

**Adoption of Chemical Fertilizers in Coffee Production in Kikyenkye Sub-County,
Ibanda District**



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**A dissertation Submitted to the Directorate of Graduate Studies, Research and
Innovations in Partial Fulfillment of the Award of Master of Agriculture
and Rural Innovations of Bishop Stuart University**

JUNE, 2024

Declaration

I **Natukunda David** hereby declare that this is my original work and has never been submitted for any award in any University or Higher institution of learning.

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Approval

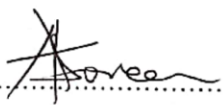
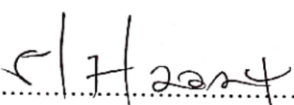
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Dedication

This work is dedicated to my spouse **Atuhaire Everlyne** (Mrs.) and my parents Mr. and Mrs. **Bagyenda Spiriano** and **Bashemereirwe Jane** for their generous support both financial and moral towards accomplishment of this course.

Acknowledgement

I thank the Almighty God for his divine grace that has enabled me to accomplish this work.

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May the Almighty God bless you all.

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List of acronyms

ACDP	Agricultural Community Development Project
BSU	Bishop Stuart University
DAP	Diammonium Phosphate
EPRC	Economic Policy Research Centre
FTF	Feed the Future
ICO	International Coffee Organization
IFDC	International Fertilizer Development Center
ITC	International Trade Centre
MAAIF	Ministry of Agriculture, Animal industry and Fisheries
NUE	Nutrient Use Efficiency
REC	Research Ethics Committee
UBOS	Uganda Bureau of Statistics
UCDA	Uganda Coffee Development Authority
USDA	United States Department of Agriculture

Abstract

This study focused on assessing the adoption of chemical fertilizers in coffee production in Kikyenkye Sub-County, Ibanda District. It was conducted from January to April, 2023 in Kikyenkye Sub-county, Ibanda district. It was limited to; (i) investigating the perceptions and attitudes of farmers on application of chemical fertilizers in coffee, (ii) determining the level of awareness of chemical fertilizer use in coffee production, (iii) investigating farm-based factors that determine farmers' choice to use chemical fertilizers in coffee production and, (iv) establishing possible strategies of promoting adoption of chemical fertilizers in coffee production. Despite government's efforts to increase coffee yield through advocacy to use chemical fertilizers, its adoption by coffee farmers remained very low causing declining coffee yields and subsequently reduced household income for small-holder rural farmers in the study area. The study employed a cross-sectional, descriptive research design and primary data was collected from 124 coffee farmers and 27 informants using questionnaires, interviews and focus group discussions. Data collected was subjected to SPSS software version 26.0 for analysis. The study found out that there is positive and significant perception and attitude of farmers on application of chemical fertilizers ($P < 0.05$). Chemical fertilizer use ensures high productivity and bean quality of coffee. Chemical fertilizers are basically used on commercial crops like tea and coffee. The decisions on chemical fertilizer use is significantly based on access to information and market prices ($P < 0.05$). It was further found out that farmers who had access to training services on the methods of application and easy access to the source of chemical fertilizers had significantly high level of awareness on the use of chemical fertilizers in coffee production ($P < 0.05$). The study also found out that small plots of land under coffee production and land fragmentation significantly influenced farmers' decisions to use chemical fertilizers in coffee ($P < 0.05$). It was established that providing constant training and stabilizing prices for both agricultural inputs and crop outputs could lead to enhanced use of chemical fertilizers in coffee significantly ($P < 0.05$). These could be used as strategies to promote chemical fertilizer use in coffee production. The study finally concluded that farmers' perceptions and attitudes, level of awareness and farm-based factors significantly affect farmers' adoption of chemical fertilizers in coffee production. The study recommends that there is a need for regular, practical and demonstration-based farmers' training, policymakers to consider development of policies that promote accessibility and sustainable use of chemical fertilizers, there is need to support farmers to increase the scale of coffee production to make it more profitable with use of chemical fertilizers and the need to reduce the cost of chemical fertilizers through subsidies.

CHAPTER ONE

INTRODUCTION

1.0 Introduction

The adoption of chemical fertilizers in coffee production is not popular in Kikyenkye Sub-County, located in the Ibanda district. This region is known for its coffee production, which has been a major source of income for the local community for many years. More than 80% of the households have coffee fields at different scales of production, with the majority growing it on small scale (UBOS, 2015). Banana is grown as the main food crop. Some farmers grow coffee in pure stands while others intercrop it commonly with banana, trees and sometimes with annual crops such as groundnuts, beans and peas. This area is characterized by high population density and high poverty levels (UBOS, 2015).

In this area, increasing coffee productivity is seen as one of the best interventions to improve household income of many rural farmers redeeming them from effects of abject poverty. During coffee harvesting season, it is evident that the purchasing power of coffee farmers increases. They are able to pay debts, buy assets, improve their homes, pay school fees and meet other welfare obligations more easily than when coffee is off season. This is a clear predictor that boosting production of coffee is synonymous to boosting social-economic wellbeing of the majority households. However, due to continuous soil cultivation with minimal or none soil nutrient replenishment, coffee yields have been on the decline in recent decades. Increasing coffee production by increasing acreage is not a workable measure due to land shortage as a result of high population density of 287.2 persons per Sq. Km (UBOS, 2015)

Whereas coffee farmers would use organic manure such as cow dung to increase yield, animal rearing is not common and this makes it expensive and unviable. The few farmers who afford, prioritize using organic manure in banana plantations for household food security purposes, leaving coffee to subsist with declining yields. Using chemical fertilizers is widely known for increasing crop yields where soil fertility is exhausted (Kadigi *et al*; 2020) and would be a potential game-changer in this situation. However, the use of chemical fertilizers in coffee production in this area is very low. The reasons for this phenomenon are not clear due to scanty information available. Therefore, this study assessed the adoption of chemical fertilizers in coffee as a production enhancing technology in the study area.

1.1 Background of the study

Globally, around 125 million people depend on coffee for their livelihoods through the generated income, and provision of the much-needed rural employment for both men and women in the labour-intensive production and harvesting processes (FTF, 2022; ITC, 2021). Global coffee production in 2019/20 was estimated at 169.34 million bags, 2.2% lower than the previous year, as output of Arabica decreased by 5% to 95.99 million bags, while that of Robusta rose by 1.9% to 73.36 million bags. Exports in the first 9 months of coffee year 2019/20 (Oct/19 to Jun/20) have decreased by 5.1% to 95.36 million bags compared to 100.46 million bags in the same period in 2018/19. In the twelve months ending June 2020, exports of Arabica totaled 79 million bags compared to 82.72 million bags the previous year; whereas Robusta exports amounted to 49.35 million bags compared to 48.89 million bags (ICO, 2021, USDA, 2022).

According to the International Coffee Organization (ICO), the world coffee demand followed an upward trend, with an average increase of 1.4% per year from 2017 to 2020 (ICO, 2021). Coffee is one of the most popular beverages and 80% of it, is produced by 25 million smallholder farmers (FTF, 2022).

In Africa, coffee production in year 2014/15 was around 16.9 million bags which was 10% of the estimated world production. Of this, an estimated 10.4 million bags were expected to be produced by just 2 countries that is, Ethiopia and Uganda (ICO, 2015). Accordingly, the total number of coffee farmers directly involved in its production in Africa was estimated at 12 million. Although many initiatives have been taken in many African countries to achieve a sustainable coffee sector, moving it from subsistence to an entrepreneurial one is still a challenge. In fact, productivity is still too low to promote sustainable coffee production in case of long periods of low prices. Farmers need sustainable income generation and long-term security of livelihood. When their income is reduced, smallholder farmers are tempted to limit practices that protect soil quality exacerbating the problem. Moreover, given the weak research and extension support, farmers in many countries on the continent have been slow to adopt good practices that could lead to required high coffee quality and productivity. Ethiopia and Uganda are the leading coffee producing countries in Africa and nearly a fifth of the population, depend on it for their livelihoods (ICO, 2015).

In Uganda, about 353,907 ha of land are under coffee cultivation (UCDA, 2022), by an estimated 1.7 million households. Accordingly, the coffee tree stock under production reached

nearly 330 million and there were 112 coffee growing districts out of 134 total districts in Uganda by December 2021. In fact, the national average annual coffee production was 282,000 tons ranking the 8th globally. Despite its value in revenue generation and expansion of land coverage, the level of production has been gradually reducing due to poor harvests acquired at the end of the different seasons due to declining soil fertility in most parts of the country (UCDA, 2022).

Similarly, soil has been subjected to severe nutrient deficiency triggered by natural and man-made factors as a result of population growth (IFDC, 2015; Workineh, 2020). Therefore, increasing coffee productivity where crop rotation would not work effectively, requires a range of measures, including appropriate use of fertilizers, soil conservation measures, and improved seeds (IFDC, 2015; Agbahey, 2015). Nowadays, effective soil fertility enhancing strategies are one of the most essential needs for increasing soil fertility in order to enhance coffee yields (Martey *et al.*, 2019). This is because soil infertility is evolving as a serious problem causing low coffee yields, leading to low household incomes among the coffee growing countries in the world (Elka *et al.*, 2020).

Worldwide, mineral fertilizer use in coffee production is steadily increasing in response to the growing population and increased demand for coffee products (Huang *et al.*, 2017). Although application of synthetic fertilizers in developing countries is still very low (Nyamangara, *et al.*, 2019), its use is increasing steadily. The major source of fertilizer sales in developing countries has been urea and DAP since the 1960s, and there has been no change in the composition of the use of fertilizers in developing countries' agriculture until 2014/15 cropping season (IFDC, 2015). In major coffee producing countries in the world, coffee yield increases have been associated with a sharp increase in the use of chemical fertilizers. This has been facilitated by farmers getting trainings from different extension agents, non- governmental organizations (NGOs) and projects funded by governments to provide chemical fertilizers on a subsidy (IFDC, 2015). For example, in Uganda the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) is implementing the Agriculture Cluster Development Project (ACDP) targeting to motivate farmers to adopt use of chemical fertilizers in coffee production in order to enhance coffee yields for the country to meet its coffee production target of 20 million bags by the year 2030 up from the current 6.2 million bags, different soil fertility enhancing technologies are being recommended and advocated for by MAAIF (UCDA, 2022).

Despite different commitments by different NGOs and government agencies on training and encouraging farmers to use chemical fertilizers in coffee enterprises, the adoption has remained low (UCDA 2022). In Ibanda district, the use of chemical fertilizers is still low due to deficits in perception, knowledge and access to chemical fertilizers by farmers. This low level of knowledge and perceptions among farmers may influence them to use inappropriate types and amounts of fertilizer, or apply them in the wrong way or at the wrong time or not to use them at all. There are many reasons for this: the recommendations are wrong; the subsidized fertilizer arrives late; the right type of fertilizers are not available; farmers lack information and skills, or divert the fertilizer to other, less suitable crops (TECHNOSERVE, 2020).

Despite Kikyenkye Sub-County being one of the highest producers of coffee in Ibanda district, farmers still have unstumped coffee trees in their plantations and the rate of adoption of different coffee management practices especially pruning and soil fertility enhancement is still low and this affects both quality and quantity of coffee beans produced by farmers in the area and reduce household incomes (Kikyenkye sub-county production report, 2018). It is factual that under good management, coffee has the potential to yield 1.1–2 kg/tree (UCDA, 2022). In Uganda, coffee production is still low, at 0.55–1.1 kg/tree which is very low. In Kikyenkye Sub-County, the average level of coffee production is 0.8 kg/ tree which is even lower than the national average. To bridge this gap different organizations like Grain Pulse and government programs like ACDP have been promoting the use of chemical fertilizers in coffee production. None the less, the adoption of chemical fertilizers in coffee production in the study area is still unclear. It is from this background that this research was conducted to assess the adoption of chemical fertilizers use in coffee production in Kikyenkye Sub-County, Ibanda District.

1.2 Statement of the problem

Coffee is Uganda's most valuable agricultural export commodity, consistently contributing 20–30 percent of foreign exchange earnings over the past two decades (UCDA, 2018). It is one of the priority crops the government is focusing on to promote its economic growth and agro-industrialization agenda (EPRC, 2018).

Coffee is the major cash crop and income base for the majority of rural farmers in Kikyenkye Sub- County, Ibanda district. In this area, the average level of coffee production at 0.8 kg/ tree is alarmingly low compared to 2 kg/tree coffee production potential under good management. This low production level is attributed to limited time invested by farmers on agronomic practices especially limited efforts to replenish soil fertility. Despite government efforts to

supply farmers with high yielding coffee variety seedlings through Operation Wealth Creation (OWC), the yield per tree is still low and this has limited the country to attain its goal of middle-income status. In spite of the fact that government and other development partners have been promoting the use of chemical fertilizers through distribution at subsidized prices and advocacy, its adoption in coffee production is still very low with less than 10% farmers applying it (UCDA, 2022). Accordingly, the average application rate of chemical fertilizers in the study area is about 17kg ha⁻¹ compared to world average of 137 kg ha⁻¹ per year. In fact, small holder farmers who make the majority of coffee farmers in Kikyenkye sub-county apply limited or no chemical fertilizers at all.

However, little is known about the possible causes for this low adoption due to lack of recent studies on the problem and scanty information available. If the status quo remains, coffee production and household income will continue to deteriorate raising poverty levels and farmers' vulnerability. It is from such basis that this research was conducted to assess farmers' perceptions and attitudes, level of awareness and farm-based factors that determine farmers' choice to use chemical fertilizers in coffee production in Kikyenkye Sub-County, Ibanda district.

