

ASSESSING THE IMPACT OF CREDIT FINANCE ON AGRICULTURAL
PRODUCTIVITY IN NAMIBIA

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NAEMI LIKIUS

201406135

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MAIN SUPERVISOR: PROF JACOB M. NYAMBE (UNIVERSITY OF NAMIBIA)

ABSTRACT

This thesis explores the impact of credit finance on agricultural productivity in Namibia, with the goal of promoting innovative, economically oriented, and modern agriculture to enhance rural living standards and drive food production. The study utilizes the bounds test (ARDL) approach to cointegration, analysing quarterly data from 2001 to 2022 to examine the short-run and long-run dynamics between credit finance and agricultural productivity. The empirical findings indicate that credit finance and prime lending rates have a significant negative impact on agricultural productivity at a 1% level, consistent with prior research. Inflation was found to negatively affect agricultural productivity but was insignificant. The stability of the model was confirmed using the CUSUM of squares, validating the use of the ARDL agricultural gross domestic product function as a target variable. The analysis reveals a unidirectional causality, with agricultural productivity predicting credit. Based on the study's findings, several major policy recommendations are proposed. Firstly, the Namibian government should focus on enhancing the banking sectors to improve farmers' access to credit and financial services, including measures such as financial inclusion, expanded banking services in rural areas, and facilitation of loan availability. Secondly, efforts should be made to develop well-functioning rural loan markets that cater specifically to the agricultural sector, through initiatives such as establishing specialized agricultural financing institutions, providing credit guarantees, and promoting financial literacy programs tailored to the agricultural sector. Thirdly, the development of township banking infrastructure in rural areas can enhance access to financial services and credit for farmers, either through banking branches or mobile banking services. Lastly, short-term and long-term plans should be formulated to support agricultural growth, including enhancing agricultural extension services, promoting technology adoption, improving market access for agricultural products, and strengthening policy and institutional support for the agricultural sector. This study's conclusions emphasize the significant role of credit finance in shaping agricultural productivity and the importance of sustained investment in enhancing productivity over time. The interdependencies among agricultural productivity, credit finance, inflation rate, and prime lending rate underscore the need for a comprehensive understanding of their dynamics. **Keywords:** Agricultural, productivity, Credit, ARDL, Cointegration

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LIST OF ABBREVIATIONS AND ACRONYMS

ADF	Augmented Dickey Fuller
AGDP	Agricultural Gross Domestic Product
AIC	Akaike Information Criterion
AMTA	Agro-processing and Trade Agency
ARDL	Autoregressive Distributed Lag
BON	Bank of Namibia
CAAPs	Common African Agro-Parks
CRA	Credit to Agriculture
DBN	Development Bank of Namibia
DVS	Directorate of Veterinary Services
ERFP	Emerging Retail Financing Product
FPBHs	Fresh Produce Business Hubs
GDP	Gross Domestic Product
INF	Inflation
MAWLR	Ministry of Agriculture, Water and Land Reform
MBN	Meat Board of Namibia
MWALD	Modified Wald test
NAB	Namibia Agronomic Board
NACP	National Agriculture Credit Programme
NAU	Namibia Agricultural Union
NBCI	Nigerian Bank for Commerce and Industries
NDP	National Development Plan
NSA	Namibia Statistic Agency
NSFR	National Strategic Food Reserve
PLR	Prime Lending Rate
PP	Philip Perron
SIC	Schwarz Information Criterion
SUR	Seemingly Unrestricted Regression
UECM	Unrestricted Error Correction Model
VAR	Vector Autoregressive

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DEDICATION

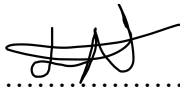
This study is wholeheartedly dedicated to my beloved husband, Mr. Serak S. Shidhudhu who have been my source of inspiration and gave me strength when I thought of giving up, who continuously provided moral and emotional support. Lastly, I dedicate this study to the Almighty God, thank you for the guidance, strength, power of mind, protection and skills.

DECLARATION

I, Naemi Likius, hereby declare that this study is my own work and is a true reflection of my research and that this work or any part thereof has not been submitted for a degree at any institution.

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CHAPTER ONE: INTRODUCTION

1.1. Background of the study

Although one of the world's driest countries, Namibia's agricultural sector is essential to the livelihood of 70% of the population and the country's biggest employer (GIZ Report, 2020). The agricultural sector is dualistic, as commercial and communal farmers are among the players. The communal farmers are found in the Northern Communal Areas (NCAs)¹, where they mostly practice subsistence farming, and it is dominated by both crops especially mahangu, maize and livestock farming mainly for household consumption because they only sell the surpluses. On the other hand, commercial farming is mostly practiced in the southern part of the country, highly dominated by livestock farming. Commercial farming covers about 44% of the total land, though it accommodates only 10% of the population. However, the communal sector covers 41% of the total land area and accommodates about 60% of the population. Due to a lack of collateral, most farmers can still not obtain credit financing from different financial institutions, such as commercial banks.

Commercial farmers, on the other hand, produce staple cereal crops such as maize, wheat, potatoes etc., for domestic consumption (Odero, 2017). Livestock is produced for domestic and international markets, and Namibia is a net exporter of livestock and livestock products. A myriad of challenges, including climatic, edaphic, technical, institutional and socioeconomic factors greatly constrain agricultural production and productivity (Mubita, 2019). In addition, market access, financing, land ownership, farm machinery, and lack of agro-inputs and irrigation are distinctive challenges among smallholder farmers. Agriculture's contribution to GDP (excluding fishing) since 1990 averaged 5% annually, of which the livestock sector historically contributed to approximately 70% (National statistical Agency, data). However, this percentage has gradually decreased to an estimated 60% over the past five years (NAU data, 2021). According to von Bach and Nyambe (2022), crop farming, biomass production, and

¹ NCAs include these regions (Kunene, Oshikoto, Omusati, Oshana, Ohangwena, Kavango West and East and Zambezi)

forestry are the other main sources of agricultural products and the shift in contributors within the agricultural sector is explained by the increase in the value of exported crops, vegetables, biomass, fruits, and forestry goods.

Between 1994 and 2011, the national development capital allocation was less than N\$800 million, whereas the following fiscal term (2012 to 2019) had an average allocation of N\$1.3 billion (NPC, 2020). Agriculture was given 14 percent of the entire capital budget in the current Medium-Term Expenditure Framework Period (MTEF) for 2019/20 to 2021/2022, making it the second-largest expenditure behind transportation. In the last decade, substantial evidence shows that the sector has received fiscal precedence over other industries. The creation of fresh produce hubs, storage facilities, and meat processing facilities, as well as the construction and updating of irrigation and market infrastructure, have all contributed to this development (NDP5,2009).

Moreover, the commitment to agricultural investment proved that the 'Maputo Declaration' continues to drive Namibia's agricultural policy programs to assist the agricultural sector's development and the country's overall economic progress. In addition to the public sector investment, local development and commercial banks are important sources of finance for private agricultural investment. The total farm debt climbed by 10% in the last decade. While bank loans are a substantial source of private investment, non-performing loans have increased by roughly 60% on average over the last decade (Bank of Namibia, 2020). Despite decades of governmental and private investment in the industry, agricultural growth has slowed and is below the CAADP's expectations of 4% annual growth (NSA, 2019).

Agricultural recovery efforts necessitate scientific inquiry and a thorough understanding of essential growth elements. However, increasing productivity means that a country produces more food to feed the growing population with fewer labour inputs, thereby releasing labour to other sectors of the economy, such as manufacturing. Agricultural improvement leads to improved living standards, which increases access to basic needs,

better health facilities, and quality education, as school learners will not be learning on empty stomachs.

1.2. Description of agricultural commodities produced in Namibia

To put Namibia's agricultural industry into perspective, it primarily focuses on the primary production of animals and crops. Namibia uses various tenure types, with agricultural land accounting for 76.9% of the total land area (Mendelsohn, 2006). According to land statistics given by the Namibia Statistics Agency (NSA, 2018), commercial freehold accounts for 45.1 percent of agricultural land, communal state land accounts for 41.73 percent, and Affirmative Action and Resettlement emerging farmers account for 14.0 percent. The country's livestock farming comprises sheep, goats, cattle and pigs. In terms of output, beef production is the major livestock farming activity in Namibia, followed by mutton/ lamb, goat, and pork.

Cattle production is practiced in most parts of Namibia, supporting most livelihoods in rural areas. According to the Directorate of Veterinary Services (DVS) (2017) report, over the last seven decades, the national bovine herd has ranged from 1 515 283 to 2 713 394, making the country a net exporter of beef and live cattle, despite its low average national offtake rate of 14 percent. This industry has long been significant to the economy, accounting for 43 percent of overall agricultural output. However, due to the drought in 2019, the bovine herd declined from 2,713,394 to 2,514,385 (DVS Census, 2021).

Fresh grapes and dates are the biggest forex earners (EU, UAE, South Africa), while onions and tomatoes have had exportable surpluses for several years. However, the lack of productivity, the lack of accessible markets, particularly for small-scale farmers, the significant post-harvest losses, particularly with vegetables, the lack of profitability due to high input prices, and other productivity concerns all pose severe obstacles to this industry. Date and grape production are fast-growing, export-oriented sectors that can use location advantage to acquire international competitiveness. When their primary competitors, primarily from the Northern hemisphere, are out of season, Namibian grapes and dates enter the market (EU, United Arab Emirates, South Africa) (NAB,2020).

Domestic production and marketing of locally sold goods (such as carrots, onions, potatoes, and tomatoes) have increased, while imports have declined significantly. This is due to the Namibian Horticulture Market Share Promotion (MSP) scheme, which requires all importers to purchase a certain percentage of their fresh fruit and vegetable purchases from local producers.

Cereals have a limited contribution to the agricultural industry compared to other items like cattle. Maize is grown in locations with appropriate rainfall and irrigation systems. Pearl millet, like wheat, is grown in many sections of the country and requires irrigation. Wheat is grown commercially, while pearl millet is virtually entirely produced in communal areas. In terms of cereal production, Namibia is not self-sufficient. Namibia imports roughly 68 percent of its local demand for pearl millet, while maize imports average 61 percent.

Small livestock production, both in the commercial and the communal areas of the southern regions of Namibia, is today based on mutton production, using predominantly Dorper sheep, Karakul sheep and to a lesser extent Black Headed Persian, Van Rooy, Damara sheep and goat production with Boer goats. Before the collapse of the Karakul industry in the early 1980s, Namibia produced approximately 4.5 million pelts per annum. With the collapse of the industry, producers were forced to diversify in order to survive. Most producers changed to mutton production, and the small stock industry changed from pelt production to mutton production. According to the (NSA agricultural report, 2022), Sheep and Goats dominated exports of live animals during quarter two, posting export earnings of N\$222.5 million and N\$27.1 million, respectively.

1.3. Challenges facing the agricultural sector in Namibia

Irrespective of the fact that the agricultural sector is regarded as one of the essential sectors in the country, the sector is constrained by several challenges, such as:

(a) Climate change and water scarcity

Given that Namibia is a semi-arid country, it is subjected to recurrent droughts in the north and southern parts of the country. In addition, the effect of climate change continued to threaten food security in the country which undermined the contribution of food security to the country's GDP. To address food security in the country, the government introduced green schemes.

(b) Livestock diseases

The agricultural sector is affected by frequent outbreaks of animal diseases such as foot and mouth disease. These outbreaks have affected growth in the agricultural sector, especially in the NCAs of the country (Smit, Zaaruka & Tjeriko, 2018). Moreover, animal illnesses may reduce market value by altering the appearance of livestock, making it less appealing to purchasers such as Meatco, which the NCAs mostly supply.

