. Credit availability influences both investment and production, and there appears to be bidirectional causality between investment and the ability to consume credit.

6.2 Implications of the research findings

The findings highlight the importance of tailoring credit access and loan repayment policies to suit the specific characteristics of farmers, such as their farm size, income, location, and education level. The study emphasizes the need to understand local contexts and cultural factors that can influence loan repayment behaviour and farmer's decision-making. Policymakers and lending institutions should consider these interconnections to design more effective and targeted agricultural credit programs, which in turn can positively impact agricultural investment and productivity in Namibia. This study reveals that what works in one region or among certain groups of farmers may not apply elsewhere, underscoring the need for localised and targeted interventions.

By tailoring agricultural credit and loan repayment policies to the specific needs and circumstances of communal and commercial farmers in Namibia, implementing targeted interventions, and drawing on the findings of this study, it is possible to enhance access to credit, promote sustainable agricultural development through investment, and improve agricultural productivity in Namibia.

6.3 Recommendations

6.3.1 Recommendations for further study

Loan performance is crucial to the sustainability and accessibility of credit facilities in the country. Therefore, it is recommended to conduct further research to explore the specific cultural and traditional factors that might affect loan repayment behaviour in communal areas. Investigate the role of agricultural extension services and financial literacy programs in improving loan repayment rates among farmers. The study found different levels of loan performance in terms of short-term, medium and long-term. Therefore, it is recommended to examine the impact of different loan repayment schedules and methods

on farmers' ability to repay loans. Finally, there is a need to investigate information asymmetric, particularly on credit access and studies to mitigate fear of risks by farmers.

The mixed or inconclusive results between investment and production need to be investigated to highlight the link between investment and production. Further studies should delve deeper into understanding the dynamics between these two variables. This could involve a more detailed analysis of specific types of investments and their impact on production outcomes in the country. The farm size effect needs to be explored. The study suggests that larger farm sizes encourage more investment. Hence, it would be valuable to explore the optimal farm size for different types of investments and their impact on production with an emphasis on the agroecological zone because Namibia experiences sporadic rainfall. Longitudinal Studies is another study recommended to be carried out. Longitudinal studies are needed to track changes in investment, credit access, and production over time and region. This can provide insights into the long-term effects of various factors on agricultural outcomes.

6.3.2 Policy recommendations

Pro-poor credit policies are essential to unlock farmer's credit access. Policymakers and lending institutions should consider the identified key factors (e.g., farm size, income, education) to improve credit access for farmers in agriculture. It is therefore recommended that policies aimed at promoting access to credit for farmers should consider the bidirectional causality between investment and credit consumption. Efforts to make credit more accessible could potentially boost both investment in farm infrastructure and production levels.

In the Namibian agricultural context, where both communal and commercial farmers face unique challenges, the following tailored assistance can help enhance loan access and repayment capacity.

Credit providers should place a greater emphasis on supporting farmers with larger farm sizes and higher agricultural yields, as these factors significantly increase the likelihood of credit access. Land ownership, which provides collateral, should be viewed more favourably by lenders, as it is linked to a 13 per cent higher probability of accessing credit. Additionally, farmers who make higher levels of investment in their farming activities are more likely to gain credit access. Therefore, financial institutions should consider offering incentives or targeted financial products to farmers who show a willingness to invest in their agricultural operations, as this indicates higher creditworthiness and the potential for greater financial stability.

Small-scale commercial farmers often struggle with accessing loans due to perceived high risks by financial institutions. Hence, a government-backed loan guarantee scheme could be introduced, where the government acts as a guarantor for a portion of the loan. This would reduce the risk of banks, and farmers defaulting and encourage banks to lend to farmers with limited collateral.

Farmers in communal farming systems, for example, face lower access to credit compared to those in commercial farming areas. Specialised financial products and outreach programmes may be necessary to support farmers in these areas. Additionally, while higher levels of education, particularly tertiary education, were found to improve credit access, secondary education and farming experience do not appear to have a significant effect. As such, lending programmes could focus on providing more educational opportunities and training on credit management for farmers with lower levels of formal education or less experience. Lastly, in terms of the factors that enhance credit, household size and full-time employment negatively impact credit access, suggesting that lenders may view larger households and full-time workers as higher risk. Tailored financial products or adjustments in lending criteria could help mitigate these challenges, making credit more accessible to a broader range of farmers.