1.3 Justification of the study

Sustainable Development Goal (SDG) number 1 focusses on ending poverty in all its forms, everywhere by the year 2030. In rural communities of developing countries like Uganda, this can partly be achieved by empowering farmers to increase their household income through improving agricultural production of the major cash crops they grow. This is only possible when rural farmers embrace yield enhancing technologies including sustainable use of chemical fertilizers (IFDC, 2015; Agbahey, 2015). In Uganda, coffee has been identified as one of the priority crops the country is focusing on to promote its economic growth and agro-industrialization agenda, consequently eradicating abject poverty for majority of rural farmers (EPRC, 2018). In fact, for the country to meet its coffee production target of 20 million bags by the year 2030 up from 6.2 million bags, different soil fertility enhancing technologies were being recommended and advocated for by MAAIF (UCDA, 2022) and among them is use of chemical fertilizers. The study helped to establish coffee farmers' attitudes, perceptions and level of awareness on chemical fertilizers application for enhancing soil fertility and improving coffee yield, and the significant strategies to address identified key challenges. This will help to increase chemical fertilizers use in coffee fields to enhance coffee productivity and

household income thereby mitigating abject poverty and financial vulnerability among coffee growing rural communities.

Constant trainings by different extension workers and other partners conducted about the financial viability, rate and the right combinations of fertilizers to be used in coffee and when such could be applied will play a vital role. The findings got from this study will also help to address mindset change needs of coffee farmers to rightly embrace chemical fertilizers use. Farm based factors which significantly influence farmers' choice to use chemical fertilizers were established. This forms basis for relevant government agencies and projects to address associated challenges.

1.4 Objectives of the study

General Objective

To assess the adoption of chemical fertilizers in coffee production in Kikyenkye Sub-County, Ibanda district.

Specific Objectives

- i. To investigate the perceptions and attitudes of farmers on application of chemical fertilizers in coffee production in Kikyenkye Sub-County, Ibanda District.
- ii. To determine farmers' level of awareness on chemical fertilizers use in coffee production in Kikyenkye Sub-County, Ibanda District.
- iii. To investigate farm-based factors that determine farmers' choice to use chemical fertilizers in coffee production in Kikyenkye Sub-County, Ibanda District.
- iv. To establish the possible strategies for promoting adoption of chemical fertilizers in coffee production in Kikyenkye Sub-County, Ibanda District.

1.5 Research questions

- i. What is the perception and attitude of farmers on application of chemical fertilizers in coffee production in Kikyenkye Sub-County, Ibanda District?
- ii. What is the farmers' level of awareness about chemical fertilizer use in coffee production in Kikyenkye Sub-County, Ibanda District?
- iii. What farm-based factors determine farmers' choice to use chemical fertilizers in coffee production in Kikyenkye Sub-County, Ibanda District.
- iv. What are the possible strategies for promoting adoption of chemical fertilizers in coffee production in Kikyenkye Sub-County, Ibanda District?

1.6 Scope of the study

The scope of the study focused on geographical, content and time scope as mentioned below.

1.6.1 Geographical scope

The study was conducted in Kikyenkye Sub-County, Ibanda district. Ibanda district is located approximately 70 kilometres (43 mi), by road, northwest of Mbarara city in the Ankole sub-region. This is about 290 kilometres (180 mi), by road, southwest of Kampala, the capital of and largest city in Uganda. The coordinates of the town are 0°08'05.0"S, 30°29'42.0"E (Latitude: -0.134712; Longitude: 30.495000) (UBOS, 2014). Ibanda district is bordered by Kitagwenda district to the west, Kamwenge district to the north, Kiruhura district to the east, Mbarara and Buhweju districts to the south, and Rubirizi district to the southwest. Kikyenkye Sub-County is located in Ibanda south constituency. It is bordered by Keihangara Sub-County in the south, Igorora town-council in the west, Bufunda Division in the north and Kazo district in the east. Kikyenkye Sub-County is comprised of 3 parishes namely; Irwaniro parish with 8 villages, Kihani parish with 11 villages and Rwengwe parish with 10 villages making a total of 29 villages.

1.6.2 Content scope

The study focused on assessing the adoption of chemical fertilizers in coffee production Kikyenkye Sub-County, Ibanda District. It was limited to; (i) investigating the perception and attitude of farmers on application of chemical fertilizers in coffee production, (ii) determining the level of awareness of chemical fertilizer use in coffee production, (iii) investigating farm-based factors that determine farmers' choice to use chemical fertilizers in coffee production and, (iv) establishing possible strategies for promoting adoption of chemical fertilizers in coffee production in Kikyenkye Sub-County, Ibanda District.

1.6.3 Time scope

The study covered fifteen-years that is from 2007 to 2022. This was the time when the government was advocating for use of improved technologies, using fertilizers inclusive to boost farmer's production and increase on their incomes in preparation to middle income status.

1.7 Significance of the study

The study findings will help policy makers especially in MAAIF to know what affects the adoption of chemical fertilizers in coffee production not only in Kikyenkye Sub-County but also in many other similar areas in Uganda. This helps to guide allocation of resources to

address critical bottle necks to adoption of chemical fertilizers to achieve increased coffee production and overall poverty alleviation in coffee growing communities.

The study findings will provide literature for future researchers who wish to carry out similar or related studies. The knowledge on coffee farmers' awareness, perceptions and attitudes on chemical fertilizers use in coffee fields was scanty. Hence, the study fills that gap of knowledge.

Civil society organizations will get grounds of intervention in promoting the use of chemical fertilizers to increase coffee production and productivity sustainably in the study area and rural farming communities of Uganda. Civil societies do that through advocacy to raise awareness, input supply support and advocacy for necessary policy changes among others.

The findings will help extension workers to focus their efforts on only salient areas in promotion of chemical fertilizer use for increased coffee production and productivity.

Coffee sector Government agencies for example, Uganda Coffee Development Authority (UCDA) benefit from the study findings by ascertaining areas of intervention in promoting sustainable quality coffee production and productivity as a result of bridging knowledge gaps on adoption of chemical fertilizers.

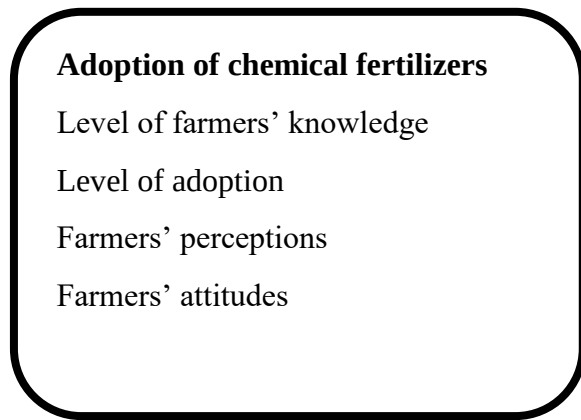
1.8 Conceptual framework

According to Kadigi *et al.*, (2020), increasing chemical fertilizers use is recognized as a key strategy for increasing farm productivity. Therefore, fertilizers are one of the inputs being advocated for by different organizations to ensure farmers increase their production and productivity of their farms. Although use of chemical fertilizers can help farmers to increase production by increasing yield and acreage as well as restoring and rehabilitating neglected coffee fields, their adoption is influenced by different variables which include; knowledge on the application and use of the fertilizer, perceptions and attitudes on the type of the fertilizers, type of crop planted and the financial viability, major goal of the farmer and farming system used by the farmer.

Other factors like farm size and location, price of the fertilizer, education level of the farmer, farmers' experience, age of the farmer, marital status of the farmer could influence farmers' perception and attitude towards chemical fertilizers use. Government policy could also affect the rate of adoption of a technology. For example, poor government policy like lack of fertilizer subsidy policy can limit farmers in adopting use of chemical fertilizers. Also, government may subsidize chemical fertilizer use for commercial crops like tea, coffee and sugarcane compared

to other crops. That would encourage farmers to adopt the use of chemical fertilizers in such crops and vice-versa.

Independent Variables



Dependent variables

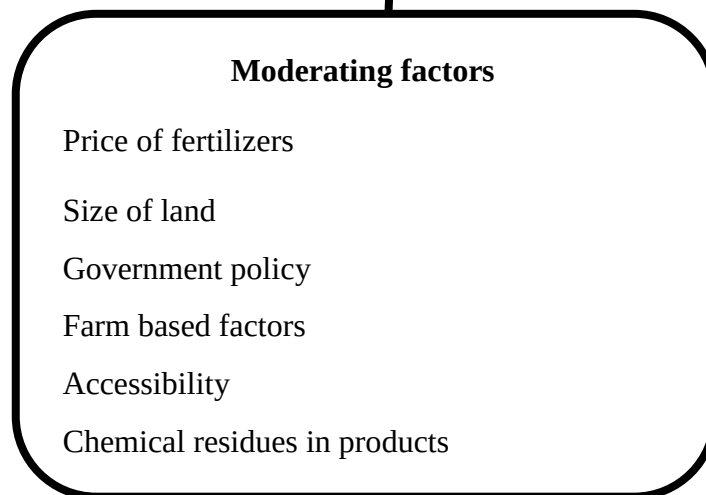
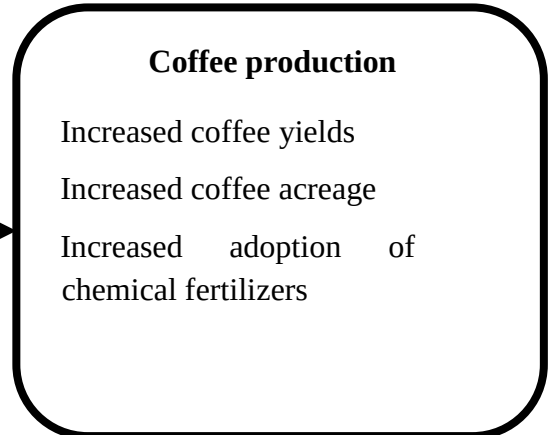


Figure 1.1: Graphic depiction of the study conceptual framework

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter explored literature on studies done by other researchers and publications relevant to the study.

2.1.1 Extension theory

According to Aryal *et al.*, (2018) awareness is an important precondition for adoption to occur. However, in most cases exposure to a technology is not random. Individuals may be exposed to new technologies because they are targeted by researchers or extension workers based on the prejudice of their higher probability of adoption. Individuals may also through their private or self-interests and efforts get exposed to a new technology.

Further the theory assumes that, increased adoption rates would occur if information about the innovation (chemical fertilizers) is communicated through farmers' social networks. That means farmers' awareness of the use of chemical fertilizers would be induced by extension agents using a variety of extension methods. The body of knowledge the individual accumulates about the innovation (chemical fertilizers) is the determination of individual interest/experiment to adopt the innovation at a small portion of his farm.

After experimenting the innovation based on the risk and benefit observed about the new innovation, the individual will confirm the innovation in his farming practice. Thus, farmers' full uptake of chemical fertilizers required building confidence of the farmers about the technologies through the use of a variety of extension methods like farmer-to-farmer extension method and demonstration plot.

Accordingly, the theory emphasizes the central role trainings play in motivating farmers to adopt new technologies and also emphasizes demonstrations, piloting and use of progressive farmers. Coffee farmers need to know the types of chemical fertilizers available for coffee production, the appropriate rates of application, the methods of application, the sources of such fertilizers and their ability to bring about increase in coffee yield as well as profit-advantage and the risks involved. Awareness is very key as it influences farmers' perceptions, attitudes, acceptability and practices as far as adoption of chemical fertilizers in coffee production is concerned. Use of farmers' social networks in dissemination of knowledge about the new technologies is also given emphasis by this extension theory. This means, use of farmers'

groups, and progressive farmers to experiment the feasibility and yield enhancing ability of chemical fertilizers in coffee is key as farmers learn better from fellow farmers. However, the theory is silent about other factors that may take centre stage in influencing acceptability of new farming technologies by farmers. Such include affordability in terms of costs involved, accessibility of the fertilizer and its associated services, comparative advantage of using the chemical fertilizers to other soil fertility enhancing technologies (in terms of marginal output, profitability, efficiency, risks involved and environmental impacts), policy based support for using the technology (for example fertilizer subsidies) and farm-based factors like land fragmentation, field sizes and social-economic status of farmers. All these need to be paid attention to and well explored if farmers are to quickly adopt the use of chemical fertilizers in coffee production.

2.2 The perceptions and attitudes of farmers on application of chemical fertilizers in coffee

Inefficient use of chemical fertilizers in agriculture causes a large number of environmental problems. Some of the problems caused by excessive use of fertilizers can have negative impacts an impact especially on water and soil quality (Aryal *et al.*, 2018). The amount of nitrate may increase in drinking water and rivers as a result of high levels of nitrogen fertilizer use. Further, eutrophication of water bodies may result from phosphorus erosion with soils from farm fields (Chen *et al.*, 2018).

Farmers make decisions based on utility maximization. Farmers' subjective assessments of agricultural technologies are also important in influencing their adoption behaviour (Liu *et al.*, 2016). Level of education is one among the variables that plays a significant role in the development of the cognitive level of farmers about the use of fertilizers (Hameed and Sawicka, 2017). It is very important to educate farmers about the vital importance of fertilization, which is based on adequate soil analysis (Chen *et al.*, 2018).

Fertilizer utilization is highly dependent on prevailing fertilizer prices (Chen *et al.*, 2018). In Kenya, fertilizer prices witnessed period of general increasing prices between 2007 and 2011. According to Takeshima *et al.*, (2016), the price increases were influenced by several global factors including increased fertilizer demand due to higher food prices and increased use in biofuel production. Moreover, supply was affected by increasing energy costs (which are particularly important in producing nitrogenous fertilizers), the introduction of export tariffs

on some fertilizers (for example by China in April 2008), and capacity limits in expanding production to meet rising demand – particularly for phosphate rock.

Many farmers in South Africa are unaware of scientifically recommended rates of fertilizer application. Rather, they apply fertilizers when and where they believe them to be necessary, often in quantities and with elements based on what are available and affordable at markets (Kishore *et al.*, 2019). Further, recommendations for fertilizer rates tend to be based upon small-plot crop yield response data that are extrapolated over large geographic areas without considering spatial variability in the nutrient supplying capacity of the soils and temporal variability due to management factors (Ladha *et al.*, 2020)

Heavy subsidies for N fertilizer relative to other nutrients, and the lack of adequate knowledge on fertilizer management have resulted in unbalanced fertilizer application (Kishore *et al.*, 2019). Inappropriate and unbalanced nutrient addition not only reduces Nutrient Use Efficiency (NUE) and profitability (Kishore *et al.*, 2019), but also increases environmental risks associated with the loss of unused nutrients through emissions, leaching and surface run-off among other processes (Sapkota *et al.*, 2014).