(c) Policies and institutional structure related to agricultural investment

Thirlwall (2011) claims that public sectors in agriculture-based developing nations should invest in agricultural production and poverty reduction. After Namibia's independence, the government's agricultural policy aimed to establish an enabling environment for the private sector to respond to market possibilities and engage in the industry's development. Within the context of Namibia's fragile ecology, the ultimate goal of the National Agricultural Policy of 1995 was to raise and sustain agricultural productivity, real farm incomes, and national and household food security. Several public, private, and civil society organizations have been highlighted as significant stakeholders in the National Agricultural Policy's implementation.

In terms of public agricultural investment, the Ministry of Agriculture is in charge of budgeting all public agricultural expenditures while also serving as the principal

implementer and coordinating body for all agriculture-related investment programs and initiatives. Budgeting and spending are carried out at the sectoral and project levels, as evidenced by the national budget and expenditure records, so specific agricultural commodities benefit from public investment through projects or sector budgets (MoF, 2020). Public investment projects are multi-purpose, incorporating a variety of operations for the benefit of all commodities in the livestock and crop sub-sectors, with no specific commodities as targets.

Though there is no clear investment strategy for specific commodities, public investment in Namibia's agricultural sector is aimed at increasing the output of strategic commodities such as beef, mutton, pelts, dates, grapes, maize, wheat, and horticulture products that can be efficiently produced given the country's climatic conditions. Beef, grapes, swakara and dates are primarily grown for export markets, whereas the rest are primarily produced for domestic consumption.

The construction of national irrigation projects, the National Horticulture Development Initiative, and the National Strategic Food Reserve facilities receive the most public investment in the crop sub-sector. These initiatives aim to help grain producers in rural farming areas expand their production beyond subsistence levels to improve food security and revenue. The government also intends to increase animal production, health, and marketing nationwide through public investment in the livestock sub-sector. Livestock disease surveillance, compliance with animal and meat trade standards, and the extension of veterinary laboratory facilities across the country are all necessary interventions focusing on transboundary animal illness diagnosis and research in the Northern Communal Areas.

Although governmental investment statistics do not reveal a regional distribution of agricultural development spending, programs are primarily focused on promoting communal production. This shows that public investments and policy solutions address development concerns such as income inequality, poverty, and food security at the national level. As a result, in the estimating model, the coefficient of public investment in livestock and livestock subsectors is projected to be positive.

The regulatory and statutory institutions such as Meat Board and Namibia and Namibia Agronomic Board are responsible for the development and management of national marketing and trade initiatives, the development and enforcement of standards, and the maintenance of a competitive domestic market while ensuring fair competition (MBN, 2019; NAB, 2019). Agricultural production and marketing agencies such as the Agro-processing and Trade Agency (AMTA) and AgriBusDev were established in 2013 as the Ministry of Agriculture and Land Reform agencies under the Agronomic Industry Act, 1992 (No. 20 of 1992). The overarching role of AMTA is to coordinate and manage the marketing and trading of agricultural produce in Namibia. AMTA's current mandate is to manage the Fresh Produce Business Hubs (FPBHs) and National Strategic Food Reserve (NSFR) infrastructure towards attaining food safety and security. The FPBH were built because Namibia's horticulture industry lacked bulk cold storage, marketing, and logistical facilities for smallholder farmers. Public development expenditure for the NSFR over the period 2008–2020 accumulated to N\$127.8 million (1% of total agricultural development expenditure), while spending related to the FPBHs has been recorded at N\$522.8 million (6% of cumulative agricultural development expenditure) over the same period (MoF, 2020).

Other policies and strategies adopted within the agricultural policy framework include the Agricultural Marketing, Trade Policy and Strategy and the Green Scheme Policy. AgriBusDev is a government agency established in November 2011 in terms of the Companies Act, Act 2004, to manage and supervise the country's Green Scheme programme according to the Green Scheme Policy 2008. The Green Scheme Policy's objectives are to support an increase in agricultural production through the empowerment of smallholder farmers, promote private investment in agriculture by leasing fully equipped irrigation land and promote food security. AgriBusDev is operating eleven Green Scheme Projects of specific farming models described in the Green Scheme Policy. Since implementing the green scheme in 2008, the Government has invested about N\$1.766 billion from 2008–2020, accounting for 15% of the total agricultural development expenditures over the same period (MoF, 2020).

Annual fiscal allocations to development banks are used to promote financial inclusion and address market shortcomings, notably in the SME sector. On the other hand, the Development Bank of Namibia (DBN) is responsible for infrastructure and SME financing, not agriculture. The Agricultural Bank of Namibia, also known as 'Agribank,' is a state-owned development bank that has played and continues to play a role in advancing relatively low-interest and longer loan terms for the agricultural sector, with a portfolio worth N\$3 billion as of the end of the financial year 2020 (Agribank Annual Report, 2020). Moreover, Agribank is a significant player in agricultural financing, recording a 38% market share in the agricultural sector compared to the market share of individual commercial banks as follows: First National Bank, 21%; Bank Windhoek, 25%; Nedbank, 5%; Standard Bank, 10% (Commercial Banks Annual reports). According to the Agribank Annual Report (2020), the bank supports communal/smallholder farmers, and as part of its development mandate, Agribank offers the following main products for communal farmers:

- Complimentary to loans, Agribank offers mentorship services to its NCA clients, while training services are open to all farmers.
- National Agricultural Credit Programme (NACP), where communal farmers can access credit at a 4% interest rate to acquire livestock and production inputs. The NACP requires collateral.
- No-collateral loans: A credit facility for salaried communal farmers who do not have collateral to offer as loan security.
- Emerging Retail Financing Product (ERFP): A credit facility earmarked for full-time communal farmers without collateral requirements as loan security. The ERFP seems to be a practical solution to meet communal farmers' credit access challenges. However, its sustainability hinges on fiscal policy support such as credit guarantee schemes and fiscal transfer to Agribank.

These financial solutions allow farmers to invest in agriculture and expand their production capacity. Purchasing cattle for breeding and restocking and a wide range of production needs such as farm infrastructure, equipment, and production inputs are all major finance needs for community farmers. However, due to a lack of collateral, most farmers can still not obtain Agribank financing. In addition, commercial banking institutions provide an alternate source of private funding for agricultural investment. Commercial banks' total credit extension stood at N\$4.4 billion as of September 2020, according to the latest available figures from their annual reports, while the combined credit extension for commercial banking institutions and Agribank totalled N\$7.5 billion (Banks Annual Reports 2019–2020). As a result, Agribank controls a higher portion of total agricultural credit extension, recorded at 40% by the end of September 2020. Agribank offers competitive interest rates and relatively extensive loan repayment terms instead of commercial banking organisations.

(d) High cost of production

According to (Shapi, 2017), The most significant difficulty is the high cost of production inputs such as seeds and fertilizers, as well as a shortage of money, which is followed by high water and electricity costs. Due to rising pricing, farmers cannot buy seeds and fertilizer, posing a barrier to agricultural productivity. Another issue for farmers is the high expense of transporting their produce to markets. Therefore, farmers find it difficult to get their produce to the market when transportation prices are high; hence profits are impacted negatively, or losses are incurred.

(e) Access to credit

The risk of a borrower defaulting on a loan is inherent in credit. Thus, lenders pursue measures to reduce default risk to minimize losses that might be incurred. Due to asymmetric information, potential borrowers are screened, raising the risk of moral hazard. Farmers also encounter difficulties obtaining credit due to a lack of collateral, high-interest rates, and delays in loan processing and approval. Collateral is necessary for anyone who wants to borrow money from a bank for business purposes.

Moreover, people might be willing to engage in agricultural-related activities but could not do so due to a lack of collateral. Therefore, Cloete (2013) postulated that farming without capital is pointless for any farming operation. Despite the availability of financial institutions such as the Development Bank of Namibia (DBN), the Agricultural Bank of Namibia, and other commercial banks, access to finance remains a challenge to farmers wanting to engage in agriculture-related activities due to high-interest rates and lack of collateral.

Furthermore, the relevance of credit to agricultural growth cannot be overstated because credit facilities help farmers to make better use of inputs and factors of production by removing financial restraints and granting them more access to resources. As a result, rather than cultivating low-yielding local crops, credit may enable increased use of improved seeds and fertilizers, resulting in higher crop output per unit of labour and land (Ahmed, 2022). Similarly, loan facilities will lower the prices of capital-intensive technology and assets compared to family labour.

Formal and informal institutions provide agricultural credit facilities; however, the informal sector remains the leading provider of agricultural credit (Benjamin, 2014). Due to their poor resource endowment, most farmers cannot meet the stipulated criteria for formal credit, especially pledging collaterals for loans, an essential requirement for credit transactions with formal financial institutions.

2. Statement of the Problem

Over the past years, agricultural operations in Namibia have primarily been deteriorating, resulting in extremely low productivity due to the inadequate application of modern technology and drought. The cost of agricultural machinery like tractors, harvesters, planters, animal feeds, medication and so forth is astronomically high and unaffordable for an average Namibian farmer. Apart from the issue of inadequate access to modern technology and land by farmers in Namibia, low investment or financing are among the significant drawbacks to agricultural growth.

Additionally, most farmers, especially small-scale farmers, face stringent conditions and cannot continue to operate in the agricultural sector. Thus, they need credit for agricultural inputs such as seeds, fertilizers, funds for purchasing cattle for breeding and restocking, medication for disease prevention etc., to be purchased; this credit comes either from farmers' saving or borrowing. They have little chance of saving money; hence they borrow from formal and informal lenders. Furthermore, there have been significant challenges in obtaining long-term capital to invest in modern farming equipment, insufficient inputs and storage facilities, weak agricultural extension, and outdated sectoral infrastructure, all of which have contributed to years of low agricultural productivity. Agribank provides various forms of collateralized and subsidized loans (by the government) for farmers in green schemes.

However, farmers who are not in green schemes receive assistance in the form of loans, although the government does not subsidize them, and they are likely not to afford them as they do not have the required collateral. Therefore, access to these credit facilities seems complicated as most small farmers do not have collateral to use as security in case of borrowing. Tenaw and Islam (2009) postulated that access to rural financial services has the potential to make a difference in agricultural productivity, food security, and poverty reduction. However, an efficient, sustainable, and widely accessible rural financial system remains a stumbling block and a significant development challenge in most developing countries.

Akinnagbe and Adonu (2014) further added that lack of access to credit causes setbacks to the productivity of farmers as a result of the fact that these farmers do not have the resources to procure improved seedlings, chemicals, and hired labour, as well as transport and market their products which would have improved their productivity, welfare and ultimately help in achieving economically sustainable production. The study attempted to assess the impact of credit finance on agricultural productivity by looking at farmers that produce for commercial purposes, regardless of their size, not subsistence farmers (who barely interact with the market).

3. Objectives of the Study

The study's main objective is to assess credit finance's impact on agriculture and agricultural productivity² in Namibia.

Specific objectives of the study:

- To estimate the long-run relationship between credit finance to agriculture and agricultural productivity
- To establish whether or not there is a causal relationship between credit and agricultural productivity.

4. Hypotheses of the Study

H_{0a}: There is no long-run relationship between credit financing to agriculture and agricultural productivity.

H_{1a}: There is a long-run relationship between credit financing to agriculture and agricultural productivity.

H_{0b}: There is no causal relationship between credit financing and agricultural productivity in Namibia.

H_{1b}: There is a causal relationship between credit financing and agricultural productivity in Namibia.