Investment in agriculture is crucial for enhancing productivity, particularly in a country like Namibia, where agriculture plays a vital role in the economy. For both communal and commercial farmers, investing in modern farming technologies could enhance productivity. In turn, a more productive and competitive agricultural sector can attract further investment, creating a positive cycle that supports sustainable development and financial stability. Therefore, by tailoring financial assistance and loan structures to the unique needs of both communal and commercial farmers, these practical measures could significantly enhance access to loans, enhance investment, improve loan repayment and increase agricultural productivity across Namibia's agricultural sectors.

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Appendix 1 An introductory letter to farmers



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6 June 2022

Dear Esteemed Farmers,

SUBJECT: PHD STUDY SURVEY - EFFECT OF AGRICULTURAL FINANCIAL CREDIT ON INVESTMENT AND PRODUCTIVITY

Reference is made to the above-mentioned subject.

This communication serves to introduce Mr Paulus Amaambo, a PhD student at the Namibia University of Science and Technology in the Department of Agriculture and Natural Resources Sciences. He is currently working on his research project titled: **Effect of agricultural financial credit on investment and productivity in Namibia**. The study aims to evaluate the level of agricultural credit accessed by farmers and identify factors that influence loan repayment performance. In addition, the study shall examine the effect of credit on agribusiness investment and agricultural productivity in Namibia.

Mr Amaambo is expected to collect information through a survey for his research. The information collected through this survey will be used to develop policy recommendations regarding the development of the agri-financing system, investment and agricultural production in Namibia.

All the information provided shall be treated with the highest confidentiality. Kindly complete the survey by clicking on the link below:

<https://tlu.nust.na/onlineSurvey/index.php/159273?lang=en>

Your assistance shall be highly appreciated.

Yours sincerely,

Prof David Uchezuba
(Supervisor)
Associate Professor: Department of Agriculture and Natural Resource Sciences
Tel. +264 61 2072491

Jonathan Kamwi (PhD)
(Head of Department)
Agriculture and Natural Resources Sciences

Appendix 2 Semi-structured questionnaires

Location of the Farm	Communal		Commercial	District	Village	GPS coordinates
/ Enterprise						

- **My name is** Paulus Mekondjo Amaambo
- I am a PhD student with the Namibia University of Science and Technology (NUST). To get information about the **Effect of agricultural financial credit on investment and productivity**, I am surveying farmers' profiles, investment verification and agricultural productivity and would like to humbly request your time to deal with several farming related questions.
- The information will be useful to assess the **Effect of agricultural financial credit on investment and productivity**.
- Participation in the survey is voluntary, and you can choose not to take part. However, the information collected through this survey will be used to develop policy recommendations regarding the development of agri-financing system, investment, and agricultural production in Namibia.
- All the information provided shall be treated with the highest confidentiality.
- The information will be used to prepare academic papers and thesis.
- Any questions that you may have regarding this survey, please do not hesitate to indicate it now or you may contact me at amaambop@gmail.com or my supervisor Prof David Uchezuba at duchezuba@nust.na anytime. Do you have any other question right now?

Your details were obtained from the farmers' union

General information

1. State the Name of the region where you are farming.

.....

2. Indicate if you are farming in communal or commercial area or both.

Communal:

Commercial:

Both:

Social characteristics

3. What is your gender?

Male:

Female:

Other:

4. Indicate your date of birth.

5. What is your marital status?

Single		Married		Divorced		Widowed	
---------------	--	----------------	--	-----------------	--	----------------	--

6. Indicate your level of education

LEVEL OF EDUCATION	PLEASE TICK IN THE APPROPRIATE BOX
No Formal Education	
Primary School (Grade 1 – 9)	
High School (Grade 10 – 12)	
Short courses related to agriculture	
College	
University	
Agricultural qualification	

7. Do you have an agricultural qualification?

Yes

No

8. If you have an agricultural qualification, please specify. eg Bachelor of Science in Agriculture

.....