Opportunities exist to improve (NUE) through the adoption of better fertilizer management practices such as adjusting application rates based on a more precise estimate of plant demand, using the right form of fertilizer, and using the right method to apply fertilizer so that it is delivered directly to the root zone (Aryal *et al.*, 2018).

Realization of the benefits of improved fertilizer and organic matter management depends on the extent to which farmers are aware of and able to implement new appropriate agronomic management techniques. Farmers' use of different management practices is difficult to predict and depends largely on the socio-economic and cultural context under which they operate (Sapkota *et al.*, 2018). Understanding farmer behavior towards use of inorganic and organic fertilizers is crucial because improving NUE for N can substantially lower the carbon footprints of agriculture (Liu *et al.*, 2016).

2.3 The level of awareness of chemical fertilizers use in coffee production

Fertilizer is not only scarce but also information related to its use and the potential increases in productivity that it could bring about are unknown, thereby reducing the incentive for its use by farmers (De Silva *et al.*, 2020). Alongside this, there is limited information on the profitability of the different soil-crop-fertilizer combinations that could be employed in the different parts of the country. Different crops on different soil types respond differently to different types of fertilizer (Sapkota *et al.*, 2018). It would be worthwhile to carry out a thorough fertilizer profitability analysis for the whole country to establish the responsiveness of the major crops grown to the application of different plant nutrients – nitrogen, phosphorus, potassium, and selected micronutrients (Sapkota *et al.*, 2018).

The use of inorganic fertilizer has increased because of increased cropping intensity with high yielding varieties. Widespread and intensive use of inorganic fertilizer is common in vegetable cultivation (Padmajani *et al.*, 2014). The chemical fertilizer application rate has ranged from zero to 830% of the recommended level in different cropping systems in Sri Lanka (Silva *et al.*, 2020). Sri Lanka imports about 800 million kg of chemical fertilizers annually (Swarnathilake *et al.*, 2022). Many argue that farmers use excessive chemical fertilizer, well above the recommended levels, as they receive the products at considerably subsidized rates (Swarnathilake *et al.*, 2022).

Farmer attitudes and perceptions towards fertilizer quality have led to an increase in the use of fertilizer in cropping fields. Most farmers who overuse chemicals believe that those chemicals in the market are of low quality (Fasina, 2013). Despite best management practices recommended by the research institutions, indiscriminate use of chemical fertilizers and low use efficiencies of fertilizers under tropical conditions, have increased environmental pollution, negatively affecting human and ecosystem health, and creating social and political unrest in the country (Jayasingha *et al.*, 2013). Agronomic practices adopted by farmers further degrade soil fertility threatening the food security in many developing countries (Jayasingha *et al.*, 2013).

Farmers often tend to apply excessive amounts of nitrogen fertilizers, while further increments are applied during the rainy season to compensate for losses due to leaching (Jayasingha *et al.*, 2013). The retention of Nitrogen (N), which is essential for plant growth, is influenced by a variety of factors including soil constituents, irrigation practices and the fertilizer application in terms of type and the quantity (De Silva *et al.*, 2020). Retention of N in the sandy soil is

restricted due to poor contents of organic matter, clay, and silt fractions. Such continuous and rigorous application of agrochemicals and over-extraction of groundwater has led to significant levels of nitrate and other agro-chemical contamination of groundwater, similar to many other countries such as China and Australia (De Silva *et al.*, 2020).

According to Wu *et al.*, (2018) there are different technologies to mitigate the extensive use of fertilizer in cropping fields. However, farmer's fertilizer application behavior, attitudes, and awareness are lacking due to limited access to information about the use of chemical fertilizers. Therefore, Fertilizer application depends on several factors including, knowledge and training (Huang *et al.*, 2015), off-farm employment, characteristics of the supply chain (Hasler *et al.*, 2016), and characteristics of the farmers (Wu *et al.*, 2018).

2.4 Farm- based factors that determine farmers' choice to use chemical fertilizers in coffee production

Secure land tenure has been widely demonstrated to play a critical role in influencing farmers' willingness to invest in soil conservation practices (Teklewold *et al.*, 2013). Empirical studies on land tenure security in relation to investment and productivity argue that the positive relation between secure land tenure and investment is based on three key factors: assurance, collateralization and reliability effects (Teshome *et al.*, 2014).

In relation to land management, it is argued that 'assurance effect' of secure land tenure provides a guarantee to farmers to invest in both short and long-term soil management practices (Grimm and Klasen, 2014) because it eliminates threats of appropriation (Bwambale, 2015). The 'collateralization effect' predicts how land can be used as collateral thus facilitating access to financial services (loans) for investment in agriculture (Grimm and Klasen, 2014).

Land is often used as a proxy for wealth in the technology adoption literature; however, this variable can have an ambiguous effect on adoption. Teshome *et al.*, (2014) suggest that small farms may be willing to adopt a technology to increase short-run profits, but financial constraints may impede such adoption. Households with larger farms are assumed to have easier access to credit and farm inputs and thus be more likely to be adopters. Moreover, extension services and agribusiness firms tend to target larger farms for trials of new agricultural technologies (Grimm and Klasen, 2014). Nevertheless, according to Teshome *et al.*, (2014), smaller farms may be more likely to cooperate in trials and to accept the risks and costs associated with experimentation. Hence, small-scale producers would be more inclined to adopt improved practices and to intensify their operation.

It is reported that female headed households are more constrained to access agricultural credit to fund production innovations that improve agricultural production than male headed households because they lack control over economic resources and the nature of their economic activity (Katungi *et al.*, 2017). Therefore, it is hypothesized that female headed households are more constrained to access agricultural credit than their male headed counterparts.

The geographical location of the farm determines the land potential and thus the expected returns from a given technology (Grimm and Klasen, 2014). Prevailing agro-ecological conditions capture the potential risk of crop failure associated with rainfall dependency and soil quality, which affects adoption decisions. Researchers have shown that households located in zones where rainfall is low and erratic are less likely to use fertilizers than those in zones with more reliable rainfall (Grimm and Klasen, 2014).

Some researchers suggest that higher income increases household liquidity, making it possible to allocate more resources to improved technologies. Thus, the availability of off-farm income can offset credit constraints while enhancing the capacity to bear risk (Nambiro and Okoth, 2013). By contrast, households with limited income or credit are likely to be capital constrained and less able to adopt riskier technologies (Svensson, 2013). Plot distance can have its own impact on the likelihood of fertilizer adoption & the level of fertilizer use. For instance, Mbowa *et al.*, (2015) stated that there was a tendency that more distant plots (further away from their homesteads) received less fertilizer.

According to Mbowa *et al.*, (2015) land fragmentation is an indicator of productive inefficiency. On the other hand, opponents of land consolidation programs note the benefits of fragmented land holding to reduce risks and encouraging more diversified production. It has been suggested that fragmented land holdings allow producers to be more adaptive to certain circumstances but may be more non-adaptive to factor prices and technology changes (Mbowa *et al.*, 2015). In the end, the issue of whether or not land fragmentation negatively affects agricultural productivity is an empirical one (ibid). In relation to measurement of land fragmentation, many have been used the number of plots, which indeed reflects land fragmentation to a certain extent, but cannot capture the variation in average plot areas (Grimm and Klasen, 2014).

2.5 Possible strategies of promoting adoption of chemical fertilizers in coffee production

Fertilizers are usually distributed through small familial agricultural shops located throughout the country (Salin-Maradeix, 2015). But supplying these shops with a consistent quantity of quality fertilizer is sometimes difficult because of losses due to packaging damage in transporting or humidity when storing the product (Salin-Maradeix, 2015). As a result, the quality of the product varies and so does its price. To improve the accessibility to fertilizers, the government has implemented fertilizer subsidy programs in which the government pays for part of the selling price where it pays for a part of the price to the supplier and offers a product more affordable for smallholder producers (Salin-Maradeix, 2015).

The constraints identified in regard to market suggest a need to determine expectations from the demand side of the market as to allow the supply side to deliver according to these demands. Additionally, there is an identified need for increased interaction between various stakeholders in the value chain, including cross level interaction. Unfortunately, solutions identified during the multi-stakeholder workshop did not cover any of these, providing evidence that fertilizer adoption is addressed as a single issue rather than a problematic affected by and affecting the entire value chain (Svensson, 2013).

Similar to the costs constraint is access to quality, whose focus is again on hard institutional interventions through standardization and enforcement. This goes against calls from Benson *et al.*, (2013) who call for a lighter fertilizer regulation regime as to allow larger fertilizer volumes to enter Uganda which make these more accessible in terms of availability and price. Nevertheless, that beyond farm-level actors identify fake and low-quality fertilizer as problematic does not come as a surprise, nor do the identified solutions. In fact, these are in line with the current trend, where fake inputs receive considerable attention in both media and at political level (Mbowa *et al.*, 2015). However, little evidence exists for significant quantities of fake inputs sold on the Ugandan market.

According to Dossou-Yovo *et al.*, (2017) lack of innovation capacity at farm-level is closely related to reasons for infrastructural failure, e.g. disease, theft, shortage of labour, lack of capital. This gives a more omnifarious situation than the one identified among higher level actors, who focus on cost of fertilizer and presence of fake or low-quality inputs only (Dossou-Yovo *et al.*, 2017). The majority of farmers take action themselves to increase their capacity to innovate, often by selling some produce after harvesting in order to obtain the financial capital needed, or by accessing credit for example through saving groups (Lemma *et al.*, 2014). Unfortunately selling seeds or ware remains a mere emergency action, taking place when

access to sufficient funds is lacking and come with low returns for sold ware or seeds, hence does not provide a lasting solution. Therefore, there is a need for enhanced farmer capacity to access credit (Benson, 2013).

2.6 Summary of literature review

Farmers' adoption of chemical fertilizers in coffee production is influenced by a variety of factors, including socio-economic, institutional, and agronomic factors. Socio-economic factors such as access to credit, farm size, and education level have been found to be important predictors of fertilizer adoption (Lemma *et al.*, 2014). Institutional factors such as extension services, government subsidies, and market access also play a significant role in farmers' decision to adopt chemical fertilizers (Dossou-Yovo *et al.*, 2017). Agronomic factors such as soil fertility, coffee variety, and rainfall also influence the use of chemical fertilizers (Jaramillo *et al.*, 2013; Mosquera-Losada *et al.*, 2017).

The impact of chemical fertilizers adoption on coffee productivity and quality is mixed. While some studies have found that the use of chemical fertilizers can increase coffee yield (Jaramillo *et al.*, 2013; Lemma *et al.*, 2014), others have reported no significant impact on yield (Dossou-Yovo *et al.*, 2017). In terms of quality, some studies have reported that the use of chemical fertilizers can negatively impact coffee flavor and aroma (Schmitt *et al.*, 2015; Mosquera-Losada *et al.*, 2017).

Despite the large body of literature on chemical fertilizer adoption in coffee production, there are still several research gaps. Firstly, there is a need for more studies that examine the long-term impact of chemical fertilizer use on soil health and fertility. Secondly, there is a need for more research on the impact of chemical fertilizers on coffee cup quality, particularly in different growing regions and under different production systems. Finally, there is a need for more research that examines the factors that influence farmers' decision to use or not use organic fertilizers as an alternative to chemical fertilizers

However, no recent studies have been made to establish farmers' awareness, perceptions and attitudes on chemical fertilizer use in coffee production as a yield enhancing technology as well as the influence of farm characteristics and challenges on its adoption. There exists a scholarly knowledge gap in this field. This knowledge gap needs to be bridged if the potential of coffee production sector is to be fully exploited to boost household income of coffee farmers as well as raising coffee export earnings for Uganda as one of the leading coffee producing countries in Africa. This is because farmers' awareness, perceptions and attitudes on same

technologies may differ with different crops. In an effort to develop full potential of coffee production sector through promotion of chemical fertilizer use, there is dire need to bridge this existing knowledge gap that this study sought to bridge

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Area of the study

The study was conducted in Kikyenkye Sub-County Ibanda District. Ibanda is located approximately 70 kilometres (43 mi), by road, northwest of Mbarara, the largest city in the Ankole sub-region. This is about 290 kilometres (180 mi), by road, southwest of Kampala, the capital of and largest city in Uganda. The coordinates of the town are 0°08'05.0"S, 30°29'42.0"E (Latitude: -0.134712; Longitude: 30.495000). Ibanda District is bordered by Kitagwenda district to the west, Kamwenge District to the north, Kiruhura District to the east, Mbarara and Buhweju District to the south, and Rubirizi District to the southwest. Kikyenkye sub-county is located in Ibanda south constituency. It is bordered by Keihangara Sub- County in the south, Igorora town-council in the west, Bufunda Division in the north and Kazo district in the east. Kikyenkye Sub-County is comprised of 3 parishes namely; Irwaniro parish with 8 villages, Kihani parish with 11 villages and Rwengwe parish with 10 villages making a total of 29 villages. This study area was selected because; it is one of the leading coffee producing sub-counties in the district, it is densely populated with high poverty levels and although the majority populations depend on coffee for income, its productivity per acre is comparatively lower.

3.2 Research Design

The study took across-sectional survey design and was descriptive research that assessed the adoption of chemical fertilizers in coffee production in Kikyenkye Sub-County, Ibanda district. It collected both quantitative and qualitative data.

3.3 Target Population

There are approximately 13,000 people in Kikyenkye Sub-County (UBOS, 2015) with estimated 3,250 households. According to Kikyenkye Sub- County production records, at least 2564 households grew coffee as a source of household income (Kikyenkye sub-county production report 2018). It is from this coffee growing household population that the sample size of 124 coffee farmers was obtained to represent the population using Yammane (1967) formula. The sample included coffee farmers, local leaders' extension workers and input sellers.

3.4 Sample size

The sample size of the study was 151 respondents. These included 124 coffee farmers, 15 leaders of local councils, 10 input sellers and 2 agricultural extension staff members

Computation of the sample size

The sample size of 124 coffee farmers was determined using Yamane formula (Yamane, 1967) from the population of 2,564 coffee growing Households in Kikyenkye Sub-County. Details of the respondent's category is shown in table 1 below.