5. Significance of the Study

Firstly, the study is inspired by the fact that less research has been done in this area. Secondly, this research will aid farmers and farm management in predicting the future behaviour and performance of loan facilities. Thirdly, the study will shed light on the government's regulatory framework for guaranteeing enough credit availability for farmers in both commercial and communal sectors. It will be necessary to the government, the ministry of agriculture, and policymakers because empirical findings from the effect of credit access on farmer output can be used as a reliable guide in designing agricultural policies and programs to ensure efficient resource allocation among the country's sectors. Similarly, the farmers will benefit from the study since it will equip

²Agricultural productivity defined as a ratio of agricultural output to inputs.

them with knowledge of the critical role of external loan facilities in increasing their farming activities and products and enhancing their revenue through increased productivity. Finally, it will also serve as a significant resource for future research on farmers' access to credit and economic growth in Namibia and worldwide.

6. Limitations

Generally, quantitative studies require a sample size of at least 30. However, the available data for some of the variables constituted in the study were limited to less than 30 years, making the acquisition of the required sample unattainable. Thus, the available yearly data for the period covered in the study were converted into quarterly data to ensure a sufficient sample that fits the nature of the study. A further limitation is the aggregation of subsectors, given that the production for subsectors differs in terms of tenure, climate, infrastructure etc. The data of credit financing to the agricultural sector is also aggregated, which may make it hard to interpret the result in terms of productivity as more of the finance could have been spent on buying land/farms and not necessarily on direct inputs such as fertilizer, water and electricity, animal feeds, vaccination and pesticides etc. that contribute directly to the production process.

7. Delimitation

While many factors influence agricultural productivity, the study only used three variables in assessing the impact of credit finance on agriculture on agricultural productivity. These variables comprise credit finance to agriculture, inflation and prime lending rate (commercial bank interest rate).

8. Organisation of the Study

The study is organised into five chapters: Chapter one is designated as an introduction to the concept. It introduces the study and provides a clear statement of the problem, overall objectives of the study, specific objectives, the study's hypothesis, limitations of the study, structure of the study, and organisation of the study. Chapter two focused on the literature review of related articles written on the topic. Secondly, it looks at theoretical literature and empirical literature reviews. Chapter three discusses the methodology used in the research. It further outlines the research methods, data sources, model specification and

definitions of variables. Chapter four is exclusively for data analysis, findings and presentations. Finally, Chapter Five is devoted to conclusions and policy recommendations. The conclusions abridge what the study sought to achieve, what it found, and where it diverges or converges from existing evidence. It makes policy recommendations and suggests possible areas for further research.

CHAPTER TWO: LITERATURE REVIEW

2.1. Introduction

The previous chapter has introduced the concept and the purpose of the study more entirely on what triggered this research. Therefore, this chapter reviews previous studies on the subject matter; the review's significance stems from the fact that it emphasizes background knowledge about the problem to be solved; it gives the situation more context and eliminates the chance of unnecessarily duplicating efforts. In addition, the previous study may also have yielded helpful information or research approaches. This chapter has two elements: theoretical literature review and empirical literature review. This section looked at theories such as the structuralist hypothesis, the Lewis model, financial repression hypotheses and literature by other authors.

2.2. Theoretical Literature Review

Scholars have proposed a number of theories to explain the relationship between credit and agricultural productivity. To begin, the researcher discussed the fund flow model in economic theories, such as the structuralist hypothesis and financial repression hypothesis, as well as the Lewis model in determining the economic importance of agriculture.

2.2.1. Structuralist Hypothesis

This hypothesis is also known as the Ger Schenkou hypothesis. It is derived from historical interpretations of the role of Banks in the capital formation process of early European industrialization. According to Omobolanle (2010), Schumpeter was the first modern economist to tolerate the banking system explicitly for development in a functional sense. In stressing the need for bank independence, he considered an enterprise's supply as a function conflated with the very nature of commercial banking in a capitalist system. Following his hypothesis, the role of banking in industrial capital formation is determined by the relative backwardness of an economy and its structural peculiarities.

The structuralist theory has stressed the small emerging economy's reliance on unstable export prices for a few essential items and the long-term degradation in its terms of trade. The structuralists blame recurrent spells of economic depression on changes in primary commodity exports, followed by inflationary pressures almost immediately (or perhaps with a lag). In their opinion, there is little that monetary policies can do to counter these external shocks. Deflationary policies amplify the revenue swings caused by a drop in exports and are akin to accepting economic stagnation and a period of slow growth. On the other hand, compensating for the external demand gap by extending domestic credit in order to stabilize the domestic economy is likely to exacerbate the foreign sector imbalance as imports catch up with home demand.

As a result, structuralists believe that an import substitution policy is required to balance the external sector over time and to protect the domestic economy from foreign shocks in the short term. They argue that the economy's reliance on inelastic international demand for agricultural exports from developing countries and the direct effects of agricultural output changes induced by poor weather must be addressed. The agricultural cycle and the deteriorating terms of trade for agricultural products are beyond the reach of monetary policy. A considerable import program is frequently required to compensate for agricultural failures, straining the foreign sector's ability to respond. This emphasizes the importance of an adaptable import substitution policy (Galbis, 1976).

2.2.2. The Lewis model

According to Lewis (2005), the model's development transforms rural Agriculture into urban manufacturing sectors. Lewis saw economic development as relocating factors of production, such as labour, from a low-productivity agricultural sector to a high-productivity modern industrial sector. He further stated that agriculture served as a source of food and labour rather than a source of economic development. Moreover, according to Byerlee et al. (2005), The Lewis model was based on the concept of agricultural surplus labour. It is claimed that lower agricultural productivity led to higher wages in the modern

sector, resulting in economic growth. Thus, the agricultural sector contributed significantly to economic growth by bridging the gap between production and consumption and providing labour and food.

Moreover, according to Johnston and Mellor (1961), agriculture might provide raw materials for non-agricultural industries in the modern economy. As a result, improved agricultural productivity could boost the income of the rural population. The linkages were further emphasized by (Singer, 1979), who stated that a country's development strategy should not be export-driven but agriculture-driven because of production and consumption linkages. Therefore, increased agricultural productivity would initiate industrialization (Dethier and Effenberger, 2011).

Similarly, Greyling (2012) discussed the Lewis model, stating that a decline in rural production leads to a loss in rural income, reducing industrialization due to decreased demand for manufactured goods. As a result, decreased agricultural output would result in a shortage of agricultural items on the market. The seminal work of Lewis provides insight into contemporary policy development. Lewis's model demonstrates that countries on a transformation path operate on a dual economic system where growth in the subsistence sector (agricultural sector) creates a demand for labour in the capitalist sector, thereby raising productivity in the national economy (Fuglie & Rada, 2013).

2.2.3. Financial Repression Hypothesis

The financial repression hypothesis highlights the negative impact of various aspects of the imposition of controls on financial structures and development. The theoretical argument, thus, centres mainly on the need for a more laissez-faire financial policy, incredibly, the freeing of domestic financial markets to allow interest rates to reflect the actual scarcity of capital in developing countries and the liberalization of foreign trade (Ammani, 2014). However, this hypothesis was criticized; the critics of the financial liberalization theory argue that fully liberalized financial sectors may neither be possible nor desirable in developing countries. Some argue that liberalization may encourage the type of private investment that makes income distribution more unequal.

2.3. Empirical Literature Review

Several empirical studies have been conducted to study the relationship between access to credit to agriculture and agricultural productivity. Some of the studies applied methodological approaches that come closer to what will be used in this paper.

Empirical Literature on credit and agricultural productivity from various countries

Omobolanle's (2010) study assessing the relationship between microcredits and agricultural productivity revealed that access to microcredits could improve farmers' productivity and uplift the livelihoods of disadvantaged rural farming communities. However, the farmers needed to be shrewd at utilising credit facilities to achieve the goal of output maximization. The study also observed that the beneficiaries of microcredits in the study area were more productive than the non-beneficiaries. In comparison, studying how financial development affects agricultural production, Chandio et al. (2020) found that financial development significantly impacts agricultural production in both the long and short run.

Similarly, Osabohien, Adeleye and Tyrone (2020) found that a 1% increase in farmers' access to agricultural finance is associated with an increase in food production by 0.002%–0.006%, depending on the model specification. Additionally, Owusu (2017) employed a logit model with the outcome that access to credit was significantly influenced by sex, age, household size, farming experience, level of education, farm size, hired labour, extension service and farmer-lender distance. It also showed that credit positively and significantly affects cassava productivity in Ghana. By extension, investment supports industry and productive capacity, creates employment, attracts technological innovations, and contributes to the Government's tax revenue (Sinha, 2017).

Furthermore, agricultural credit was found to be an engine for agricultural productivity in various studies in certain countries, and those include studies done by, among others (Saleem and Ali Jan, 2011; Madugu, 2012; Etonihu, Rahman and Usman, 2013; Ojiya, 2017; and Akinrinola and Okunola, 2020). They revealed that credit disbursed for seed, fertilizers and pesticides, irrigation, and tractors were found to be strongly connected to

the agricultural gross domestic product. Thus, the availability of credit increased agricultural production.

Another by Ojiya (2017) found a positive association between credit and agricultural productivity. Credit enables the farmers to purchase superior quality or high-yield seeds, fertilizers and pesticides. In addition, a stepwise linear regression analysis was used by (Etonihu, Rahman and Usman, 2013). Their analysis indicated that about 26% of the variation rate in farmers' accessibility to agricultural credit was explained by all variables. Furthermore, Omobolanle (2010) researched to determine the relationship between microcredit program participation and the productivity of smallholder farmers. His work revealed a significant difference between the productivity of the participating and non-participating farmers. He further concluded that the participation of smallholder farmers in microcredit programs could improve their livelihoods.

Sebaggala and Matovu (2020) showed that increasing extension impact on farm productivity would require efforts to improve the quality of extension services that directly translate into productivity effects. Moreover, Nzomo and Mutiri (2014) studied the relationship between agricultural productivity and credit in Kenya, and the result indicated that agricultural credit could potentially increase farmers' income and productivity. Girabi and Mwakaje (2013) did another study in Tanzania and concluded that participants in microcredit programs recorded high productivity of smallholder farmers. Using empirical ordinary least squares regression results, Egbo's (2018) study disclosed a positive relationship between credit and agricultural output.

Similarly, Sarker (2016) argues that access to credit enables poor rural farmers to venture into new areas of economic activities, broaden their sources of capital and manage shocks and stress that are bound to occur. Ammani's (2012) position is not different; the paper's findings indicated that farmers' credit is positively and significantly related to the productivity of Nigerian Agriculture's crop, livestock, and fishing sectors.

Moreover, Carter (1989) argued that credit could lead to efficient resource allocation, increase farmers' technical efficiency, and increase farmers' profitability. Findings from the studies above have primarily concluded that increasing agricultural producers' access to credit significantly and positively impacts productivity.

Equally, Ayegba and Ikani (2013) assessed how agricultural credit has improved rural farmers' production/productivity in Nigeria using cross-sectional data. They found that agricultural credit supply had not significantly boosted the production and productivity of farming households in rural areas. Similarly, Awe (2013) investigated the mobilization of domestic financial resources for agricultural productivity in Nigeria, using credit supply through Nigerian Bank for Commerce and Industries (NBCI) and commercial banks. His findings strongly correlated with Nigeria's credit supply and agricultural productivity.

Additionally, Tasie (2013) analyzed the impacts of the International Fund for Agricultural Development (IFAD) credit supply on rural farmers' production and income in River State, Nigeria, by administering questionnaires. They found that the programme contributed significantly to farm output and income. Another study by Jacob (2021), exploring the linkage between agricultural investment and agricultural output in Namibia, found that investment and agricultural output exhibit a long-run relationship. The coefficient estimates showed that public investment, development bank loans and agricultural export have a positive impact on agricultural output.