.....

9. How long (years) have you been farming?

.....

.....

10. Indicate your sources of labour.

Family:

.....

Hired:

.....

Self:

.....

11. What is your employment status?

Employed:

.....

Unemployed:

.....

Fulltime farmer:

.....

Part time farmer:

.....

Business:

.....

Self:

.....

12. If your employment is different from the above, please specify:

13. Indicate your source of income:

.....

14. How many people are in your household?

.....

Male

.....

Female.....

.....

Credit / loan information for successful and unsuccessful application

15. Have you applied and secured loan from financial institution? Yes / No

16. If yes complete the information below:

Indicate the year when the loan was acquired.

.....

Indicate the total amount received.

Indicate the total amount outstanding.

.....

Indicate the name of the bank.

.....

Indicate the purpose of the loan.

.....

17. If you applied for loan and your application was rejected by financial institution, please complete the information below:

Indicate the year the application was rejected.

.....

Indicate the amount applied.

.....

Indicate the bank name.

.....

Indicate the reason for rejection.

.....

18. Indicate how your rejected loan application have affected your farming operation.

.....

19. If you have NEVER applied for agricultural loan, please choose reasons below and provide any other reasons if not stated below:

Not interested in agricultural loan.

.....

Lack of collateral.

.....

The cost of loan is higher (interest rate).

.....

I did not meet qualifying criteria.

.....

Other reasons why you never applied for loan.

.....

20. Indicate the types of farming practices

- Crop:.....
- Livestock:.....
- Mixed:.....
- Other (please specify) eg processing enterprises
etc.....

21. Indicate the cost of the following variable cost per year (factor of production) eg. eg. vaccine, licks, gasoline, diesel fuel, oil and lubricants as indicated below:

- Vaccine.....

- Licks.....
- Gasoline (eg diesel, petrol, paraffin, oil & lubricant).....
- Labour.....
- Seeds.....
- Other (specify).....

22. Indicate your farm total cost per year for each of the following production

- Crop production annual cost.....
- Livestock production annual cost.....
- Other cost (please specify).....

23. Indicate the area size of the following production. eg. crop = 20 hectares and livestock production = 2000 hectares

- Area size of crop production.....
- Area Size of large stock production eg cattle.....
- Area Size of small stock production eg, sheep and goats.....
- Other (please specify).....

24. Indicate your production yield for crop (Please specify the unit of measurement eg. One ton of Maize per year):

- Maize yield in Kg or ton per year.....
- Pearl Millet (Mahangu) yield in Kg or ton per year.....
- Wheat yield in Kg or ton per year.....

- Groundnut in Kg or ton per year.....
- Sorghum in Kg or ton per year.....
- Rice in Kg or ton per year.....
- Other (specify eg. sunflower).....

25. What is the market unit price for each of the following farming produce?

- Crop (please specify) eg. 50 kg Maize = N\$500.....
- Large stock (Please specify) eg. one Haifer = N\$5000.00.....
- Small stock (please specify) eg. one goat = N\$1000.00.....
- Small stock (please specify) eg. one sheep = N\$2000.00.....
- Other (Please specify).....

26. Indicate your farm total annual income for the following farming practices

- Crop:.....
- Livestock.....
- Other (please specify).....

27. Complete the information below by indicating the number of livestock owned

- How many large stock (cattle) you have?:
.....
- How many small stock (sheep) you have?:
.....
- How many small stock (goats) you have?:
.....

- Please specify if there are other livestock owned?:

.....

25. Complete the information below by indicating the number of livestock you sell per year

- How many large stock (cattle) you sell per year?:

.....

- How many small stock (sheep) you sell per year?:

.....

- How many small stock (goats) you sell per year?:

.....

- Please provide number of other small stock you sell per year?:

.....

26. Complete the information below by indicating the number of livestock you sell per year

- How many calves born per year?:

.....