Table 3.1: Respondent categories, sampling methods and data collection tools

Coffee Farmers	124	Questionnaire	Random sampling
Extension workers	2	Interview	Purposive sampling
Local council leaders	15	Interview	Purposive sampling
Input sellers	10	Interview	Purposive sampling
Total	151		

3.5. Sampling techniques

Both purposive and random sampling techniques were used to obtain the respondents. Random sampling was applied in selecting coffee farmers because research findings from the application of simple random sampling would be generalized. Simple random sampling was used on coffee farmers because the target population was big and all members had more less similar characteristics. Names of all coffee farmers per village were written on pieces of paper, folded and put in a basin. Each name was picked at a time after shaking (balloting) until 124 coffee farmers were obtained from all 29 villages. Each of the coffee farmers had an equal opportunity for being selected. On the other hand, purposive sampling was used to select local leaders, input sellers and agricultural extension workers. They were selected because of their

positions and roles of disseminating information concerning the adoption of different agricultural technologies including chemical fertilizers.

3.6 Sources of data

Data was collected from both primary and secondary sources as listed below;

3.6.1 Primary data

According to Galvan (2013), the term primary source is used broadly to embody all sources that are original. Primary sources provide first-hand information that is closest to the object of study. Primary data is the unprocessed information that is gathered from the field (during process of interviewing and questioning the respondents). Primary data was collected from coffee farmers, local council leaders and sub-county agriculture extension workers. Primary data provided reliable and accurate first-hand information relevant to the study.

3.6.2 Secondary data

According to Galvan (2013), a secondary source is a source that provides non-original or second-hand data or information. Secondary data was obtained from the published and documented sources that aided in providing answers to the research problem and included: documents comprising research works, textbooks, magazines, journals, newspapers, Agricultural office records/statistics and on-line information.

3.7 Data Collection Methods

Two methods of collecting data namely questionnaire and interviews were used.

3.7.1 Questionnaire survey method

Questionnaires was researcher-administered to coffee farmers who directly participated in coffee production (Appendix i). A questionnaire had structured and semi-structured questions in order to capture both qualitative and quantitative responses from farmers. The interviews were conducted in the local language that was well understood by farmers.

3.7.2 Interview Method

Face-to-face interview was used widely to get knowledge about individual(s) thoughts, feelings and behaviors. Interviewing was done with the help of an interview guide (Appendix ii). This was used to capture data from key informants/technocrats that included the local council leaders, input sellers and extension workers because much detailed information was needed from this category to explain what was observed on-farm. While interviewing, probing was used in case inadequate answers were given to the questions which were largely open ended though some closed ended questions were also used in the interviews.

3.7.3 Focus Group Discussions.

These were used with local government leaders and agro-input sellers as part of the key informants. The same structured guide (appendix ii) was used to guide discussions focusing on adoption of chemical fertilizers in coffee production in the study area. Data collected through this method is presented as qualitative data to give deeper insights on the study findings.

3.8 Data Quality Control

According to Galvan (2013), quality control refers to the efforts and procedures that survey researchers put in place to ensure the quality and accuracy of data being collected using the methodologies chosen for a particular study. To ensure high data quality, precautionary measures were taken at various stages of the study. Prior to the survey, a questionnaire pre-test was conducted to ensure that the questionnaire was clear, precise and exhaustive. After the pre-test, some questions were edited and some more information added for clarity. Simple random sampling was used in selecting respondents. Furthermore, well-trained research assistants were used in data collection. To ensure accuracy and efficiency, face to face interviews were also conducted and the questions were asked in the local language which farmers understood best. Data cleaning was done shortly after it was collected to iron out any errors or inconsistencies. Each questionnaire was labeled so as to trace responses from participants and to record responses effectively. Data was then carefully entered and analyzed. Data which was obtained through key informants' interviews was captured using tape recorders to ensure that no valuable information was lost and this data was then transcribed, analyzed and reported. Validity and reliability tests were used as major quality control measures.

3.8.1 Validity of Instruments

In order to ensure the validity and reliability of the content of the questionnaires, the questionnaire was reviewed by the supervisor. The questionnaire was piloted with five respondents to test their validity and reliability. The following processes for ensuring validity and reliability, legitimizing the data, and finally lending credibility to the research report were used for this study.

3.8.2 Reliability of Instruments

According to Creswell (2014), reliability refers to the consistency, stability and repeatability of results. Reliability of this study's instruments was ascertained by pre-testing and re-testing the questionnaires and interview guides in the field. Because reliability is consistency of measurement over time or stability of measurement over a variety of conditions, the most

commonly used technique to estimate reliability is with a measure of association. The reliability of the questionnaire was done by pre-testing and retesting it with the same group of respondents from different settings.

3.9 Data analysis

Data from the study was analyzed in order to present the findings as information. This was done using both qualitative and quantitative approaches.

3.9.1 Qualitative data analysis

The qualitative data was collected through questionnaires and interviewing key informants. Data was coded and analyzed. After the field, responses were arranged basing on the study objectives and this was basically done to search for the relationship between various codes. To avoid bias, the collected data was analyzed by cross checking questionnaire codes to have accurate results. Qualitative data was analyzed by thematic content analysis using Nvivo version (9.5) where the responses from respondents were recorded, conceptualized and segmented basing on the study objectives. Qualitative data was analyzed using thematic analysis.

3.9.2 Quantitative data analysis

Data was analyzed using SPSS version 26.0. The responses were categorized under sub-headings and respondents' views analyzed under themes by tallying the responses from the questionnaires. Simple descriptive statistics like frequencies and percentages were generated using tabulation method. The information that was acquired from the respondents' reactions reflected the objectives and research questions.

One way ANOVA was conducted to establish the relationship between use of chemical fertilizers and time spent (farmers' experience) in coffee growing. Coefficients were obtained through binary regression of variables on farmers' perceptions and attitudes on use of chemical fertilizers in coffee fields and farm based factors that determine farmers' choice to use chemical fertilizers in coffee fields.

3.10 Empirical model specification

The study used Multiple Regression model (Samoilikova et al., 2023) since there was more than one independent variable and one dependent variable. The model applied to the study is suitable for the assessment of the relationships between variables in social sciences. The specific model applied is highlighted below:

$$Y = \beta_0 + \beta_1x_1 + \beta_2x_2 + \beta_3x_3 + \beta_4x_4 + \beta_5x_5 + \beta_6x_6 + \epsilon$$

Where: Y is the dependent variable; coffee yields, β_0 is the constant β_1 , β_2 , β_3 , and β_4 are the regression coefficients for the variables under chemical fertilizers and coffee production respectively. X is the independent variable (chemical fertilizers) x_1 , x_2 , x_3 , x_4

Table 3.2: Operationalization of variables

Variable	Variable type	Indicators	Mode of analysis
perceptions and attitudes of farmers	Categorical variable	1. Chemical fertilizers use ensure high productivity. 2. Chemical fertilizers are not suitable for use in coffee 3. Chemical fertilizers use alter the soil properties 4. Fertilizers use is influenced by agro-climatic characteristics	Binary regression
Farmers' level of awareness	Categorical variable	1. Method of application 2. Type of fertilizers used 3. Who provided training services 4. Source of chemical fertilizers	Frequencies and percentages
Farm based factors affecting decision to use chemical fertilizers	Categorical variable	1. Coffee-banana inter-planting 2. Small plot of land 3. Land ownership rights 4. Distance to the land 5. Land fragmentation 6. Farm location	Binary regression
Strategies for promoting adoption of chemical fertilizers	Categorical variable	1. Stabilizing coffee and chemical fertilizer prices in the market 2. Provision of Fertilizer subsidies 3. Constant training services 4. Public-private partnership fertilizer provision 5. Knowledge of coffee yield response to chemical fertilizers	Binary regression

3.11 Ethical considerations

In compliance with the rules and regulations of the university with regard to conducting research using human subjects, the following ethical considerations were taken into account during the course of the research. These considerations were applied to both the quantitative and qualitative research sections of this study.

Written permission from the Faculty of Agriculture, Environmental Sciences and Technology of Bishop Stuart University was obtained to conduct this research, in order to ensure that it was a legal exercise.

Confidentiality refers to handling the information concerning the respondents in a confidential manner. Respondents' codes were used instead of their names to observe strict confidence. This aspect included the principle of trust developed with the respondents during the entire period of conducting the interviews.

The principle of voluntary participation was explained to the respondents and they were also be informed of their right to withdraw from the study at any time. The principle of informed consent was verbally explained to the interviewees and was included on the questionnaire. Both principles were made clear in the research process and its purposes to the participants.

The research proposal was submitted to the University's Research Ethics Committee for clearance before data collection was done. The guidelines in accordance with ethics while conducting research were followed.

3.12 Research procedure

After successfully presenting the research proposal and obtaining ethical clearance from BSU REC, an introductory letter was obtained which was presented to the authorities of Kikyenkye Sub-County, Ibanda District. Thereafter, data collection commenced by administering the questionnaires and interviewing the respondents. In the administration of the questionnaire and interview schedules, an informed consent from respondents guided by informed consent forms was done. This approach enabled mutual understanding of the purpose of the study with the respondents. The questionnaires and interviews were administered at the places of the various respondents. During the survey, the questionnaire content was explained to the interviewee and responses recorded.

3.13 Limitations to the research study

A number of challenges were met during the course of the research study and these included; (i) Inadequate financial resources to meet respondents expectations, (ii) High transport and stationery costs and (iii) Locating sampled respondents.

CHAPTER FOUR

PRESENTATION AND INTERPRETATION RESEARCH FINDINGS

4.1 Demographic characteristics of respondents

Characteristics like age, gender, family size and education level of the household heads are important proxy indicators for individual behaviors and are commonly used as explanatory variables for adoption decisions. Data collected on various characteristics are presented in figures below.

4.1.1 Gender of respondents

The proportion of respondents by gender is as indicated in figure 4.1 below.

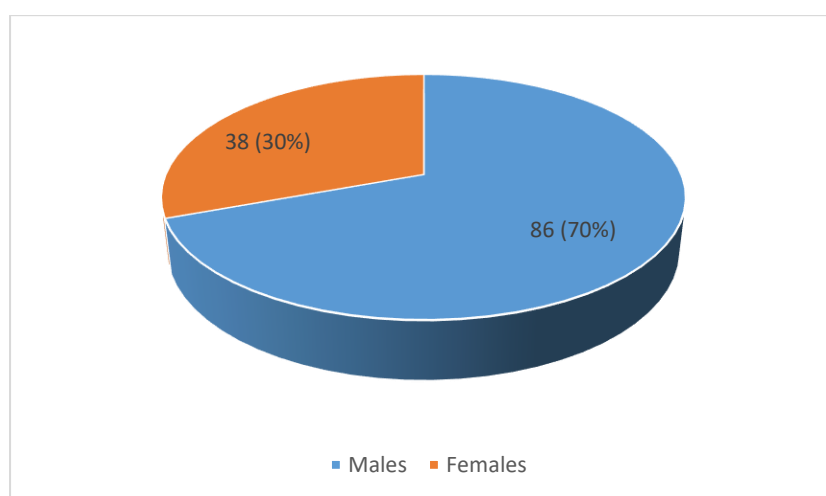


Figure 4.1: Distribution of respondents by gender interviewed

Source: Primary data, 2023

The study results revealed that majority of respondents 70% were males compared to females who constituted 30%. There was an observed difference between participants by gender where male dominated the study. This implied that coffee production is dominated by men. While as males take ownership of coffee projects, it was found out that females do bulk of coffee fields' management activities. One of the local leaders reported that since females are mostly engaged in coffee plantation management activities and yet do not have financial decision, it's not easy to adopt innovative technologies like use of chemical fertilizers, one of the reasons why it is not commonly used in coffee.

4.1.2 Age of respondents

Distribution of respondents by ages is as indicated in Figure 4.2 below.

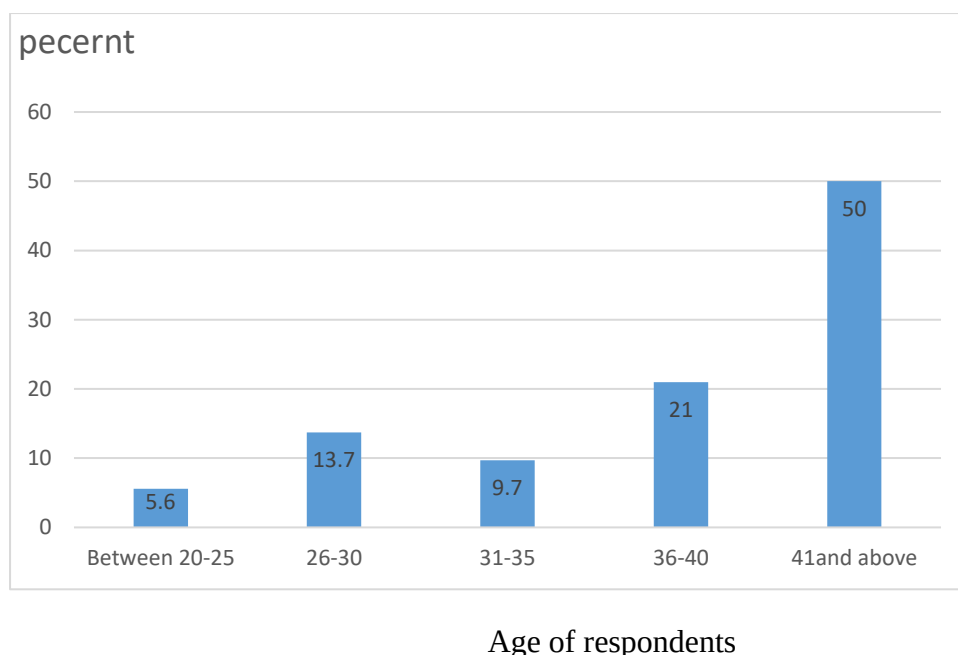


Figure 4. 2: Variations of respondents by age.