Studies such as Osabohien et al. (2020), Matthew et al. (2019), Osabohien et al. (2018), Awotide et al. (2015), Obilor (2013), and Tasie and Offor (2013), among others, have been conducted in examining the impact of credit on output in Nigeria, with different findings. Moreover, Matthew et al. (2019) applied the Generalized Method of Moments to examine how poverty would be reduced through agricultural productivity as an aftermath of credit facilities. Their paper attests that agricultural performance is an essential stimulant for sustainable development in the ECOWAS sub-region, implying that credit access is necessary to enhance agricultural sector performance.

Furthermore, The study by Olagunju and Babatunde (2011), validated by Adetiloye(2012) on agricultural financing in Nigeria, found that credit to the agricultural sector is critical but noted that credit supply has not been growing with the economy. Additionally, (Ahmad et al., 2011) indicated that boosting agricultural performance depends on farmers' availability and accessibility of credit facilities. Accountability in agricultural governance is required to ensure fair access to credit (Osabohien et al. 2020c). Rural farmers do not have enough savings to finance their different agricultural pursuits, resulting in lower yields. Due to the arbitrary allocation of credit, Akinngbe and Adonu (2014) indicated that farmers have insufficient funds to carry out pre-, planting, and post-planting operations. The provision of agricultural financing is not enough in modern farming in Nigeria; smart utilization of such credit has become critical in increasing output.

Akinngbe and Adonu (2014) added that lack of access to credit causes setbacks to the productivity of farmers because these farmers do not have the resources to procure improved seedlings, chemicals, and hired labour, as well as transport and market their products which would have improved their productivity, welfare and ultimately help in achieving economically sustainable production. Equally, Zakaree (2014), using the ordinary least squares approach, a study of the impact of the agricultural credit guarantee scheme fund (ACGSF) on domestic food supply in Nigeria, indicated that the credit scheme had a positive and significant influence on domestic food supply. Nasir (2007) discovered that credit is critical to development. It assists farmers in making new investments and implementing new technologies to boost agricultural productivity.

In the same vein, Chisasa and Makina's (2015) recent study on bank credit and agricultural output in South Africa using the cointegration and error correction model (ECM) showed that credit supply has a positive and significant impact on agricultural output in the long run. Ahmad et al. (2018) investigated the impact of providing smallholder farmers in Ethiopia with in-kind credit in fertilizer and seed. They discovered that fertilizer and seed in-kind input credit boosted crop output reasonably. Similarly, Raifu and Aminu (2020) examine the intervening role of institutions in Nigeria's financial development and

agricultural performance nexus. Using the autoregressive distributed lag time series model, the findings indicate that financial development positively impacts agriculture.

On the contrary, Akinleye, Akanni, and Oladoja (2005) studied Nigeria's agricultural loan guarantee system and found that it had failed to achieve the expected productivity in the agricultural sector. Similarly (Foltz, 2004) using ECM revealed that bank credit has a negative impact on agricultural output in the short run. Also, Petrick (2004), in a cross-sectional analysis of on-farm investment, credit rationing, and government-sponsored credit access in Poland, discovered that credit rationing was influenced by the borrower's character rather than the availability of land as collateral. The findings also revealed that farmers' investment behaviour is strongly influenced by access to subsidized credit and that investment size is negatively related to farm size.

Additionally, (between 2006 and 2008) studied 177 fruit and vegetable growers in Chile to see how access to credit affected their on-farm productivity. The study's findings indicated that while short-term credit does not affect farm productivity, other factors, such as education and type of activity, do. Waheed et al. (2009) examined the rural farmer's borrowing behaviour and credit constraints in Punjab. Pakistan's government established numerous lending programs through banking institutions. Due to unfavorable credit policies, the impact of these programs was minimal on productivity. In his research article titled "Microcredits and Agricultural Productivity in Ogun State, Nigeria," Nosiru (2010) demonstrated that microcredit enabled farmers to purchase the inputs required to boost their agricultural productivity. However, the total amount of credit secured by the farmers in the study area had no positive impact on output.

2.4. Summary

There is massive literature and theories on credit and agricultural productivity. Numerous studies have examined credit and agricultural productivity. A selective list of theories and empirical studies done from a global perspective and Namibia were discussed in this chapter. According to the reviewed literature, a positive, negative, or inconclusive relationship exists between credit supply and agricultural production. This, therefore, has

induced this study to assess the impact of credit supply on agricultural production through Agribank, youth and women loan schemes and commercial loans.

CHAPTER THREE: METHODOLOGY

3.1. Introduction

The last chapter provided a detailed look at the theories and research that are already out there about our topic, which helped shape our comprehensive literature review. Now, this chapter will lay out our research design, which is essentially our plan for the study, and explain where the data came from. It will go over the tools used to analyse that data and how the data was collected. The chapter will also discuss the econometric models used in this study and the variables being examined. Important ethical considerations will also be addressed. By the end of the chapter, there should be a clear understanding of how we went from raw data to the findings that will be shared in the upcoming chapters.

3.2. Research Design

This study utilized quantitative econometric methods to analyse the relationship between credit availability and agricultural productivity in Namibia. Through a robust process of gathering and vetting data from various reliable sources, the study ensured the validity of the subsequent analysis. The econometric analysis was a comprehensive process that included exploratory data analysis, model specification, estimation, and hypothesis testing, with potential statistical issues meticulously addressed. The ultimate goal was to provide meaningful insights into how credit influences agricultural productivity, in hopes of informing future policy decisions and academic research within this sphere.

3.3. Data and Source

In this study, secondary quarterly data spanning from the first quarter of 2001 to the fourth quarter of 2022 was utilized. The data encompassed several crucial indicators pertaining to the agricultural sector, including agricultural output and its contribution to Namibia's Gross Domestic Product (GDP), credit finance allocated to agriculture, as well as interest rates and inflation within the agricultural industry. These data points were sourced from reputable and reliable databases such as the Bank of Namibia (BON) and the Namibia Statistics Agency (NSA).

By drawing upon this comprehensive dataset, the study aimed to capture long-term trends and fluctuations in the agricultural sector, allowing for an in-depth analysis of the relationship between credit availability and its impact on agricultural productivity in Namibia.

3.4. Description and measurement of variables

In this study, the variables of interest revolved around assessing the relationship between agricultural productivity and several key factors. Agricultural gross domestic product (AGDP) served as the dependent variable, representing a proxy for measuring agricultural productivity, as previously employed in a study by Akinrinola and Okunola (2020). The control variables included credit finance to agriculture (CRA), prime lending rate (PR), and inflation rate (INF). CRA was considered to capture the extent of financial resources allocated to the agricultural sector, while PR represented the prevailing interest rate applicable to agricultural financing. INF, on the other hand, served as a gauge of the general inflationary pressures affecting the agricultural industry. Each of these variables played a crucial role in understanding the dynamics and influences on agricultural productivity within the context of the study. Detailed descriptions of these variables will be presented in subsequent sections, shedding light on their significance and implications for the analysis.

3.5. Agricultural productivity

According to Awoyemi *et al.* (2017), agricultural productivity refers to the output produced by a given level of inputs in the agricultural sector of a given economy. More formally, it can be defined as “the ratio of the value of total farms outputs to the value of total inputs used in farm production”. On the other hand, Odero (2017) put it differently by defining agricultural productivity as the ratio of the final output in appropriate units to some measure of inputs. In this study, agricultural productivity was measured by Agricultural gross domestic product³ expressed as agricultural productivity.

³ Agricultural gross domestic product-real value of agricultural sector contribution to GDP

3.6. Credit

Credit is the ability to borrow money or access goods and services with the understanding that you will pay back later (Wu et al., 2021). Credit also means the capacity to borrow (Adewale et al., 2022). In this paper, we refer to the loans obtained by farmers to start or expand their farming businesses. Credit is acquiring funds, goods or services without immediate payment. The acquisition of funds be in the form of money borrowed or agricultural credit, including trade credit and bank credit. Therefore, Agricultural credit can be in various forms, for example, seed, fertilizer with deferred payment, use of tractors, labour, storage facilities, animal feeds, restocking, medication, etc.

Farm credit includes loans, notes, bills of exchange, and bankers' acceptances, among other credit vehicles used to support agricultural activities. Farmers' specialized financial demands, which are dictated by planting, harvesting, and marketing cycles, are met with these sorts of finance. Short-term credit is used to fund operating expenses, intermediate-term credit is used to finance farm machinery, and long-term credit is used to finance real estate (Adebayo & Adeola, 2008). It is also crucial financial support that farmers can get to bridge the gap between their income and expenditure on the field. It is a vital instrument for enabling farmers to acquire command over working capital to enhance their productivity and income. Thus, credit is an essential ingredient in the growth strategy of the agricultural sector (Mohsin, Ahmad & Anwar, 2011).

3.7. Inflation rate

Inflation was defined as the increase in consumer prices or the decline in the purchasing power of money. Inflation refers to the continuous increase in the economy's general price level, indicating macroeconomic stability. Furthermore, when the general price level in the economy increases, the cost of production also increases, agricultural productivity falls, and a shortage of food supply in the market brings about high demand, which causes farmers to produce more in order to meet the demand in the market (Gokal and Hanif, 2004). Thus, an inverse relationship between the inflation rate and agricultural productivity is expected in this study.

3.8. Prime lending rate

The prime lending rate is the rate at which commercial banks loan funds to their most creditworthy customers, and hence, it is usually lower than other market lending rates; the reason why it is considered a “base or reference rate”(Perera, Silva and Silva, 2018). The prime lending rate was considered in this study as the farmers borrowed at the commercial rate.

3.9. Data analysis

The estimation technique employed in this study is the Autoregressive Distributed Lag (ARDL) cointegration methodology, which is well-suited for analysing time series data. This technique helps avoid the issue of spurious results and misleading inferences that can arise from using non-cointegrated variables. Time series variables often exhibit mean and time-dependent variances, making the ARDL approach an appropriate choice (Aghabozorgi, Shirkhorshidi, and Wah 2015).

Cointegration analysis is particularly valuable as it addresses the problem of spuriousness and allows for the identification of long-run relationships among variables. In this study, the ARDL framework was utilized to explore the presence of cointegration and examine the long-term dynamics between the variables of interest.

Furthermore, the Augmented Dickey-Fuller (ADF) unit root test was conducted to ascertain the trend properties of the variables included in the model. This test helps determine whether the variables are stationary or non-stationary, providing insights into their behaviour over time. To explore the causal relationship between the variables, the Toda-Yamamoto Granger causality approach was employed. This technique helps assess the direction of causality between the variables, offering valuable insights into the interplay and potential causal links among them. By employing these estimation techniques, including ARDL cointegration, ADF unit root tests, and Toda-Yamamoto Granger causality, this study aims to provide robust and reliable findings on the relationships and dynamics among the variables under investigation.

3.10. Model specification

Considering the importance of the agricultural sector to development, this study examines the long-run relationship and the casual relationships between credit finance and agricultural productivity in Namibia using Auto-Regressive Distributed Lag (ARDL) and Granger Non-causality proposed by Toda and Yamamoto (1995). The choices of estimations are based on the strength of the techniques. That is, irrespective of the fact that the series is $I(0)$ and $I(1)$ or a combination of both $I(0)$ and $I(1)$, the ARDL technique is most suitable for estimating long-run behaviour (Pesaran, Pesaran, 1997). On the other hand, Toda and Yamamoto's approach to the causality test overcomes the limitations of the standard Granger causality test by considering possible non-stationary or co-integration between series when testing for causality.

Though the Vector Error Correction Model (VECM) also overcomes the limitation of the ordinary causality approach, there is a loss of long-run information due to the first difference in VECM. The estimated equation in assessing the long-run relationship between agricultural productivity and credit can be specified from this general formula as follows.

$$AGDP = f (AGDP, CRA, PR, INF) \dots\dots\dots[1]$$

For this study, the dependent variable, agricultural gross domestic product (AGDP), was used in the analysis as a proxy for agricultural productivity, being explained by itself, credits finance to agriculture (CRA), prime lending rate (PR) and Inflation rate (INF). β_0 is a constant, $\beta_1 \beta_2, \beta_3$ are coefficients of the independent variables and ε_t is the error term.