- How many kid born per year?:

.....

- How many lamb born per year?:

.....

27. Please provide the number of other offspring born per year if any:

.....

28. If you are not selling your produce, please indicate reason why you are not marketing?

.....

29. Indicate your expenses per month on food, school fees, water and so on as listed below for each item

Water.....

Security.....

Electricity.....

Bond/Rent.....

Groceries.....

Insurance.....

Medical.....

Dining out.....

Others.....

Total expense
cost.....

30. Indicate the distance to each of the following infrastructure in meters

Distance to borehole:
.....

Distance to Kraal:
.....

Distance to Auction and vaccination kraal:
.....

Distance to storage facilities (silo):
.....

Distance to other infrastructures (please specify):
.....

31. Indicate the date you invested in the following infrastructures / equipment's.

Borehole.....	
Harvester.....	
Kraal.....	
Road.....	
Fencing.....	Auction
kraal.....	
Tractor.....	
Planter.....	
Water tank.....	
Sprayer.....	
Plough.....	Storage facilities
(silo).....	
Irrigation (eg: irrigation pipes).....	Others (please
specify).....	

32. Which of the following farm infrastructures / equipment's have you invested in and indicate the
COST of each item?

Borehole.....
 Harvester.....

Kraal.....
 Road.....
 Fencing..... Auction
 kraal.....
 Tractor.....
 Planter.....
 Water tank.....
 Sprayer.....
 Plough..... Storage facilities
 (silo).....
 Irrigation (eg: irrigation pipes)..... Others (please specify).....
 Total cost of all infrastructures that you have invested in.....

33. Indicate in the space provided if the following infrastructures are functional (in normal working condition), owned by yourself, shared with other farmers, hired or inherited)?

Borehole.....
 Harvester.....
 Kraal.....
 Road.....
 Fencing..... Auction
 kraal.....
 Tractor.....
 Planter.....
 Water tank.....
 Sprayer.....
 Plough..... Storage facilities
 (silo).....
 Irrigation (eg: irrigation pipes)..... Others (please specify).....

34. In the space provided, please indicate constraints encountered with the following infrastructures (eg borehole drilled but no water, borehole dried up, theft of fencing materials or vandalism? Others (please specify)

Borehole..... Harvester.....
 Kraal..... Road.....

Fencing.....

Auction

kraal.....

Tractor.....

Planter.....

Water tank.....

Sprayer.....

Plough.....

Storage facilities

(silo).....

Irrigation (eg: irrigation pipes).....

Others (please specify).....

34. Indicate if you have invested in the following financial investments.

Have you invested in Mortgage:

.....

Have you invested in Bond:

.....

Have you invested in Insurance for agricultural enterprises:

.....

Other (specify):

.....

35. If you have made a financial investment, indicate the value of each investment and the name of the financial institution.

.....

36. Provide reasons for investing in these investments below.

Reason for investing in Mortgage.

.....

Reason for investing in Bond.

.....

Reasons for investing in Insurance.

.....

Any other reasons?

.....

37. Rank the impact of the following factors on your farming enterprises (Rating 1 = minimal and 5 is maximal)

Finance/Credit:

Seed:

.....

Water:

Fencing:

Poor grazing:

Diseases:

Drought:

38. Please indicate in more detail how access to credit has affected your farming enterprise. (e.g. purchasing of farm investments such as solar, boreholes, water troughs, kraal, tractors, fencing etc.)

.....

39. Please indicate in more detail how access to agricultural infrastructure such as solar, boreholes, water troughs, kraal, tractors, and fencing has affected your farming enterprise. (e.g. productivity etc.)

.....

39. Please indicate any other challenges/constraints you are experiencing in your enterprise operation. (e.g. purchasing of infrastructures, marketing, productivity etc.).

.....

40. Please indicate how these challenges affect your farming enterprise operation. (e.g. purchasing of infrastructures, marketing, productivity etc.)

.....