Source: Primary data, 2023

The majority of the respondents (50%) were aged 40 years and above, followed by those of age category between 36-40 years. The youngest were aged between 20-25 years of age. The dominance of aged respondents implied that the adoption of chemical fertilizer use on coffee production needed those who had spent long period of time in coffee production. Coffee production required some reasonable investment for example buying land. It was therefore associated with people with increasing family responsibility who were the elders in the community. It was discovered that these farmers of advanced age are usually conservative in their agricultural practices and do not take up new innovations so easily. One of the extension workers had this to say; *“Most coffee farmers are old people who find it difficult to take up new innovations for fear of the unknown. They are comfortable using the traditional practices they are used to hence low adoption of chemical fertilizers in coffee production in this area....”*

4.1.3 Education level

Majority of the respondents (47.6%) had attained primary level (Figure 4.3) followed by those that had secondary (32.3%) and (13.7%) tertiary education. Only 6.5% of respondents had no formal education. The level of education of the farmer indicated the degree at which a farmer could understand and adopt or reject a technology. The majority of coffee farmers had primary education and below. One of the local leaders had this to say; *“Many coffee farmers here are less educated. They are not modern farmers, they are local. They do not quickly adopt technologies they don’t understand. They perceive them as practices of the learned....”*

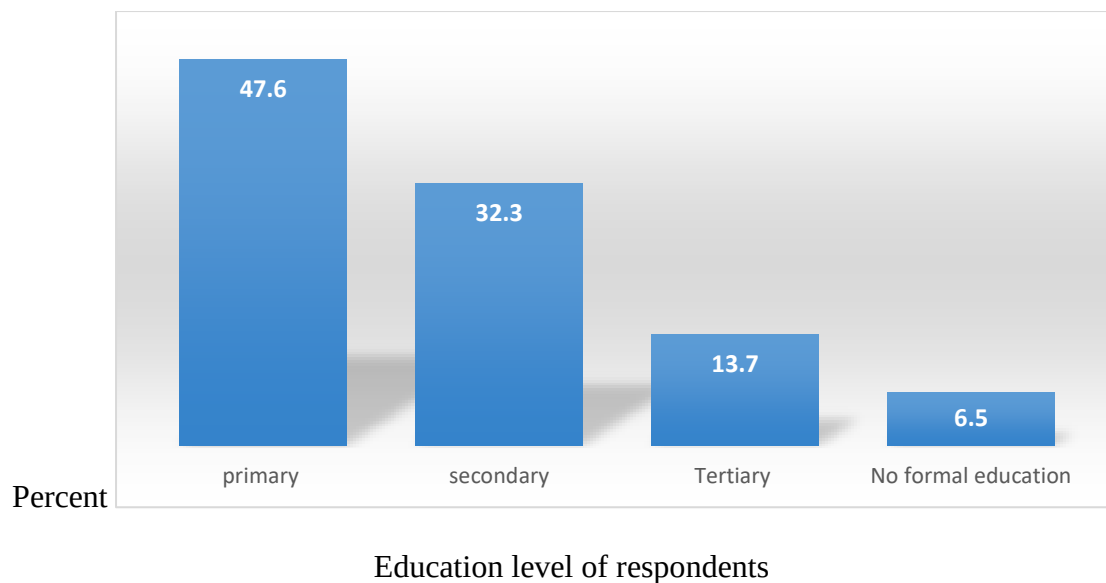


Figure 4. 3: Variation of the education levels of respondents.

Source: Primary data, 2023

4.1.4 Marital status

Respondents during survey were also asked to mention their marital status, responses were also captured and indicated in the Figure 4.4 below;

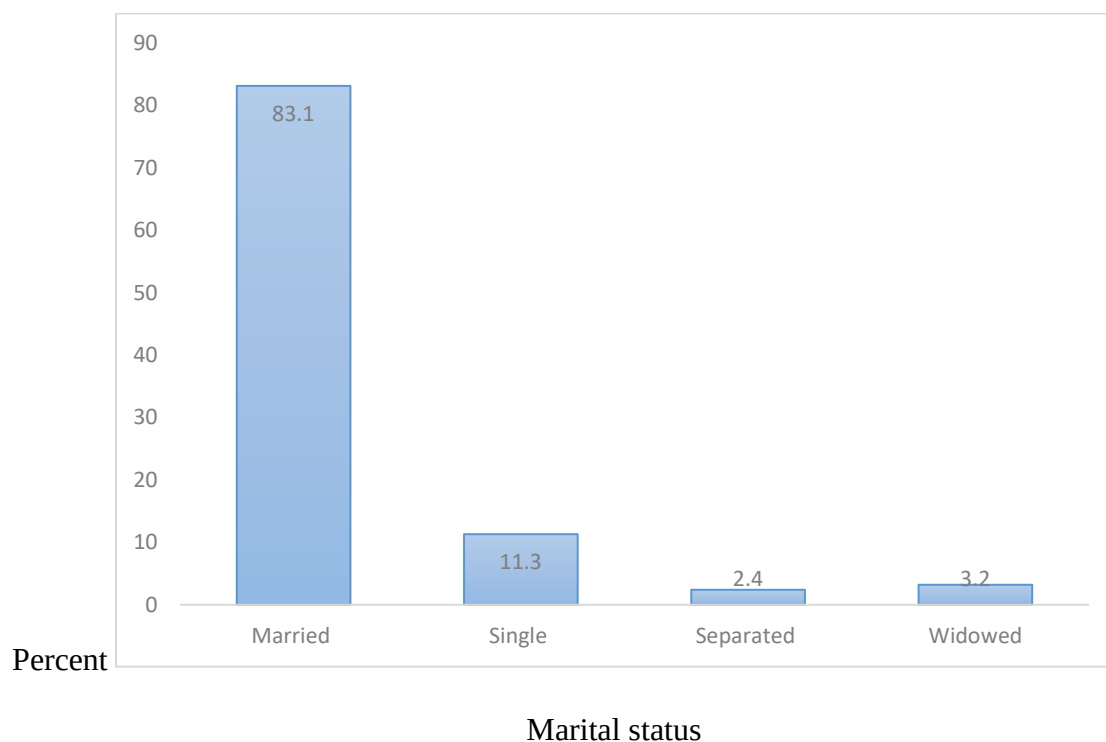


Figure 4. 4: Variation of marital status of the respondents.

Source: Primary data, 2023

The study findings indicated that 11.3% of the respondents were single, 83.1% were married, 3.2% were widowed and 2.4% had separated (Figure 4.4). The majority coffee farmers were married which implied that they had engaged in coffee growing to meet their family needs and basic social services.

4.2 Perceptions and attitudes of farmers on application of chemical fertilizers

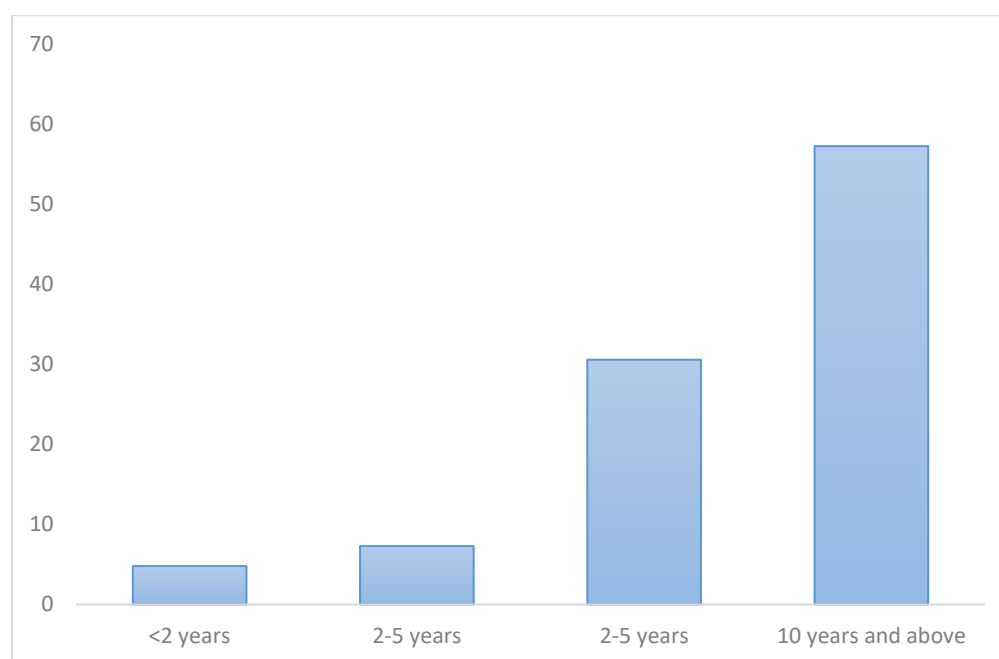
Coffee farmers had different perceptions and attitudes on the application of chemical fertilizers in their coffee plantations, and this depended on the level of training, farmers experience as well as accessibility and availability of such fertilizers in different agro-input shops.

4.2.1 Farmers' experience in growing coffee

The time spent while growing coffee determines the experience of the farmer in using different management practices in their coffee plantations. Majority of farmers (57.3%) had spent 10 years and above growing coffee (Figure 4.5).

Figure 4. 5 Farmers' experience in growing coffee

Percent



Time spent while growing coffee

Source: Primary data, 2023

Farmers with limited experience in coffee production were only 4.8%. Distribution of farmers with either 2-5 and 6-9 years of experience in coffee production was 7.3% and 30.6% respectively. This implied that farmers with more years in coffee production would quickly adopt the use of chemical fertilizers. However, the low adoption in this respect was found to

be conservativeness versus experience. One of the extension worker during interview had this to say; *“The more the years farmers take using their traditional practices in production, the more they cling to them, so for coffee farmers who have taken long in production find it risky to adopt new technologies they are not used to hence low adoption of chemical fertilizers in coffee....”*

4.2.2 Number of farmers using chemical fertilizers in coffee production

Due to continued soil fertility loss in the coffee fields, chemical fertilizers have been advocated to be used. Some of the chemical fertilizers recommended for use in coffee production include NPK, DAP, CAN, Urea and SSP depending on soil conditions (limiting nutrients for coffee production in that soil).

Table 3.1: Number of farmers using chemical fertilizers in coffee

Number of farmers using chemical fertilizers in coffee	Frequency	Percent(n=124)
Yes	22	17.7
No	102	82.3
Total	124	100.0

Source: Primary data, 2023

It was observed that only 17.7% of farmers had ever used chemical fertilizers in coffee production (Table 4.1). On the other hand, the majority of farmers (82.3%) had never used chemical fertilizers in coffee fields. This indicated a low adoption of chemical fertilizer application for coffee production. One of the local leaders in one of the focus group discussions reported that chemical fertilizer use in coffee fields was not a common practice citing a range of factors such as high cost, lack of good knowledge about their use and small coffee fields among others.

When an R-square was performed on coffee growing and variables of coffee farmers' perceptions and attitudes on use of chemical fertilizers in coffee fields, an R-squared of 12.6 % was obtained. This implied that the simple linear model with farmers' perception and attitude

on the use of chemical fertilizers in coffee plantations as the independent variable explained 7.3% of the variations in farmers using chemical fertilizers in coffee production (Table 4.2).

Table 4.2: Model Summary for the relationship between growing coffee and Perceptions and attitudes of farmers on application of chemical fertilizers

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.355 ^a	.126	.073	.79481	.629

Source: Primary data, 2023

When farmers' experience in growing coffee (time spent) was regressed with farmers using chemical fertilizers in coffee using one way ANOVA, a p-value of less than 0.05 ($p = 0.026$) was obtained. This implied that the use of chemical fertilizers in coffee production was significantly influenced by the time spent while growing coffee (experience) but this would be achieved effectively when farmers access information on the availability and accessibility of such fertilizers in the locality (Table 4.3).

Table 4.3: ANOVA for the relationship between growing coffee and Perceptions and attitudes of farmers on application of chemical fertilizers

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	10.559	7	1.508	2.388	.026 ^b
	Residual	73.280	116	.632		
	Total	83.839	123			

Respondents had a positive attitude and perception that chemical fertilizer use ensured high productivity and yields of coffee (Table 4.4). Chemical fertilizers were basically used in commercial crops like tea and coffee and that the decisions on chemical fertilizers use were significantly based on access to information and market prices ($p < 0.05$). However, negative perceptions and attitudes of respondents on the use of chemical fertilizers on premises that; chemical fertilizers applied in coffee did not provide optimal economic returns to farmers, fertilizers use was influenced by agro-climatic and farm characteristics, chemical fertilizers

were not suitable for use in coffee and that chemical fertilizers use altered the soil properties (both physical and chemical) were not significant ($p>0.05$)

One of the local leaders in an interview had this to say; “*The majority of coffee farmers have a positive perception about the possible benefits of using chemical fertilizers although they are not practically using them in their coffee fields. They seem to think that they may require special skills to select and use them. They may be lacking comprehensive knowledge about using these fertilizers although their attitude is positive.....*”

Table 4.4: Coefficient for the relationship between coffee growing and Perceptions and attitudes of farmers on application of chemical fertilizers

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	.743	.800		.929	.355
Chemical fertilizers are basically used in high commercial crops like tea and coffee	.197	.083	.225	2.387	.019
Chemical fertilizers use ensure high productivity and yields of coffee	.500	.444	.215	1.125	.003
Chemical fertilizers applied to in coffee do not provide optimal economic returns to farmers	-.071	.425	-.034	-.168	.867
The decisions on chemical fertilizers use are based on access to information and market prices (cost).	.241	.133	.160	1.814	.009
Fertilizers use is influenced by agro-	.071	.189	.051	.378	.706

climatic and farm characteristics						
Chemical fertilizers are not suitable for use in coffee.	.340	.127	.350	2.674	.263	
Chemical fertilizers use alters the soil properties (both physical and chemical) spoiling the soil.	.100	.212	.048	.473	.637	

Source: Primary data, 2023

4.3 Farmers' level of awareness on chemical fertilizers use in coffee production

Majority of farmers (82.3%) did not use chemical fertilizers in coffee fields (Table 4.5). the distribution of farmers using broadcasting and hole placement methods were 16.1% and 1.6% respectively. Among coffee farmers using chemical fertilizers, 13.7% access chemical fertilizers from farmers' associations. Only 4% of coffee farmers buy chemical fertilizers from the agro-input suppliers.