3.11. Unit Root Testing

Economic and financial time series exhibit trending behaviour or non-stationarity. Thus, prior to the estimation, unit root tests were carried out to determine the order of integration of the series. In practice, the choice of the most appropriate unit root test is difficult.

Enders (1995) suggested that a safe choice is to use both types of unit root tests the Augmented Dickey–Fuller (ADF) (1981) test and the Phillips–Perron (PP) (1988) test. For this study, the Augmented Dickey-Fuller test is estimated with a time trend, as shown in the following regression for a given variable Y.

$$\Delta Y = \varphi_0 + \varphi_i T + (\rho - 1)Y_{t-1} + \sum_{i=2}^n \varphi_i Y_{t-i+1} + \varepsilon_t \dots \dots \dots [2]$$

The above equation tests the null hypothesis of a random walk or non-stationarity against a trend stationary alternative. In addition, if time series are stationary, they do not diverge from each other, whereas if they are non-stationary, they tend to move too far. It is, therefore, essential to ensure that the series is stationary for the model to be feasible. Although ARDL does not require pre-testing variables for unit roots, it is required to ensure that no order $I(2)$ or higher variables were included in the model because including such variables would indicate that the F-statistic derived based on the assumption of variables integrated of order zero and one was invalid.

For this reason, the unit-roots test was employed to determine whether the time series were stationary and to identify their order of integration by using the Augmented Dickey-Fuller test (ADF) method of unit root test that was proposed by various previous literature.

3.12. Modelling of the long-run impact

After determining stationarity, the next step was determining cointegration, which denotes a long-term link between variables. This is cointegration if variables converge to equilibrium in the long run. Furthermore, depending on the model being tested, cointegration can be tested by using various methods. The Engle-Granger method is used when evaluating a single equation, and the Johansen method is used when testing a multivariate system.

The unit root test results can determine which method to use; thus, if some of the variables are integrated of order zero while others are integrated of order one, then Autoregressive Distributed Lag (ARDL) is the appropriate approach.

The ARDL “Bounds test” approach is based on the ordinary least square (OLS) estimation of a conditional unrestricted error correction model (UECM) for cointegration analysis developed by (Pesaran, Shin and Smith, 2001). It was used to test for the existence of a long-run relationship as well as to make an estimation of long and short-run coefficients.

Pesaran, Shin and Smith (2001) developed two sets of critical values for the cointegration test, namely the upper and lower bound (Narayan, 2016). They said that the upper bound test implies that all variables are integrated of order one. In contrast, the lower bound test assumes that all variables are integrated of order zero I (0), implying no cointegration. A conclusive inference can be drawn if the computed Wald test or F- statistic falls outside the critical value bounds. However, if the F-statistic falls inside the critical value bound, the inference would be inconclusive.

According to Pesaran and Pesaran (1997) and Pesaran and Shin (2001) (cited in Pahlavani, Wilson,

Worthington, 2005), the unrestricted error correction model ARDL model can be expressed in the following form:

$$\Delta AGDP_t = \beta_0 + \beta_1 AGDP_{t-i} + \beta_2 CRA_{t-i} + \beta_3 PR_{t-i} + \beta_4 INF_{t-i} + \sum_{i=1}^p \gamma_{1i} \Delta CRA_{t-i} + \sum_{i=1}^p \gamma_{2i} \Delta AGDP_{t-i} + \sum_{i=1}^p \gamma_{3i} \Delta PR_{t-i} + \sum_{i=1}^p \gamma_{4i} \Delta INF_{t-i} + \varepsilon_t$$

..... [3]

In equation (3), the coefficients with the summation signs represent the short-run dynamics while β for $i= 1,2, \dots, 4$ are the long-run multiples corresponding to the long-run relationship. The $\beta_1, \beta_2, \beta_3, \beta_4$ are the coefficients of the independent variables. Δ denotes the difference operator, ε_t is the error term, t is the period, and the variable ‘ p ’ is the lag length for the unrestricted error correction model.

The bounds test analyzes the following hypotheses:

$$H_0: \gamma_1 = \gamma_2 = \gamma_3 = \gamma_4 = 0$$

$$H_1: \gamma_1 \neq 0, \gamma_2 \neq 0, \gamma_3 \neq 0, \text{ or } \gamma_4 \neq 0$$

The null hypothesis states no cointegration, while the alternative states that there is cointegration. The null hypothesis is tested by employing the F- statistic, which tests the significance of the lagged levels of the variables.

3.13. Modelling the Causal Effects

The study followed Toda and Yamamoto (1995) to examine the causal relationship between the chosen variables. This approach showed how VAR could be formulated at levels form and carried out restrictions on the parameter's matrices, and it is relevant if the series are integrated or cointegrated of arbitrary order (Toda and Yamamoto, 1995). The Granger causality test determines if two variables can predict one another (Stock et al., 2001). It was feasible to have causation from variable X to variable Y but not vice versa. Granger causality does not guarantee that variable X causes variable Y, but it does imply that X could be the source of Y.

There are four types of causality: first, unidirectional causality from X to Y; second, unidirectional causality from Y to X; third, bidirectional causality; and fourth, no causality. Granger (1988), as cited in (Ojiya, 2017), stated that if co-integrating vectors exist between variables, there must be causality in at least one direction between these two variables. The standard Granger causality test was the most commonly used method for determining causation between variables. However, the test was linked to non-stationarity flaws, which resulted in erroneous results. It was then improved by the Toda- Yamamoto by employing a modified Wald test (MWALD).

Toda- Yamamoto was used in this study due to the following reason:

- (a) It involves estimating a VAR model in levels that minimize the risks associated with wrongly identifying the order of integration of variables (Amiri and Ventelou, 2012).
- (b) Because it does not involve pre-testing variables for cointegration, the Toda– Yamamoto technique was superior to Ordinary Granger Causality. As a result, performing a causality test on non-stationary or non-linear data avoids the problem of asymptotic critical values of non-cointegrated variables (Dembure and Ziramba, 2016).
- (c) The Toda-Yamamoto (1995) test adds the maximum order of integration, d_{max} To the right order of the VAR k , ensuring that the standard test statistics are preserved because Granger causality has the standard asymptotic distribution (Amiri and Ventelou, 2012).

In testing the causality, the following steps are involved under the Toda- Yamamoto approach: Firstly, determine the order of integration of the variables. Secondly is the determination of the optimal lagged length (k) estimated from the VAR estimation of variables in their levels. The lag length criteria were obtained using the Akaike Information Criterion (AIC) and Schwarz Information Criterion (SIC). Lastly, the Modified Wald (MWALD) approach was used to test for causality. The MWALD test follows a Chi-square distribution and has an asymptotic property when VAR ($k + d_{max}$) was estimated. To apply Toda- Yamamoto’s version of the Granger non-causality test, the model in the following VAR system was summarized:

Model when Agricultural gross productivity is the dependent variable:

$$\begin{aligned}
 AGDP = & \alpha_0 + \sum_{i=1}^k \alpha_{1i}AGDP_{t-i} + \sum_{j=k+1}^{d_{max}} \alpha_{2j} AGDP_{t-j} + \sum_{i=1}^k \gamma_{1i}CRA_{t-1} + \\
 & \sum_{j=k+1}^{d_{max}} \gamma_{2j} CRA_{t-j} + \sum_{i=1}^k \phi_{1i} PR_{t-1} + \sum_{j=k+1}^{d_{max}} \phi_{2j}PR_{t-j} + \sum_{i=1}^k \sigma_{1i} INFR_{t-1} + \\
 & \sum_{j=k+1}^{d_{max}} \sigma_{2j} INFR_{t-j} + \\
 & \varepsilon_{1t}.....[4]
 \end{aligned}$$

Model when Credit finance to Agriculture is the dependent variable:

$$\begin{aligned}
 \text{CRA} = & \beta_0 + \sum_{i=1}^k \beta_{1i} \text{CRA}_{t-i} + \sum_{j=k+1}^{d_{\max}} \beta_{2j} \text{CRA}_{t-j} + \sum_{i=1}^k \theta_{1i} \text{AGDP}_{t-1} + \\
 & \sum_{j=k+1}^{d_{\max}} \theta_{2j} \text{AGDP}_{t-j} + \sum_{i=1}^k \vartheta_{1i} \text{PR}_{t-1} + \sum_{j=k+1}^{d_{\max}} \vartheta_{2j} \text{PR}_{t-j} + \sum_{i=1}^k \delta_{1i} \text{INFR}_{t-1} + \\
 & \sum_{j=k+1}^{d_{\max}} \delta_{2j} \text{INFR}_{t-j} + \\
 & \varepsilon_{2t} \dots \dots \dots [5]
 \end{aligned}$$

Where ε_{1t} and ε_{2t} are considered to be white noise error terms, k is the ideal number of lags, and d_{\max} is the highest order of integration. Seemingly Unrelated Regression (SUR) is used to estimate the model. When testing whether AGDP Granger causes CRA from equation (4) above, the null (H_0) and alternative (H_1) hypotheses are specified as follows:

$$\begin{aligned}
 H_0: & \beta_{11} = \beta_{12} = \beta_{13} = \dots = \beta_{1k} = 0 \\
 H_1: & \beta_{11} \neq \beta_{12} \neq \beta_{13} \neq \dots \neq \beta_{1k} \neq 0
 \end{aligned}$$

Similarly, when testing whether CRA Granger causes AGDP from equation (5) above, the null (H_0) and alternative (H_1) hypotheses are specified as follows:

$$\begin{aligned}
 H_0: & \delta_{11} = \delta_{12} = \delta_{13} = \dots = \delta_{1k} = 0 \\
 H_1: & \delta_{11} \neq \delta_{12} \neq \delta_{13} \neq \dots \neq \delta_{1k} \neq 0
 \end{aligned}$$

The results might be unidirectional, bidirectional, or independence between the variables. Unidirectional causality exists when the null hypothesis of equation (4) is rejected. At the same time, the null hypothesis of equation (5) is not rejected, leading to the conclusion that changes in CRA cause changes in AGDP. Similarly, unidirectional existed when the null hypothesis of equation (4) was not rejected, while the null hypothesis of equation (5) is rejected, leading to the conclusion that changes in AGDP cause changes in CRA. When both null hypotheses of equations (4) and (5) are rejected, bidirectional causality arises. If none of the null hypotheses in equations (4) and (5) is rejected, there is no causality between the variables. Thus, failure to reject the null hypothesis in either situation suggests that the variables are independent.

3.13. Diagnostic test

Diagnostic and stability tests were conducted to assess the goodness of fit and suitability of the ARDL model employed in this study. To examine the stability of the model, cumulative sum of recursive residuals (CUSUM) tests was employed.

Additionally, several supplementary tests were carried out, including tests for normality, serial correlation, autoregressive conditional heteroscedasticity, and the functional form of the model for omitted variables (Manyeki, 2017).

The stability test is of utmost importance as unstable parameters can lead to model misspecification. To address this concern, the Breusch-Pagan-Godfrey test was utilized to detect heteroscedasticity between the variables. The Arch test, on the other hand, was employed to examine the presence of conditional heteroscedasticity. Moreover, the Breusch-Godfrey test was performed to identify any potential association of serial correlation within the residuals. Finally, the Jacque-Bera test was utilized to assess the normality distribution of the residuals. By conducting these diagnostic and stability tests, this study aimed to ensure the reliability and robustness of the ARDL model, as well as to identify any potential issues such as misspecification, heteroscedasticity, serial correlation, or deviations from normality. The outcomes of these tests contribute to the overall validity and credibility of the study's findings.