Appendix 3 Data request letter to Agribank



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21st October 2021

**The Chief Executive Officer
AgriBank
39 Post ST Mall
Namibia
Dear Sir/Madam**

SUBJECT: REQUEST FOR FARMERS FINANCIAL DATA FOR RESEARCH PURPOSE

A humble request for assistance is hereby made to your office to give our subject, Mr Paulus Amaambo access to your farmer's financial data for a research purpose.

Mr Paulus Amaambo is a PhD student at the Department of Agriculture and Natural Resource Sciences. He is currently working on a research project titled: **Effect of agricultural financial intermediation on investment and productivity in Namibia.**

This study intends to evaluate the level of agricultural credit accessed by farmers and identify factors that influence loan repayment performance. In addition, the study shall examine the effect of credit on agribusiness investment and agricultural productivity in Namibian.

We recognize the confidentiality of the data requested and promise to strictly uphold it. Your assistance shall be highly appreciated.

Yours sincerely,

Prof David Uchezuba
(Supervisor)
Associate Professor: Department of Agriculture and Natural Resource Sciences
Tel. 0810425716

Jonathan Kamwi, PhD
(Head of Department)

Appendix 4 Data request letter to Bank Windhoek



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21st October 2021

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SUBJECT: REQUEST FOR FARMERS FINANCIAL DATA FOR RESEARCH PURPOSE

A humble request for assistance is hereby made to your office to give our subject, Mr Paulus Amaambo access to your farmer's financial data for a research purpose.

Mr Paulus Amaambo is a PhD student at the Department of Agriculture and Natural Resource Sciences. He is currently working on a research project titled: **Effect of agricultural financial intermediation on investment and productivity in Namibia.**

This study intends to evaluate the level of agricultural credit accessed by farmers and identify factors that influence loan repayment performance. In addition, the study shall examine the effect of credit on agribusiness investment and agricultural productivity in Namibian.

We recognize the confidentiality of the data requested and promise to strictly uphold it. Your assistance shall be highly appreciated.

Yours Sincerely,

Prof David Uchezuba
(Supervisor)
Associate Professor: Department of Agriculture and Natural Resource Sciences
Tel. 0810425716

Jonathan Kamwi, PhD
(Head of Department)

Appendix 5 Data request letter to First National Bank



**NAMIBIA UNIVERSITY
OF SCIENCE AND TECHNOLOGY**

Faculty of Natural Resources and Spatial Sciences

Department of Agriculture and Natural Resources Sciences

13 Jackson Kaujeua Street
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Windhoek
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F: +264 61 207 9141
E: nra@nust.na
W: www.nust.na

21st October 2021

The Chief Executive Officer
First National Bank
Windhoek
Namibia

Dear Sir/Madam

SUBJECT: REQUEST FOR FARMERS FINANCIAL DATA FOR RESEARCH PURPOSE

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Yours sincerely,

Prof David Uchezuba
(Supervisor)
Associate Professor: Department of Agriculture and Natural Resource Sciences
Tel. 0810425716

Jonathan Kamwi, PhD
(Head of Department)

Appendix 6 Data request letter to Development Bank of Namibia



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W: www.nust.na

21st October 2021

The Chief Executive Officer
Development Bank of Namibia
Windhoek
Namibia

Dear Sir/Madam

SUBJECT: REQUEST FOR FARMERS FINANCIAL DATA FOR RESEARCH PURPOSE

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Yours sincerely,

Prof David Uchezuba
(Supervisor)
Associate Professor: Department of Agriculture and Natural Resource Sciences
Tel. 0810425716

Jonathan Kamwi, PhD
(Head of Department)

Appendix 7 Data request letter to Standard Bank of Namibia



NAMIBIA UNIVERSITY
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21st October 2021

The Chief Executive Officer
Standard Bank
Kleine Kuppe
Windhoek
Namibia

Dear Sir/Madam

SUBJECT: REQUEST FOR FARMERS FINANCIAL DATA FOR RESEARCH PURPOSE

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Prof David Uchezuba
(Supervisor)
Associate Professor: Department of Agriculture and Natural Resource Sciences
Tel. 0810425716

Dr. Jonathan Kamwi
(Head of Department)