Coffee farmers received training on the use of chemical fertilizers from different sources, majority of coffee farmers (67.8%) got training from extension workers (both for government and non-government organisation). On the other hand, equal proportions of farmers (16.1%) obtained training from input suppliers and fellow farmers.

The type of fertilizers used by the farmer depends on the type of crop, soil and the method of application. It was revealed that among farmers using chemical fertilizers, 16.1% and 1.6% used NPK and DAP fertilizers respectively. The findings implied that farmers who had access to chemical fertilizers and those who attended trainings on demonstrating the use of chemical fertilizers had enough knowledge, which enhanced their awareness on how to improve on coffee production, but the majority of coffee farmers had superficial awareness. One of the farmers had this to say during a focus group discussion; *“Many of us coffee farmers know that chemical fertilizers exist and can enhance coffee yields but we are not familiar with most of the details on their types, sources and how to apply them in coffee fields....”*

Table 4.5: Parameters that determine farmers’ awareness on the use of chemical fertilizers in coffee production.

Parameter	Category	Frequency	Percent
Method of application	Hole placement	2	1.6
	Broadcasting	20	16.1
	Missing value (never used)	102	82.3
	Total	124	100
Source where farmers acquired chemical fertilizers	Farmers’ associations	17	13.7
	Input suppliers	5	4
	Missing value (never used)	102	82.3
	Total	124	100
Who provided the training to you	Extension workers	84	67.8
	Input suppliers	20	16.1
	Fellow farmers	20	16.1
	Total	124	100
Type of fertilizers used	NPK	20	16.1
	DAP	2	1.6
	Missing value (never used)	102	82.3
	Total	124	100

Source: Primary data, 2023

4.5 Farm-based factors that determine farmers’ choice to use chemical fertilizers in coffee production

There are different farm-based factors that determine the choice of coffee farmers to use chemical fertilizers and these are basically initiated by different land conditions especially in ownership, access, size, location and control. Plot size and distance to agro-input suppliers had significant influence on farmers’ decision on use of chemical fertilizers in coffee production ($p < 0.05$) (Table 4.6) below. Other variables studied did not have significant influence on farmers decision in using chemical fertilizers in coffee production ($p > 0.05$). A coffee farmer in one of the focus group discussions said “*Many of us coffee farmers have small coffee fields*

which do not motivate expensive investments like use of chemical fertilizers. We think large scale commercial farmers are well placed to use such technologies in coffee fields.....”

Table 4.6: The coefficient of the farm-based factors that determine farmers’ choice to use chemical fertilizers in coffee production

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	3.641	1.121		3.249	.002
Land ownership	-.326	.162	-.183	-2.015	.146
Coffee-banana intercropping	.203	.410	.044	.495	.622
Farm location	-.033	.303	-.010	-.110	.913
Plot size under coffee production	-.330	.119	-.296	-2.782	.006
Distance in relation to chemical fertilizer distribution channels	-.110	.118	-.102	-.936	.351
Land fragmentation	.263	.097	.319	2.699	.008

Dependent Variable: Farmers’ choice to use chemical fertilizers.

4.6 Possible strategies for promoting adoption of chemical fertilizers use in coffee production

In order to improve on the adoption of chemical fertilizers use among coffee farmers, different strategies have to be implemented and put in place. The most relevant strategies are those that address farmers’ perceptions and attitude towards use of chemical fertilizers. In the same vein, awareness of farmers on the role and use of chemical fertilizers is also key as it promotes farmers’ positive attitude and perceptions. Strategies targeting to improve institutional and structural functions are also important in promoting accessibility, affordability, awareness and profitability of using chemical fertilizers. From the study, farmers gave their responses on what they think can be of help in promoting the use chemical fertilizers among coffee farmers.

Provision of farmer training on use of chemical fertilizers in coffee production and stabilizing coffee and fertilizer prices (Table 4.7) were significant strategies in promoting use of chemical fertilizers ($p < 0.05$). However, Knowledge of coffee yield response to chemical fertilizers and

its profitability, providing chemical fertilizer subsidies, designing a fertilizer promotion strategy and considering the potential for public-private partnerships to provide fertilizers and trainings to farmers were not significant ($p>0.05$). One of the farmers during a focus group discussion had this to say; *“If coffee farmers are well trained to fully understand how to apply and the profitability of using chemical fertilizers in coffee fields through demonstrations, many of us coffee farmers would find it easy to adopt its use.....Many of us think it is expensive and lack good knowledge on how to use it.....”*

Table 4.7: Coefficient of possible strategies of promoting adoption of chemical fertilizers use in coffee production

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
(Constant)	1.134	.295		3.844	.000
Designing a fertilizer promotion strategy	.184	.167	.129	1.102	.273
Knowledge of coffee yield response to chemical fertilizers through a study.	.014	.181	.012	.078	.938
Potential for public-private partnerships to provide fertilizer and trainings to farmers	.283	.193	.242	1.472	.144
Stabilizing coffee and chemical fertilizer prices in the market	.259	.101	.230	2.557	.002
Provision of Fertilizer subsidies	.046	.154	.038	.299	.766
Constant training on the value and use of fertilizers by extension workers	.547	.098	.479	5.571	.000

Dependent Variable: number of times you have used fertilizers

CHAPTER FIVE

DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

5.1 Influence of Demographic characteristics of farmers to chemical fertilizer use in coffee production.

Gender of respondents is very important in determining the number of males and females who have adopted different technologies leading to the use of chemical fertilizers (Obiero et al.,2019). It was found that majority of the respondents (69.4%) were male compared to their female counterparts. This was because most of the coffee fields were owned and controlled by males in the households and decisions to use different inputs including chemical fertilizers were majorly determined by men except for women headed households. This is a common practice where men want to control profitable family agro-enterprises that generate income. They want to control family finances as a sign of power and authority. Coffee is one of such projects in the study area. Women only did other management practices like weeding, harvesting and part of processing. The study findings also indicated that there was difference between gender in adopting the use of chemical fertilizers as the percentage of males was bigger than that one of females. This is because women were more constrained to accumulate assets, and had limited access to productive resources such as credit and land and hence, their access to improved technologies including using chemical fertilizers was negatively affected than men. However, women readily reserve time for trainings and related meetings hence tend to be more informed than men. If they would be empowered to have a decision and access to resources and credit, adoption of chemical fertilizer use in coffee production would be higher in the study area. These findings agree with Katungi *et al.*, (2017), who reported that females were more constrained to access agricultural credit to fund coffee production innovations that improve agricultural production. Therefore, it was hypothesized that female smallholder farmers were more constrained to access agricultural credit than their male counterparts.

The farmers' age can have positive or negative effects on the adoption of a technology (Neway and Zegeye 2022). Farmers age determine the level of experience of the farmer in the management of a certain enterprise. The majority of the respondents (50%) were aged 40 years and above and this implied that most coffee fields were owned by adults since most of them were owning land by hereditary means and accumulated wealth compared to young ones. Older farmers had more experience and knowledge about traditional farming methods and could have

a stronger connection to the land and the coffee plants. It was also found that older farmers had an advantage in terms of access to financing and land ownership.

The study findings indicated that the majority of the respondents (83.1%) were married. There were also more widows with coffee fields than single mother families. This was largely because coffee enterprises were taken to be masculine as it was basically income generating. Females' farmers were mostly associated with food production enterprises as they were more responsible for household food security. The occurrence of widows with coffee fields was due to the demise of their husbands. In such circumstances widows would adapt and continue maintaining coffee fields due to family income needs. Shared interest and responsibility was another reason why most married couples had coffee projects as a means of generating family income. However, single individuals, on the other hand, least owned coffee farms as it was always expensive and time-consuming. It was found out that gender roles impacted coffee ownership and use of chemical fertilizers. For example, it was clear that men were the primary coffee growers and decision-makers regarding to fertilizer use, regardless of their marital status.

The level of education of the farmer indicates the degree to which a farmer can adopt a technology or technologies (Mapiye *et al.*, 2023). This was because a good level of education enables the farmer to adopt different technologies used in an agro-enterprise because they understand the technology. It was found that almost all the respondents had acquired a certain level of education, hence they were able to understand the procedures of using chemical fertilizers and their dangers to the environment. This is because education can raise awareness about the potential risks associated with the overuse of chemical fertilizers (Andrianarison *et al.*, 2022). For example, excessive use of chemical fertilizers can lead to soil degradation, which can reduce crop yields over time (Ireru *et al.*, 2021). It can also result in water pollution and other negative environmental impacts. By understanding these risks, coffee farmers may be more likely to adopt sustainable farming practices and follow instructions for safe and proper use of chemical fertilizers.

5.2 Perception and attitude of farmers on application of chemical fertilizers in coffee fields

The farmers' perceptions and attitudes towards the application of chemical fertilizers in coffee growing can vary depending on a range of factors, including their level of education, cultural background, and economic circumstances (Ireru *et al.*, 2021). Some farmers viewed the use of

chemical fertilizers as a necessary and effective way to improve coffee yields and maintain the health of their coffee plants but lacked knowledge and skills of applying chemical fertilizers

Respondents interviewed had a positive attitude and perception on opinions that; use of chemical fertilizers ensured high coffee productivity. Chemical fertilizers were basically used cash crops like tea and coffee. Decisions on chemical fertilizer use were significantly based on access to information and market prices ($p < 0.05$). However, results indicated that farmers' opinions on effects of chemical fertilizers on coffee productivity were not significant ($p > 0.05$). This implied that coffee farmers were opposed to negative opinions on chemical fertilizers use in coffee which was indicative of their positive perception and attitude.

There positive and significant relationship between farmers' age and perceptions indicating that use of chemical fertilizers enhanced coffee yields ($p < 0.05$). This was because farmers had seen or heard of other farmers who had successfully used chemical fertilizers to increase coffee yields, and this reinforced their perception that use of chemical fertilizers was effective. In the study area, it was observed that coffee fields where chemical fertilizers were used had healthy plants with high berry bearing coffee plants, and were more drought and disease tolerant than fields where chemical fertilizers were not used. Furthermore, agricultural extension services, agricultural input dealers, and other sources of agricultural information were promoting the use of chemical fertilizers as a means to increase coffee yields.

During an interview one of the local leaders had this to say;

“Farmers perceive that the use of chemical fertilizers will result in higher coffee yields because these fertilizers provide a readily available source of essential nutrients for plants, such as nitrogen, phosphorus, and potassium. Chemical fertilizers are formulated to deliver these nutrients in precise amounts and in a form that plants can easily absorb, which can lead to faster growth and higher yields. However, despite the perceived benefits of chemical fertilizers, the adoption of these inputs may be low for several reasons. For example, some farmers may lack the knowledge or resources to properly apply chemical fertilizers, leading to reduced yields or even crop damage. Affordability and access to quality chemical fertilizers are yet other factors that may be limiting its use.....”

This can be compared with Bwambale (2015) who noted that fertilizer is not only scarce but also information related to its use and the potential increases in productivity that it could bring about are unknown, thereby reducing the incentive for its use by farmers.

Coffee farmers perceived the use of chemical fertilizers to be associated with cash crops and commercial farmers than subsistence farmers who grow mostly food crops for home use. Although farmers positively perceived chemical fertilizers to be used in commercial crops including coffee, the majority were not using it since they were smallholder farmers. While as the size of coffee plantations should not be a determinant factor to using chemical fertilizers, the majority of coffee farmers who used chemical fertilizers in coffee fields were found to have large fields. This was because commercial farmers had greater access to information and resources related to modern agricultural practices, including the use of chemical fertilizers. Smallholder farmers, on the other hand, had limited access to such resources due to limited education, language barriers, and limited access to technology and credit services. The most important of these limiting factors limited of education and low access to friendly credit, leading to low coffee production and productivity.

An interview with one of the agriculture extension workers confirmed this when he said;

“Chemical fertilizers are often cheaper and more readily available in larger quantities, making them a more affordable option for commercial farmers who may have larger plots of land to cultivate. Similarly, Commercial coffee farmers may be catering for a different market that places more emphasis on yield and consistency in flavor, rather than organic or sustainable farming practices.....”

This is in line with Totin *et al.*, (2020) who pointed out that the demand for fertilizer technology depends on the contribution to the value of output. One of the factors that determine the adoption of fertilizer technology is the technical relationship between fertilizers use and the quantity of output and the additional output derived from additional units of fertilizer application. This means that for farmers to use chemical fertilizers, they need to be sure of the profit as a result of using them.

There was positive and significant relationship between farmers decision on use chemical fertilizers and access to information and market prices ($p < 0.05$). The use of chemical fertilizers in coffee production was often perceived as a decision that was based on access to information and market prices as farmers assess the benefits and costs of using chemical fertilizers in their coffee fields. Therefore, access to information about the benefits and drawbacks of using fertilizers, as well as information on the specific nutrient needs of coffee plants, can influence farmers' decisions on whether or not to use chemical fertilizers (Teklewold *et al.*, 2013). For example, farmers may be more likely to use fertilizers if they are aware of the potential yield

benefits and understand the proper application rates and timing. During an interview one of the local leaders confirmed this when he revealed that;

“Market prices for coffee can also influence farmers' decisions on fertilizer use. If coffee prices are high, farmers may be more willing to invest in fertilizers to increase coffee yields and potentially earn more income. On the other hand, if coffee prices are low, farmers may be more hesitant to invest in expensive fertilizers that may not provide a significant return on investment.”

This can be compared with Fasina, (2013) who pointed out that farmers' attitudes and perceptions towards fertilizer quality have led to an increase in the use of fertilizer in cropped fields. Most farmers who still use chemicals believe that those chemicals in the market are of low quality and therefore need to apply above the recommended rates. This becomes costly and less profitable. Once they are assured of high-quality fertilizers, farmers will increase their use sure of chemical fertilizers leading to increased coffee yields.