3.15. Research Ethics

In this study, strict adherence to ethical principles was upheld, ensuring the practice of truthful reporting. The data used in the research were handled with the utmost integrity and were not distorted, falsified, or fabricated in any manner. Transparency and accuracy were maintained throughout the study, with appropriate citation and acknowledgment of all sources utilized in the research. The reference list comprehensively documented and attributed the contributions of external sources, guaranteeing the integrity and credibility of the study. By adhering to these ethical guidelines, the study aimed to uphold the highest standards of research integrity, promoting trustworthiness, and contributing to the overall body of knowledge in a responsible and ethical manner.

CHAPTER FOUR: ANALYSIS AND DISCUSSION

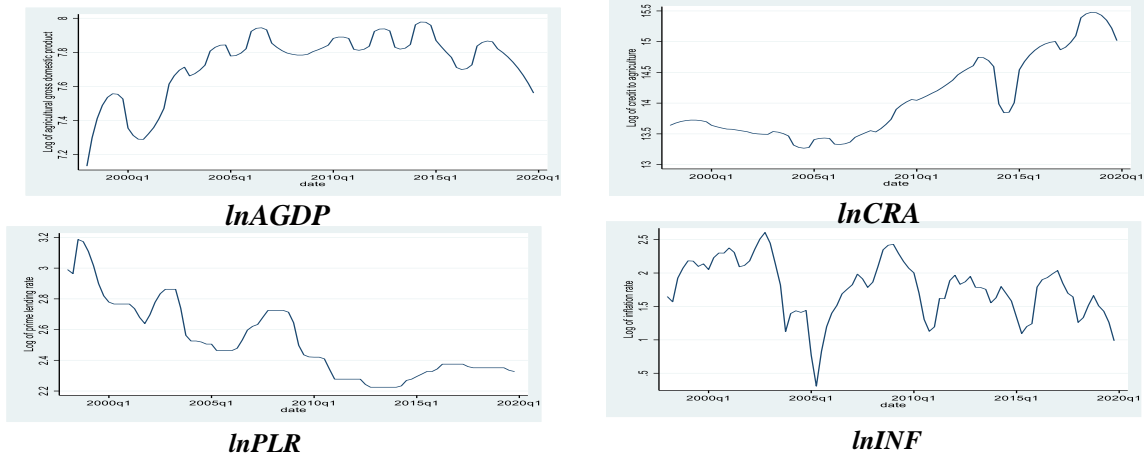
4.1. Introduction

This chapter serves as a description of the findings derived from the comprehensive tests discussed in the previous chapter. It commences by presenting graphical representations of the time series data to identify trends and conduct unit-root tests for each variable. Additionally, the determination of lags, bounds testing for cointegration, and the evaluation of variable stability are conducted to further explore the relationships between the variables. Moreover, the Toda-Yamamoto approach to Granger causality is employed to gain insights into the interdependencies and causal links among the variables. Using EViews 9 software, the impact of credit finance on agricultural productivity is thoroughly analyzed, and the results are effectively presented and interpreted. This chapter summarizes a crucial stage of the research process, providing a comprehensive understanding of the outcomes and facilitating meaningful discussions and conclusions based on the empirical evidence derived from the analyses.

4.2. Graphical presentation of the data

In order to comprehend the characteristics of the data, such as forms of trend, the direction of the trend, structural discontinuities, and stationarity, the first step in any time series econometric analysis is to examine the graphical presentation of the data. In Fig. 4.1, the data are shown graphically in natural log form for the agricultural gross domestic product variables, the aggregate credit finance, Prime lending rate and inflation rate.

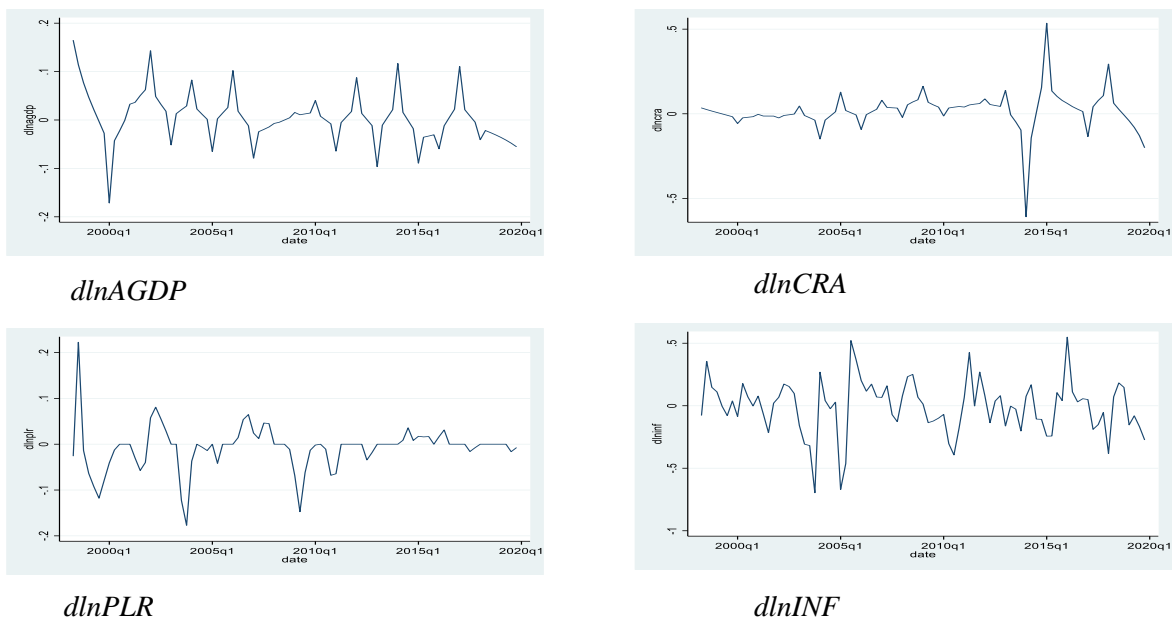
Figure 4.1 Unit root test of variables in level



Source: Authors Computation using Eview 9

The presented variables exhibit some linear trends. Therefore, the visual inspections showed that the variables are non-stationary. If the researcher continued to do some analysis with such data, it would produce spurious or biased results. Therefore, to proceed with the estimation, the variables were differenced to get rid of the trend, as indicated in Figure 4.2.

Figure 4.2 Unit root test of variables in their first difference



Source: Author's computation

4.3 Unit root test of variables

Before conducting the estimation, we undertook unit root tests to assess the order of integration of each series. This preliminary step is crucial because we need to ensure that the conditions of stationarity, which are requisite for applying the Autoregressive Distributed Lag (ARDL) technique, are sufficiently met by each series. To do this, we used the Augmented Dickey-Fuller (ADF) unit root test. The purpose of this test is to determine whether a unit root is present in the series, which is another way of evaluating if the series is non-stationary. If a series is found to be non-stationary, it indicates that its statistical properties, such as mean and variance, change over time. Non-stationarity poses a problem for conventional statistical inference and, hence, it is important to transform non-stationary series into stationary ones before applying techniques such as ARDL.

The results of the ADF unit root tests are documented in Table 4.1. After examining these results, we found that all the variables became stationary after the first difference, thereby indicating that they are integrated of order one, $I(1)$. This means that we had to difference each series once to achieve stationarity. The order of integration is an important aspect to consider in the application of the ARDL approach to cointegration. A series can be said to be integrated of order d , or $I(d)$, if it becomes stationary after differencing d times. So, a series is $I(0)$ if it's stationary in its level form, and $I(1)$ if it becomes stationary after differencing once, and so on. In our case, the fact that all variables were $I(1)$ justified the adoption of the ARDL approach.

Subsequent to verifying the stationarity of the series, the study followed a 'general to specific' approach for lag selection. We began with a general model with many lags, and gradually simplified it to a more specific model with fewer lags. The number of lags for the dependent variable and the dynamic regressors were chosen based on the Akaike Information Criterion (AIC). AIC balances the complexity of a model against its goodness of fit; it penalizes the addition of unnecessary lags while rewarding improvements in fit, thus facilitating a robust selection of the maximum lag order.

Table 4.1 Result of Augmented Dickey fuller Unitroots

Variable	AGDP (lnAGDP)	CRA (lnCRA)	INFR (lnINFR)	PR (lnPR)
Test	Augmented Dickey-Fuller	Augmented Dickey-Fuller	Augmented Dickey-Fuller	Augmented Dickey-Fuller
t-stat (Level)	-3.172 (0.097)	0.377 (0.999)	-3.067 (0.121)	-3.271 (0.078)*
t-stat (1st Difference)	-5.68 (0.000)***	-15.45 (0.000)***	-7.238 (0.000)***	-4.037 (0.011)*
1% Critical Level	-4.072415	-4.072415	-4.068290	-4.0683
5% Critical Level	-3.464865	-3.464865	-3.462912	-3.4629
10% Critical Level	-3.158974	-3.158974	-3.157836	-3.1578
Order of Integration	I(1)	I(1)	I(1)	I(1)

Source: Author's computation

The null hypothesis for this test was that AGDP, CRA, INFR, and PR all have a unit root. Each column in the table represents a variable. The rows provide the t-statistic (with probability in parentheses) for the test at level and first difference, as well as the critical values for each significance level. Asterisks indicate the significance of the coefficients, with *** representing 1% significance, **5%, and * 10%. The bottom row indicates the order of integration, with 'I(1)' indicating that the series becomes stationary after differencing once. Therefore, the results showed that none of the variables was $I(2)$ or higher, indicating that the ARDL-bound cointegration testing was appropriate for the study.

4.4. Optimal lag length selection criteria

The choice of lag length should be exercised with caution because inappropriate lag length can lead to biased results and cannot be accepted for policy analysis. Consequently, the AIC was used to illustrate the relative lag length to confirm that the lag length is chosen appropriately. The AIC (see Footnote 10) criterion gives robust results and has excellent performance compared to the SC (11) and HQ (12). The results are presented in Table 4.2. We determined that lag 4 fits the sample size.

Table 4.1: Optimum lag selection criteria results

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-115.4271	NA	0.000202	2.843502	2.959255	2.890034
1	231.7232	652.9732	7.60e-08	-5.041029	-4.462263	-4.808370
2	286.5392	97.88568	3.03e-08	-5.965219	-4.923440*	- 5.546433*
3	304.4398	30.26057	2.91e-08	-6.010472	-4.505681	-5.405558
4	333.7188*	46.70695*	2.15e-08*	-6.326638*	-4.358834	-5.535597

Source: Author's Computation using EViews and * indicates lag order selected by the criterion

The abbreviations used in the table represent the following:

- LogL: Log-likelihood
- LR: Likelihood ratio
- FPE: Final prediction error
- AIC: Akaike information criterion
- SC: Schwarz information criterion
- HQ: Hannan-Quinn information criterion

In this table, the asterisks (*) indicate the lag order selected by each criterion. Lag order 2 has been selected by the SC and HQ criteria, while lag order 4 was chosen for LogL, LR, FPE, and AIC criteria. Note: The "*" next to a number indicates that this is the optimal lag order selected by that criterion. The computations for this table were performed using

EViews. Each row corresponds to a different lag length, ranging from 0 to 4. The values in the table indicate the results of various statistical tests and criteria used to determine the optimal lag length for time series analysis.