High fertilizer prices (cost) on the market reduces profit margin on investment, and therefore discourage coffee farmers especially smallholders from using them. For example, it is on record that in Uganda, agro-chemicals market prices have gone up substantially since 2020 where one kilogram of NPK fertilizer shot from 3,000= up to more than 5,000= and a 50kg bag rose from 120,000= to 200,000= in the same period. Despite efforts to promote chemical fertilizers use in coffee, the cost factor can be a big setback to such efforts. This is in agreement with Mbowa, *et al.*, (2015) who asserts that fertilizer utilization by farmers is highly dependent on prevailing fertilizer prices on the market.

Farmers' perception indicating that use of chemical fertilizers did not have economic returns in coffee production was not significant ($p < 0.05$). Since the majority of farmers were smallholders, it was revealed that use of chemical fertilizers would not lead to economic returns of coffee. This is why farmers normally opt to use organic fertilizers which they can make using locally available resources. This can be compared with Jayasingha *et al.*, (2013) who pointed out that the use of fertilizers is not always profitable. Firstly, it is an expensive investment, which means increased costs. Secondly, if it is not handled properly, fertilizers will have a negative impact on the nature and can be harmful for both animals and human's health when not used carefully.

The study findings also indicated that chemical fertilizer use was not significantly influenced by agro-climatic and farm characteristics ($p > 0.05$). Fertilizers can be used in different agro

climatic zones depending on the level of nitrogen flush, hence some farmers lack knowledge on which type of fertilizers should be applied in the soil to improve its fertility. This can be compared with Benson *et al.*, (2013) who pointed out that in most agro-ecological zones, extension workers recommend the use of organic manure and/or triple super phosphate (TSP), calcium phosphate (CAP) or rock phosphate, but not di-ammonium phosphate (DAP), which is soil acidifying being nitrogenous. However, DAP makes up about one half of all the fertilizer used among the 12 types available because of its adaptability to the environment as well as enhancing quick coffee plant growth. This negative perception is a limitation to the use of chemical fertilizers by coffee farmers due to limited knowledge.

5.3 Farmers' level of awareness on chemical fertilizers use in coffee production

The type of fertilizers used by the farmer depends on the type of crop, soil and the method of application. There were varying proportions of farmers using different chemical fertilizer types, NPK (16%) and DAP (1.6%). Majority of farmers (82.3%) had never used chemical fertilizers in coffee fields. Majority of the respondents who were using chemical fertilizers in coffee revealed that they were using NPK because it was the most available fertilizer type on the market. Still, most organizations (farmers' organizations) were promoting it to be adopted by coffee farmers. NPK was deemed appropriate as farmers had no access to soil testing kits to find out which essential nutrients were limiting coffee productivity on the farms. This was because NPK supplied the three primary essential nutrients (nitrogen, phosphorus and potassium) which were commonly limiting coffee production in most agro-ecological zones. 82.3% of coffee farmers interviewed had never used chemical fertilizers in coffee production. it was evident that the use of chemical fertilizers in coffee production in the study area was very low.

The study findings showed 67.8% of the farmers received training from extension workers (both for government and non-government organisations) and 16.1% were trained by fellow farmers and input suppliers. Most farmers acquired training from extension workers because agriculture extension services were often the most accessible source of information and technologies for farmers. None the less, there were no field demonstrations that could provide hands on training for farmers. Further, skills given to farmers were not consistent with chemical fertilizer use in coffee production. The theoretical mode of training to farmers was largely attributed to poor facilitation given to extension workers. This partly made it difficult to make follow ups after training. The low extension worker: farmer ratio (1:5000) is overwhelming to

enable sufficient training to take place and cause an impact of technology diffusion. During an interview one of the local leaders had this to say;

“Most farmers get trainings on fertilizer use from agriculture extension workers especially of different non-government organization promoting the use of chemical fertilizers in coffee production like TECHNO SERVE. However, these trainings are not always hands-on and regular and always lack follow up. This is one of the important reasons why it’s not effective in winning more coffee farmers to adopt the technology.”

This can be compared with Neway and Zegeye (2022) who pointed out that agriculture extension workers are one of the major actors in changing the perception of farmers towards the use of chemical fertilizers in coffee and this can be achieved through constant trainings.

The study also found that farmers were getting chemical fertilizers they used in coffee mainly from two sources namely; farmers’ associations (13.7%) agro-input suppliers (4%). Majority of farmers (82.3%) were not using chemical fertilizers. Majority of farmers using chemical fertilizers were accessing it from farmers’ associations and agriculture cooperatives because these organisations would provide the fertilizers to them on credit and subsidised price. Individual farmers could not easily access chemical fertilizers due to high prices on open market. During an interview, one of the farmers confirmed this when she said that;

“I acquired the fertilizer I used from farmer associations since the organisation was giving it to us on credit than buying it from agro-input dealers. This helped me in improving my production hence acquiring high revenue”

This can be compared with Teklewold *et al.*, (2013) who pointed out that fertilizer is not only scarce, but also information related to its use and the potential increases in productivity it could bring about are unknown. Further, severe lack of information research results on the profitability of the different soil-crop-fertilizer combinations that could be employed in the different parts of the country is a disincentive to farmers in using chemical fertilizers.

The study findings indicated that 16.1% of the farmers were using broadcasting method of application and 1.6% were using hole placement. Broadcasting fertilizers ensured that all the coffee plants receive fertilizers although it was irregular. This method often saved time and labor costs, as farmers could apply the fertilizer quickly over a large area. However, hole placement had an advantage of concentrating measured amounts of fertilizers around the root region of each coffee tree. This promoted efficiency and reduced wastage that could be used

by weeds. Hence, hole placement method was more recommended but farmers lacked knowledge of this comparative advantage of hole placement over broadcasting method.

5.4 Farm based factors that determine farmers' choice to use chemical fertilizers in coffee production

There are different farm-based factors that determine farmers' choice to use chemical fertilizers in coffee production.

Plot size under coffee production had negative but significant influence on farmers' decision to use chemical fertilizers ($p < 0.05$). Chemical fertilizers were expensive for small coffee farm owners with limited financial resources. It was observed that coffee farmers who had coffee fields less than one acre were not using chemical fertilizers. However, using chemical fertilizers would be profitable for both large and smallholder coffee farmers. The amount of chemical fertilizers applied was always directly proportional to the size of the coffee field. This was because, chemical fertilizer was capable of increasing yield evenly per tree holding other factors constant. The quantity of chemical fertilizer applied was equally dependent on the number of coffee trees. This indicated that a small holder farmer applied comparatively less fertilizer and it was still profitable. During an interview, one of the local leaders had this to say;

“Most coffee farmers are operating on small plots and this discourages them from using chemical fertilizers since they are considered to be profitable for commercial farmers”

This can be compared with Chen *et al.*, (2018) who pointed out that small plot of coffee discourages farmers from using chemical fertilizers, hence they opt to continue using organic fertilizers or leaving coffee plantations to subsist. While as Teshome *et al* (2014) observes that small scale producers would be more inclined to adopt improved practices. However, they always fear risks and uncertainties that come with extra financial investment on their adoption which badly affects their operations in case it proves not to be profitable. Unless practical demonstrations are part of coffee farmer trainings and demonstrated technology proves more financially viable, small scale coffee farmers remain reluctant to adopt (Andrianarison *et al.*, 2022).

The study findings indicated that land ownership (rights to own and use land) did not significantly influence farmers' choice to use chemical fertilizers in coffee production ($p > 0.05$). Insecure land ownership rights can discourage farmers from investing in their land or making long-term improvements, including the use of chemical fertilizers. If farmers are

unsure whether they will be able to keep their land, they may be less likely to make investments that could increase yields or improve soil quality. However, it was evident that most coffee farmers had coffee plantations on land which they either inherited from their parents or they bought, which ownership guaranteed them full rights and decision to use the land. Cases of hiring land or owning land communally which would render them insecure in land use rights were not common. All coffee farmers who were not using chemical fertilizers had secure tenure rights. This indicated that land ownership did not influence farmers' decision in use of chemical fertilizers in coffee production. During an interview one of the agriculture extension workers had this to say;

“Without secure land rights, farmers may have difficulty accessing credit to purchase the necessary inputs, including chemical fertilizers. Lenders may be hesitant to lend money to farmers who don't have clear title to their land or who are at risk of being evicted, but as for farmers in this area, land is commonly acquired through inheritance or buying and therefore individually owned by households.....”

This is in line with Teklewold *et al.*, (2013) who pointed out that secure land tenure has been widely demonstrated to play a critical role in influencing farmers' willingness to invest in soil fertility management practices.

The study findings also established that land fragmentation had significant influence on farmers' decision to use chemical fertilizers ($p < 0.05$). When land is fragmented, farmers may have smaller plots of land to work with. This can make it difficult to access chemical fertilizers as they may be sold in large quantities that are not affordable for small-scale farmers. In addition, transportation costs to reach the plots of land in different locations may be high, further limiting access to inputs. In the study area, land fragmentation was real. Most coffee farmers had small scattered coffee fields sometimes across different villages. Accordingly, this was part of the negative incentives for reasonable investment including the use of chemical fertilizers. During an interview one of the local leaders confirmed this when he said that;

“Fragmentation of land result in increased labor costs as farmers need to manage multiple plots of land instead of a single larger plot. This can make the use of chemical fertilizers uneconomical, as the cost of inputs and labor may exceed the benefits of increased yields....”

This is in line with Totin *et al.*, (2020) who pointed out that land fragmentation is an indicator of productive inefficiency. On the other hand, opponents of land consolidation programs note

the benefits of fragmented land holding to reduce risk and encouraging more diversified production.

The study findings also indicated that distance in relation to chemical fertilizer distribution channels was insignificant farm-based factor that determine farmers' choice to use chemical fertilizers in coffee production ($p>0.05$). The distance between the distribution channels and the coffee farms can impact the availability of different types of fertilizers (Karuri, 2020). For example, some areas may have limited access to certain types of fertilizers due to the distance to the nearest distribution channel. This may limit the options available to farmers and result in the use of less effective or inappropriate fertilizers (Morales *et al.*, 2022). The geographical location placed the study area at a long distance from the common main distribution centres of chemical fertilizers mainly in bigger commercial centres and towns. In an interview with one of the local leaders, he pointed out that;

“If the distance between the distribution channels and the coffee farms is too far, it can result in delays in the delivery of the fertilizers. This delay can affect the timing of the fertilizer application, which may lead to reduced effectiveness of the fertilizers. Additionally, if the distance is too great, it may increase the cost of transportation, which can make the fertilizers more expensive for farmers to purchase and use.....”

The study findings contradicted with Rwigema (2021) who pointed out that Plot distance can have its own impact on the likelihood of fertilizer adoption & the level of fertilizer use that is distant plots (further away from their homesteads) received less fertilizer.

Research findings still show that geographical location of the farm did not significantly influence farmers' decision on use of chemical fertilizers ($p>0.05$). During an interview one of the agricultural extension workers had this to say;

“Some regions have limited access to water resources, which can make it difficult to effectively use chemical fertilizers. Many chemical fertilizers require adequate water resources to dissolve and move through the soil to reach plant roots. In areas with limited water resources, the use of chemical fertilizers may not be a viable option, or farmers may need to invest in expensive irrigation systems to support their use.....”

This can be compared with Rwigema (2021) who pointed out that the geographical location of the farm determines the land potential and thus the expected returns from a given technology. Prevailing agro-ecological conditions capture the potential risk of crop failure associated with rainfall dependency and soil quality, which affects adoption decisions. Researchers have shown

that households located in zones where rainfall is low and erratic are less likely to use fertilizers than those in zones with more reliable rainfall (Dapilah and Nielsen 2020).

Intercropping banana and coffee did not significantly influence farmers' decisions on use of chemical fertilizers for coffee production ($p>0.05$). In the study area, most farmers grew bananas as a main food crop and coffee as a main cash crop. It was a common practice to find coffee farmers integrating banana with coffee or other arable crops in the same field. It was observed that more than 50% coffee farmers intercropped banana with coffee or other arable crops such as beans, ground nuts and other trees. This made it difficult for such farmers to commit a decision to apply chemical fertilizers for the benefit of coffee since their cropping interests are divergent. In addition, many leguminous crops and trees, such as beans and acacia, fix nitrogen from the air and make it available to plants in the soil. When these crops are integrated into coffee farming systems, they can help supply nitrogen to coffee plants, reducing the need for synthetic nitrogen fertilizers (Ncube et al., 2018).

5.5 Possible strategies of promoting adoption of chemical fertilizers in coffee production

The study findings indicated provision of training being significant strategy that could lead to increased adoption of chemical fertilizers in coffee production ($p<0.05$). This was because training could enhance farmers' knowledge on the importance of chemical fertilizers in coffee production (Ado *et al.*, 2020). Benefits of using chemical fertilizers in coffee production include increased yield, improved coffee bean quality and consequently a higher income turnover. This increased understanding can help farmers make informed decisions about the use of chemical fertilizers in their coffee fields. From the findings, most coffee farmers were not conversant with information related to profitability, methods of application, formulation options and types available for use in coffee and application rates among other basic information. This was an indicator that if such knowledge and skills related to effective and efficient chemical fertilizer use in coffee was practically availed to farmers through constant trainings, the trend would significantly change. During an interview one of the local leaders confirmed this when he said that;

“In some cases, coffee farmers may have misconceptions or negative attitudes towards chemical fertilizers. Extension workers can address these misconceptions and provide accurate information about the benefits of chemical fertilizers, helping to overcome any resistance to their use.....”

This is in agreement with Rwigema (2021) who pointed out that extension workers can monitor the use of chemical fertilizers in coffee production and provide feedback to coffee farmers on their effectiveness. This can help coffee farmers see the direct impact of using chemical fertilizers in coffee fields, which can motivate them to continue using them.