4.5. Result of ARDL Bounds tests to Cointegration

To investigate the impact of aggregate credit finance on agriculture, the study utilized an Unrestricted Error Correction Model (UECM) version of the ARDL model with a lag of four for agricultural gross domestic product (AGDP). After confirming through the unit root test that all variables were integrated of order one, Equation 3 was employed to examine long-term relationships between the variables. This approach allowed for a dynamic analysis, capturing both short-term dynamics and the equilibrium relationships between the variables. By considering a lag of four for AGDP, the model accounted for potential delayed effects of credit finance on agricultural productivity. The UECM framework, combined with the unit root test and exploration of long-term relationships, provided a robust methodology to assess the impact of aggregate credit finance on the agricultural sector.

Table 4.3: Bounds test to cointegration results

Critical value bounds of the F- Statistics at:							
	10%		5%		1%		Outcome
K=3	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	
	2.72	3.77	3.23	4.35	4.29	5.61	Cointegration at 5% and 10% level

Source: Authors Computation using EViews 9

F= 5.469 t = -2.490

The result in Table 4.3 indicated that the computed F-statistics based on the Wald tests of 5.47 clearly exceeded the upper bound of 4.35 and 3.77 for the equation at 5% and 10% significance levels, suggesting that the null hypothesis of no cointegrating relation is rejected for the equation. However, at 1%, its inconclusive because the F-statistics lay between the lower and upper bound. Therefore, the long-run relationship was confirmed among the agricultural gross domestic product, credit finance to agriculture, inflation rate

and prime lending rate. The result implies that these variables move together and cannot diverge too far away independently.

Table 4.2: ARDL (4 0 0 0) Bound test Result

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNAGDP(-1))	-0.511969	0.125704	-4.072806	0.0001
D(LNAGDP(-2))	-0.370174	0.117808	-3.142172	0.0024
D(LNAGDP(-3))	-0.586143	0.082738	-7.084341	0.0000
C	6.196081	1.491800	4.153426	0.0001
LNCRA(-1)	-0.163183	0.044723	-3.648747	0.0005
LNINFR(-1)	-0.043682	0.034369	-1.270952	0.2076
LNPR(-1)	-0.326262	0.151179	-2.158121	0.0341
LNAGDP(-1)	-0.555267	0.144896	-3.832173	0.0003
R-squared	0.911342	Mean dependent var		0.006603
Adjusted R-squared	0.903176	S.D. dependent var		0.490721
S.E. of regression	0.152695	Akaike info criterion		-0.830356
Sum squared residual	1.771998	Schwarz criterion		-0.598849
Log likelihood	42.87494	Hannan-Quinn criteria		-0.737292
F-statistic	111.6042	Durbin-Watson stat		1.759373
Prob(F-statistic)	0.000000			

Source: Author's Computation using EViews 9

Note: the ***, ** and * sign indicates the significance of the coefficients at 1%, 5% and 10% significance level, respectively

As presented in Table 4.4, the ARDL (4 0 0 0) bound test revealed that the estimated coefficient lag for agricultural productivity proxied by agricultural gross domestic product had a very high significant impact on AGDP. That is, a one unit increase in AGDP lag from one to three leads to an approximately 0.51, 0.37 and 0.59 unit decrease in agricultural productivity, respectively, holding everything constant. The negative sign and very significant at one per cent level, indicated a reduction in agricultural products and low agricultural productivity.

The impact of credit finance on agriculture lag was significant at 1% t-probability level, and lag one negatively impacted agricultural productivity. This means that a -unit increase in the first lag of credit finance to agriculture leads to a 0.16 unit decrease in agricultural productivity, all equal. Interestingly, the coefficient of the prime lending rate had a negative impact on agricultural productivity, and it is even significant at a 5% level (t-test

probability); this could be true because a high-interest rate will make it expensive for farm owners to acquire funds leading to a reduction in the agricultural production and indirectly productivity. Another negative relationship was observed between inflation and agricultural productivity; the coefficient is insignificant at the t-probability level. Given that inflation indirectly impacts the monetary policy, and, in most cases, the central bank will raise the repo and the commercial bank, in return, raises the prime lending rate. Moreover, the negative relationship between the two variables is justifiable because when the inflation is high, the price of agricultural production inputs rises, making it difficult for farmers to afford.

The coefficient of determination ($R = 0.911$) of the estimated model shows that about 91.1% of the variation in agricultural productivity proxied by the agricultural gross domestic product of Namibia is jointly explained and accounted for by the independent variables in the estimated ARDL (4,0, 0, 0) model. When adjusted for the degrees of freedom based on the adjusted coefficient of determination (Adjusted R-bar squared =0.903), it showed that the ARDL (4, 0, 0, 0) model has about 90.0% explanatory power with respect to variation in agricultural productivity. This implies that the ARDL model has satisfactory goodness of fit. The F-test, used to determine the overall statistical significance of a regression model, shows that the overall regression is statistically significant at a 1% level.

4.6 The ARDL Cointegrating and Long-run Form

The estimation result of equation 3 in Tables 4.3 and 4.4 indicated a short-run and Long-run relationship between the agricultural gross domestic product and the credit finance to agriculture. Thus, the ARDL result in Table 4.4 was used to estimate the unrestricted error correction model. The UECM was chosen because, from the graphical analysis of data in the study, it is found that the main variables in the model exhibit a linear trend in pattern, and there is no quadratic trend.

Table 4.5 ARDL Cointegrating And Long Run Form

Cointegrating Form				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNAGDP(-1))	-0.528394	0.124115	-4.257292	0.0001
D(LNAGDP(-2))	-0.372354	0.117872	-3.158977	0.0023
D(LNAGDP(-3))	-0.589431	0.082872	-7.112580	0.0000
D(LNCRA)	-0.169110	0.043818	-3.859340	0.0002
D(LNINFR)	-0.021063	0.034571	-0.609256	0.5442
D(LNPR)	-0.369088	0.149437	-2.469853	0.0158
ECT _{t-1}	-0.525151	0.141540	-3.710276	0.0004
ECT _{t-1} = LNAGDP - (-0.3220*LNCRA -0.0401*LNINFR -0.7028*LNPR + 11.5885)				
Long Run Coefficients				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNCRA	-0.322022	0.080995	-3.975821	0.0002
LNINFR	-0.040108	0.068379	-0.586555	0.5592
LNPR	-0.702822	0.295085	-2.381763	0.0197
C	11.588486	1.248647	9.280838	0.0000

Source: Author's computation using Eview 9

Specify the Error correction term:

$$ECT_{t-1}=LNGDP-(-0.322022LNCRA-0.040108LNINFR-0.702822LNPR)$$

$$ECT_{t-1}= LNCRA - (-0.4327*LNAGDP + 1.1338*LMINFR -0.1020*LNPR)$$

The results of the ARDL model, as presented in Table 4.5, reveal the long-run and short-run relationships between agricultural productivity and credit finance to agriculture. The lagged coefficients of agricultural gross domestic product exhibit a negative impact on AGDP, indicating that an increase in AGDP in the previous quarters could lead to a significant decrease in AGDP by 0.53, 0.37, and 0.58 for lag one to lag three, respectively. Similarly, the short-run analysis shows that credit finance to agriculture, inflation, and the prime lending rate all have negative effects on agricultural productivity. Specifically, a

one-unit increase in credit finance to agriculture is associated with a decrease of (-0.17) in agricultural productivity. The prime lending rate, with a coefficient of (-0.36) and a probability of 0.0158, exhibits an inverse relationship with agricultural productivity in the short run. Inflation, however, does not have a significant effect on agricultural productivity.

The estimation of the error correction terms (ECTt-1) in both agricultural gross domestic product and credit finance to agriculture provides insights into the speed of adjustment between the variables. The negative and statistically significant coefficients of ECTt-1 indicate that any long-term imbalances among the dependent and independent variables will converge to their equilibrium relationship. The absolute value of the ECTt-1 coefficient in agricultural gross domestic product is 0.525, suggesting that agricultural productivity adjusts at a rate of 53% per quarter towards its long-run equilibrium. This implies that it will reach full equilibrium by the second quarter. Similarly, the absolute value of the ECTt-1 coefficient for credit finance to agriculture is 0.022, indicating an adjustment rate of 2.3% per quarter towards its long-run equilibrium. It is projected to take approximately 44 quarters to reach its full equilibrium. These findings provide valuable insights into the dynamics and convergence of agricultural productivity and credit finance to agriculture over time.

4.6. Toda- Yamamoto Granger Causality test

Furthermore, the concept of causality pertains to the cause-and-effect relationship between variables. In this study, the Toda-Yamamoto Granger causality test was employed to examine whether lagged values of one variable had a Granger-causal influence on the other variables. By applying the Granger causality test, which corrects for past observations, the aim was to determine if the variables could be used to predict one another. The null hypothesis of no causation was either rejected or failed to be rejected based on the results of the Granger causality test.

The rejection or failure to reject the null hypothesis of no causality is contingent upon the significance level, typically set at 1%, 5%, or 10%. If the probability value is below the chosen significance level, the null hypothesis is rejected, indicating a linkage between the variables. Conversely, if the significance level is greater than the predetermined threshold, the null hypothesis of no causality is not rejected. In this study, the Toda-Yamamoto Granger causality test was selected due to its superiority over the traditional Granger causality test, as well as the absence of cointegration between the variables. The outcomes of the Toda-Yamamoto Granger causality test are presented in Table 4.5, providing insights into the causal relationships among the variables under examination.

Table 4.3: Toda- Yamamoto Granger causality test results

Dependent variable: AGDP			
Excluded	Chi-sq	df	Prob.
CRA	16.44468	4	0.0025
All	16.44468	4	0.0025
Dependent variable: CRA			
Excluded	Chi-sq	df	Prob.
AGDP	4.534693	4	0.3385
All	4.534693	4	0.3385

Sources: Author's Compilation using Eview 9

The estimated findings were derived using the seemingly unrelated regression technique, focusing on testing the null hypotheses outlined in equations (2) and (3) as presented in Table 4.5. These null hypotheses specifically examined whether Agricultural Gross Domestic Product (AGDP) does not Granger Cause Credit to Agriculture or vice versa if Credit to Agriculture does not Granger Cause Agricultural Gross Domestic Product. The results of the analysis indicated that the probability value associated with agricultural gross domestic product (0.0025) was found to be below the chosen significance level of 0.01 (1%), indicating statistical significance.

This implies that there is sufficient evidence to reject the null hypothesis and conclude that there exists a significant causal relationship between agricultural gross domestic product and credit finance to agriculture. On the other hand, the probability value associated with credit finance to agriculture (0.3385) exceeded the 1% significance level, suggesting a lack of statistical significance. Consequently, the null hypothesis of no causality was not rejected in the case of credit finance to agriculture.

Based on these findings, there is substantial evidence of unidirectional causality flowing from agricultural gross domestic product. Thus, it can be concluded that agricultural productivity plays a predictive role in credit finance to agriculture. These findings are consistent with previous studies conducted by Lawal et al. (2019), Ammani (2014), as well as Anetor et al. (2016), all of which identified a relationship between agricultural productivity and credit finance to agriculture in developing countries. Overall, these results contribute to our understanding of the dynamics between agricultural productivity and credit finance, highlighting the significance of agricultural performance in influencing credit allocation within the agricultural sector.

4.5. Diagnostic tests

The diagnostic tests for the ARDL (4, 0, 0, 0) model are presented in Table 4.6, providing insights into the model's goodness of fit and suitability. The results of these tests can help evaluate the validity of the model's assumptions and identify potential issues or limitations. The serial correlation test, which assesses the presence of autocorrelation in the model's residuals, yielded a chi-squared statistic of 8.7109 with a corresponding p-value of 0.0687. Since the p-value is above the conventional significance level of 0.05, there is no strong evidence to suggest the presence of serial correlation in the residuals. This implies that the model adequately accounts for the temporal dependencies in the data.

The heteroscedasticity test examines whether the model's residuals exhibit unequal variances. The test yielded a chi-squared statistic of 7.9065, accompanied by a p-value of 0.3409. As the p-value exceeds the significance level of 0.05, there is no significant evidence to suggest the presence of heteroscedasticity. Therefore, the model's assumption

of constant variance in the residuals appears to hold. The normality test evaluates whether the model's residuals follow a normal distribution. The chi-squared statistic for this test is 0.6252, with a corresponding p-value of 0.7315. Since the p-value is higher than 0.05, there is no strong evidence to reject the assumption of normality. This suggests that the model's residuals are reasonably well approximated by a normal distribution.

Lastly, the functional form test examines the appropriateness of the chosen functional form for the model. The test yielded a chi-squared statistic of 3.0436, with a p-value of 0.5506. Since the p-value exceeds 0.05, there is no significant evidence to suggest a departure from the chosen functional form. In summary, the diagnostic tests indicate that the ARDL (4, 0, 0, 0) model used in the analysis demonstrates satisfactory results. There is no strong evidence of serial correlation, heteroscedasticity, departure from normality, or functional form misspecification. These results support the validity and suitability of the model for examining the relationships and dynamics among the variables under investigation.

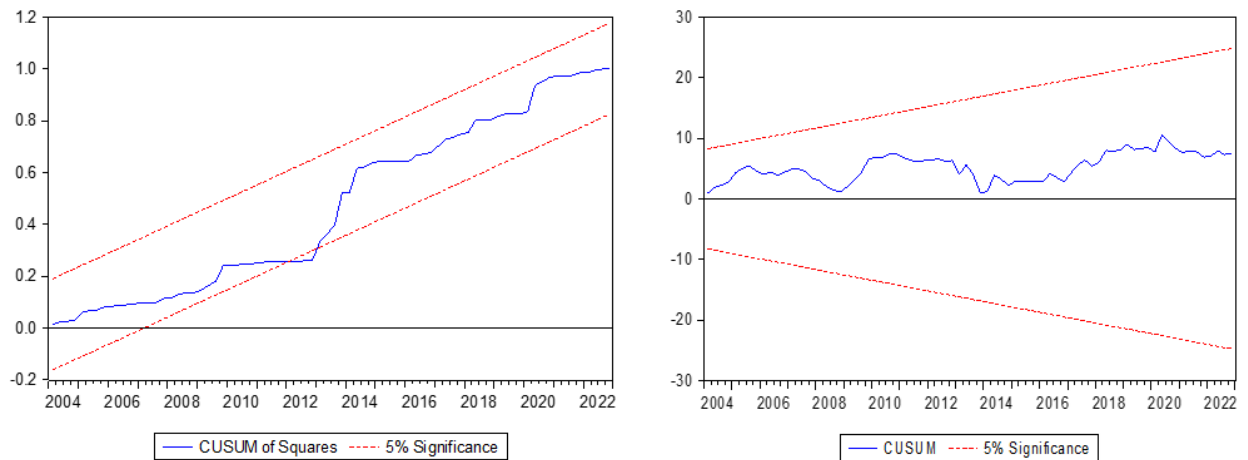
Table 4.4: ARDL (4, 0, 0, 0) Diagnostics Tests

TEST	χ^2 -STATISTICS	P-VALUE
Serial correlation	8.7109	0.0687
Heteroscedasticity	7.9065	0.3409
Normality	0.6252	0.7315
Functional form test	3.0436	0.5506

Source: Author's computations using EViews 9

The CUSUM and CUSUM-of-squares stability test in Autoregressive distributed lags method, which Brown et al. (1975) developed to show the stability of the data. The result in Figure 4.3 suggested that the parameters were stable over the sample period in terms of CUSUM. However, in terms of CUSUM Square, the parameter was not stable in all quarters in 2013.

Figure 4.3. Cumulative sum (CUSUM) of the recursive residual plot



Source: Author's Computations using EViews 9

Figure 4.3, the instability in 2013, is attributed to the drought that occurred in that year, as most farmers lost their livestock. Overall, the model was stable, and it was concluded that ARDL agricultural gross domestic product function is stable and agricultural gross domestic product can be used as a target variable.

4.6 Summary

The results of the ARDL model revealed important insights into the relationships and dynamics among the variables examined in this study. The model's estimation, based on the Unrestricted Error Correction Model (UECM) with a lag of four for agricultural gross domestic product (AGDP), allowed for the analysis of both short-term and long-term relationships. The findings indicated a significant negative impact of lagged agricultural gross domestic product on AGDP, implying that previous levels of agricultural productivity have a diminishing effect on current productivity. Similarly, credit finance to agriculture, inflation rate, and prime lending rate were found to negatively influence agricultural productivity in the short run.

Furthermore, the bounds test to cointegration revealed that the null hypothesis of no cointegrating relationship was rejected for the equation, indicating the presence of a long-term relationship among the variables. The coefficients of the error correction term (ECT_{t-1}) showed that agricultural productivity and credit finance to agriculture converge towards their long-run equilibrium at rates of 53% and 2.3% per quarter, respectively.

The Toda-Yamamoto Granger causality test provided evidence of a significant causal relationship from agricultural gross domestic product to credit finance to agriculture, highlighting the predictive role of agricultural productivity in credit allocation. However, the causal relationship from credit finance to agriculture to agricultural gross domestic product was not significant. The diagnostic tests for the ARDL model indicated satisfactory results, as there was no strong evidence of serial correlation, heteroscedasticity, departure from normality, or functional form misspecification. These findings support the validity and suitability of the model for analysing the relationships and dynamics among the variables.

Overall, this chapter's findings contribute to a better understanding of the impact of aggregate credit finance on agriculture and the relationships between agricultural productivity and various factors such as credit finance, inflation rate, and prime lending rate. These insights can inform policymakers and stakeholders in the agricultural sector, facilitating evidence-based decision-making and the formulation of effective strategies to enhance agricultural productivity and credit allocation in Namibia.

CHAPTER 5: CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

The analysis of the results was reported in the preceding chapter. Conclusion based on the findings are provided in this closing chapter. Recommendation to policy decision makers and future researchers are also outlined in this section. Throughout this study, several key findings have emerged from the analysis. The unit root tests conducted confirmed the need for differencing to achieve stationarity in the variables. By applying the Augmented Dickey-Fuller (ADF) unit root test, it was established that all variables became stationary after the first difference, indicating integration of order one (I (1)). This justified the adoption of the Autoregressive Distributed Lag (ARDL) approach for cointegration analysis.

In determining the appropriate lag length, the Akaike Information Criterion (AIC) was utilized, which indicated that a lag length of four was optimal for the estimation. This lag length selection helps ensure that the model strikes the right balance between complexity and goodness of fit.

Cointegration analysis revealed the presence of a long-term relationship among agricultural gross domestic product (AGDP), credit finance to agriculture (CRA), inflation rate (INFR), and prime lending rate (PR). This implies that these variables move together over time and cannot diverge too far from each other independently. The estimated coefficients of the error correction term (ECT_{t-1}) further confirmed the convergence of AGDP and credit finance to agriculture towards their long-run equilibrium at rates of 53% and 2.3% per quarter, respectively.

The short-run analysis showed that lagged AGDP, credit finance, inflation rate, and prime lending rate negatively influenced agricultural productivity. Specifically, an increase in lagged AGDP led to a significant decrease in current agricultural productivity. Credit finance to agriculture, inflation rate, and prime lending rate also exhibited negative effects on agricultural productivity in the short run. Additionally, the Toda-Yamamoto Granger

causality test demonstrated a significant causal relationship flowing from AGDP to CRA, indicating the predictive role of agricultural productivity in credit allocation. However, no significant causal relationship was found from CRA to AGDP.

5.2 Conclusions

Based on the findings of this study, several conclusions can be drawn:

- Credit finance plays a significant role in shaping agricultural productivity. The availability of credit and financial services has a direct impact on the performance and growth of the agricultural sector.
- Lagged levels of agricultural productivity have a diminishing effect on current productivity. Past levels of agricultural output influence the current level of productivity, highlighting the importance of sustained investment and efforts to enhance productivity over time.
- AGDP, CRA, INFR, and PR are interdependent variables and exhibit long-term relationships. These variables move together and are influenced by each other, emphasizing the need for a comprehensive understanding of their dynamics.
- Agricultural productivity has a predictive role in credit allocation. The performance of the agricultural sector directly influences the allocation of credit to agriculture, indicating that credit institutions consider agricultural productivity as a key factor in their lending decisions.

5.3 Recommendations

Based on the findings and conclusions of this study, the following recommendations are put forth:

- Enhance access to credit and financial services: Policies should be implemented to improve the availability and accessibility of credit and financial services to farmers and agribusinesses. This can include initiatives such as establishing specialized agricultural financing institutions, providing credit guarantees, and promoting financial literacy programs tailored to the agricultural sector.
- Promote agricultural extension services and technology adoption: Efforts should be made to strengthen agricultural extension services, providing farmers with access to knowledge, best practices, and innovative technologies. This can

contribute to improving productivity, efficiency, and sustainability in the agricultural sector.

- **Improve market access and value chain integration:** Measures should be taken to enhance market access for agricultural products and promote value chain integration. This can involve developing infrastructure, establishing market information systems, fostering partnerships between farmers and agribusinesses, and facilitating market linkages.
- **Strengthen policy and institutional support:** Government policies and institutions need to be strengthened to create an enabling environment for agricultural productivity growth. This includes providing supportive policy frameworks, implementing effective agricultural risk management strategies, and ensuring the availability of adequate resources for research, development, and implementation of agricultural programs.

5.4 Recommendations for Future Research

To further enhance understanding of the relationship between credit finance to agriculture and agricultural productivity, future research should consider the following areas:

- **Longitudinal studies:** Conduct longitudinal studies to assess the long-term impact of credit finance on agricultural productivity, considering factors such as changes in credit availability, loan repayment patterns, and the effects of credit access on investment and technological adoption.
- **Gender analysis:** Investigate the differential impacts of credit finance on men and women farmers. Analysing the gender dimensions of credit access and agricultural productivity can provide insights into potential gender disparities and opportunities for promoting gender equality in the agricultural sector.
- **Climate change adaptation:** Explore the role of credit finance in supporting climate change adaptation in agriculture. Investigate how credit can be utilized to finance climate-smart agriculture practices, resilience-building initiatives, and investments in sustainable farming systems.
- **Comparative studies:** Conduct comparative studies to identify best practices in credit access and agricultural productivity. Examine successful case studies from

other countries or regions to understand the key factors that contribute to effective credit allocation and improved agricultural productivity.

- **Impact of digital technologies:** Investigate the impact of digital technologies on credit access and agricultural productivity. Assess how digital innovations, such as mobile banking, fintech solutions, and digital platforms, can enhance farmers' access to credit and financial services and promote agricultural productivity.

5.5 Conclusion

In conclusion, this study has shed light on the relationship between credit finance to agriculture and agricultural productivity in Namibia. The findings highlight the significant role that credit finance plays in shaping agricultural productivity, with lagged levels of agricultural productivity influencing current levels. The analysis revealed long-term relationships among agricultural productivity, credit finance, inflation rate, and prime lending rate, emphasizing the interdependencies among these variables.

Policy recommendations have been proposed to enhance credit access, promote technology adoption, improve market access, and strengthen policy and institutional support. These recommendations aim to create an enabling environment for agricultural productivity growth and facilitate sustainable development in the agricultural sector.

Furthermore, areas for future research have been identified, focusing on longitudinal studies, gender analysis, climate change adaptation, comparative studies, and the impact of digital technologies. Continued research in these areas will contribute to a deeper understanding of the dynamics between credit finance to agriculture and agricultural productivity and inform evidence-based decision-making and policy formulation in the agricultural sector.

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