The study findings also suggested stabilizing prices for both chemical fertilizers and coffee in the market could significantly influence adoption of chemical fertilizers in coffee production ($p < 0.05$). Stabilizing prices for both agricultural inputs and crop outputs without direct government intervention in the market can create a more predictable business environment for farmers, which in turn can improve the adoption of chemical fertilizers in coffee production. Currently, coffee prices fluctuate a lot on the market while prices of chemical fertilizers keep on steady increase. This brings a lot of uncertainty on the profitability of using chemical fertilizers. If this situation can be reversed by relevant policy interventions, farmers could venture into using the technology assured of increased yields as well as returns on investment. During an interview one of the local leaders had this to say,

“When prices for inputs such as fertilizers are unstable, farmers may hesitate to invest in them, as they cannot be sure they will be able to recoup the cost of the investment. Conversely, when prices for crop outputs are unstable, farmers may be hesitant to invest in fertilizers and other inputs, as they cannot be sure they will be able to sell their crops at a price that will allow them to cover the cost of their investments”

This can be compared with Mbowa *et al.*, (2015) who pointed out that by creating a more stable business environment, farmers may be more willing to invest in chemical fertilizers, which can increase coffee yields and improve the quality of coffee beans. This, in turn, can lead to higher profits for farmers, which can incentivize them to continue using chemical fertilizers.

The study findings indicated that providing fertilizer subsidies was not significant for promoting adoption of chemical fertilizers in coffee production ($p > 0.05$). During an interview one of the agricultural extension workers had this to say;

“Fertilizer subsidy programs can improve the adoption of chemical fertilizers in coffee production by making them more affordable and accessible to farmers, especially smallholder farmers who may have limited resources to invest in inputs.....”

None the less, the study findings contradicted with Svensson, (2013) who pointed out that fertilizer subsidy programs can have positive spillover effects on the entire coffee value chain.

By increasing coffee yields and quality, these programs can increase the supply of coffee beans, leading to lower prices for consumers and increased exports for the country.

The study findings also indicated that the potential of public-private partnerships to provide chemical fertilizers and trainings to farmers was not a significant strategy of promoting adoption of chemical fertilizer use in coffee production ($p>0.05$).

This contradicted with Mbowa *et al.*, (2015) who pointed out that PPPs can improve the adoption of chemical fertilizers is by providing technical assistance and training to farmers. Many farmers lack the technical knowledge needed to make the best use of chemical fertilizers, such as understanding how to apply them effectively and how to minimize negative environmental impacts. By partnering with public extension services and private companies, governments can help provide farmers with the knowledge and skills they need to make the most of chemical fertilizers.

5.6 Conclusions

The study concluded in accordance with study objectives as summarised below;

The study concluded that there was positive perception and attitude of farmers on application of chemical fertilizers for enhanced coffee productivity and bean quality. Chemical fertilizer application in coffee fields is significantly influenced by access to information and market prices. Farmers are aware that chemical fertilizer use improves coffee yields. However, the majority of farmers do not use chemical fertilizers in coffee-grown fields due to high cost of the technology. Farmers' awareness on chemical fertilizer use is enhanced through training and access to information.

Coffee field size and the nature of the farm (fragmented or consolidated) had significant influence on farmers' decision to use chemical fertilizers in coffee-grown fields.

Continuous farmers' training and stabilizing agricultural input prices more especially that of soil improving technologies are significant strategies needed to enhance adoption of chemical fertilizers for coffee production

5.7 Recommendations

It is recommended that government through its agencies engages farmers in more educational and awareness-raising activities to help them make informed decisions about the use of chemical fertilizers for coffee. This could include training on proper application rates, and the selection of appropriate fertilizer blends. Such trainings should be regular, practical and supported by demonstrations.

Extension service providers need to enhance farmers' awareness through field demonstrations where hands-on skills and deeper insights on chemical fertilizer use could be obtained.

Farmers should be supported to increase the scale of coffee production to make it more profitable when chemical fertilizers are used.

There is need to enhance farmers' training and awareness for increased adoption of mineral fertilizers for coffee production.

There is need to reduce the cost of chemical fertilizers through subsidies and other support mechanisms for smallholder farmers. This will make these inputs more affordable and accessible to farmers in the region.

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Appendices

Appendix: I Consent Form



BISHOP STUART UNIVERSITY

RESEARCH ETHICS COMMITTEE

P.O. Box 09 Mbarara-Uganda Tel: +256 485-

433468 E-mail: rec@bsu.ac.ug

INFORMED CONSENT FORM

This document outlines the research study and expectations for potential participants. It should be written in lay man terms and typed on BSU-REC letterhead.

Instructions

1. The wording of this document should be directed to the potential participant not BSU- REC.
2. If a technical term must be used, then define it the first time it is used and any acronyms or abbreviations used should be spelled out the first time they are used.
3. All the sections of this document must be completed without any editing or deletions.
4. Please use a typing font that is easily distinguishable from the questions of this form. Preferably the font size should be 12.

Study title – This should be the same as on all other documents related to the study.

Adoption of Chemical Fertilizers Use in Coffee Production in Kikyenkye Sub-County, Ibanda District

Principal

Investigator(s)

NATUKUNDA DAVID

Leave blank for REC office only: BSU-REC Stamp: 	REC OFFICE USE ONLY: APPROVAL DATE: 13.01.2023 APPROVED CONSENT IRB VERSION NUMBER: PI NAME: NATUKUNDA DAVID IRB NO: BSU-REC-2022-33
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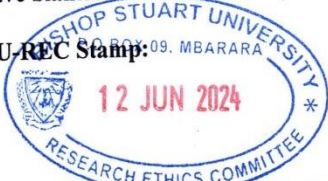
Introduction

What you should know about this study:

1. You are being asked to join a research study.
2. This consent form explains the research study and your part in the study.
3. Please read it carefully and take as much time as you need.
4. You are a volunteer. You can choose not to take part and if you join, you may quit at any time. There will be no penalty if you decide to quit the study.

Brief background to the study

Most people in Uganda earn their living from agricultural production. Coffee is Uganda's leading cash crop and foreign exchange earner after tourism. More than 1.7 million households depend on coffee for their livelihood in Uganda. Here in Kikyenkye Sub-County, more than 80% households have some trees of coffee, and is a major cash crop followed by bananas. Most households here rely on coffee as a major source of income. Production levels are low due to soil nutrient depletion as a result of continuous cropping and soil mining without replenishing the nutrients. Chemical fertilizers use is widely considered as a key remedy to address soil fertility depletion crisis to increase agricultural production. However, coffee farmers here apply little or no chemical fertilizers at all, which has kept coffee production levels low affecting household income. This study therefore intends to find out from you coffee farmers your perceptions, attitudes, awareness and farm based challenges that limit adoption of chemical fertilizers to increase coffee production and household income.

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Purpose of the research project

Include a statement that the study involves research, estimated number of participants, an explanation of the purpose(s) of the research procedure and the expected duration of the subject's participation.

This study involves research where 97 coffee farmers from this sub-county will participate in giving information about adoption of chemical fertilizers in coffee production. Other informants such as extension workers, input sellers and local leaders will also be contacted for their opinions, making a total of 124 participants. You will participate in this study for only one month where you may be contacted with notice any time to give information within your reach as a coffee farmer/ informant.

Why you are being asked to participate?

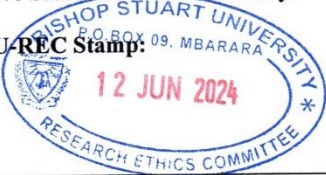
Explain why you have selected the individual to participate in the study.

As a coffee farmer/input seller/extension worker/local leader, you have been selected to take part in this study due to your position to give relevant information relating to adoption of chemical fertilizers use in coffee production and how it can be improved.

Procedures

Provide a description of the procedures to be followed and identification of any procedures that are experimental, clinical etc. If there is need for storage of biological (body) specimens, explain why, and include a statement requesting for consent to store the specimens and state the duration of storage.

As a participant, you will give information by filling a questionnaire or by sharing your opinions with me in an interview that takes a few minutes. For a questionnaire, I will leave it with you to fill it in your time, then I will come and pick it from you. For the interview, I will make an appointment with you for convenient time. Feel free to give the information you have to the best of your knowledge.

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Risks or discomforts

Describe any reasonably foreseeable risks or discomforts-physical, psychological, social, legal or other associated with the procedure, and include information about their likelihood and seriousness. Discuss the procedures for protecting against or minimizing any potential risks to the subject. Discuss the risks in relation to the anticipated benefits to the subjects and to society.

No potential risks are foreseen arising from the procedure given the nature of information required by the investigation from the participants.

Benefits

Describe any benefits to the subject or other benefits that may reasonably be expected from the research. If the subject is not likely to benefit personally from the experimental protocol note this in the statement of benefits.

From this research findings, you as coffee farmers are likely to benefit when agricultural officers, government and development partners get informed about what limits you from using chemical fertilizers. Measures may be put to address such gaps to increase coffee production there by increasing your household income.

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Incentives or rewards for participating. It is assumed that there are no costs to subjects enrolled in research protocols. Any payments to be made to the subject, e.g., travel expenses, token of appreciation for time spent, must also be stated, including when the payment will be made.

You will be given a humble token of 2,000= worth airtime for your time and accepting to participate in this important investigation that seeks to improve your coffee production and income levels. This will be paid to you cash on picking the filled questionnaire/ after the interview.

Protecting data confidentiality

Provide a statement describing the extent, if any, to which confidentiality or records identifying the subjects will be maintained. If data is in form of tape recordings, photographs, movies or videotapes, researcher should describe period of time they will be retained before destruction. Showing or playing of such data must be disclosed, including instructional purposes.

On interview guides and questionnaires, systematically planned codes will be used instead of your real names to protect your identity. Audios and photographs will be reserved and specifically used for purposes of this study and will be destroyed after successful presentation and publishing of findings.

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Protecting subject privacy during data collection

Describe how the privacy of the participant will be ensured during the process of data collection.

To protect your privacy, the researcher will always interact with you from your home. You will not be involved in any gatherings while interacting with the researcher for study information.

Right to refuse or withdraw

Include a statement that participation is voluntary and that refusal to participate will involve no penalty or loss of benefits to which the subject is otherwise entitled.

Your participation in this study is voluntary. You can withdraw from the study any time you feel uncomfortable. Your withdrawal from the study or refusal to participate in the study will involve no penalty or loss of benefits which you are entitled to. So it is your choice to take part or not to take part in the study without any compromise.

What happens if you leave the study?

Include a statement that the subject may discontinue participation at any time without penalty or loss of benefits.

You may discontinue participation in the study at any time without penalty or loss of benefits you may be entitled to.

Leave blank for REC office only: BSU-REC Stamp: 	REC OFFICE USE ONLY: APPROVAL DATE: 13.01.2023 APPROVED CONSENT IRB VERSION NUMBER: PI NAME: NATUKUNDA DAVID IRB NO: BSU-REC-2022-33
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Who do I ask/call if I have questions or a problem?

Include contact for the researcher, and Chairperson, BSU-REC.

If you have a problem or any question you need to ask regarding this study, call any of these contacts.

1. Dr. Godfrey Zaari
Rukundo Chairman, BSU-
REC

P.O. Box 09

Mbarara Tel:

0772663671

2. Mr. Natukunda

David, principal

investigator

Tel. 0779410506

What does your signature or thumbprint on this consent form mean?

Your signature on this form means

- You have been informed about this study's purpose, procedures, possible benefits and risks
- You have been given the chance to ask questions before you sign
- You have voluntarily agreed to be in this study

Leave blank for REC office only: BSU-REC Stamp: 	REC OFFICE USE ONLY: APPROVAL DATE: 13.01.2023 APPROVED CONSENT IRB VERSION NUMBER: PI NAME: NATUKUNDA DAVID IRB NO: BSU-REC-2022-33
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Name of adult participant

Signature of participant or
Legally authorized
representative

Date

Name of person obtaining consent

Signature

Date

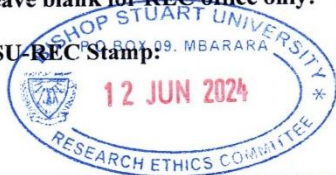
Print Name of witness

Signature or thumbprint or mark

Date

Leave blank for REC office only:

BSU-REC Stamp:



REC OFFICE USE ONLY:

APPROVAL DATE: 13.01.2023

APPROVED CONSENT IRB VERSION NUMBER:

PI NAME: NATUKUNDA DAVID

IRB NO: BSU-REC-2022-33

Appendix II: Questionnaire for coffee farmers

Dear Sir/Madam,

My name is **Natukunda David**, a student from Bishop Stuart University pursuing a Master of Agriculture and Rural Innovations. I am carrying out a study titled "*Adoption of chemical fertilizers use in coffee production in Kikyenkye Sub-County, Ibanda District.*" You have been selected to participate in this research by providing information in regard to this topic. Kindly fill in the questionnaire below. The ideas shared with me will be used specifically in my dissertation and not for any other purpose.

Thank you.

Instructions: *Tick your answer in the brackets given and explain where you are asked to do so.*

SECTION A: PERSONAL DATA

1. Sex distribution: (a) Male ☐ (b) Female ☐
2. Age group: (a) 20 - 25years ☐ (b) 26 - 3 ☐ (c) 30 - 35years ☐
(d) 36-40 years ☐ (e) 40 years & above ☐
3. Marital Status: (a) Married ☐ (c) Single ☐
(b) Divorced ☐ (d) Widow ☐
4. Education level: (a) Tertiary level ☐ (b) Secondary level ☐
(c) Primary ☐ (d) None ☐

SECTION B: FARMERS' PERCEPTIONS AND ATTITUDES ON THE APPLICATION OF CHEMICAL FERTILIZERS IN COFFEE

5. How long have you been in coffee Farming?.....
6. Are you aware of chemical fertilizers?
- a) Yes ☐ b) No ☐



7. Do you use chemical fertilizers in coffee production?

(a) Yes ☐

(b) No ☐

8. If yes, what types of chemical fertilizers do you commonly use?

a) NPK ☐

(b) Urea ☐

(c) SSP ☐

(d) DAP ☐

(e) Others

specify.....

9. If no, why are you not using chemical fertilizers in coffee?

.....

10. How many times have you used chemical fertilizers in coffee?

a) 1-2 times ☐ b) 3-5 times ☐ c) 5 and above ☐ d) None ☐

11. Are you still using chemical fertilizers?

(a) Yes ☐ (b) No ☐

12. If yes, what are the benefits of using chemical fertilizers in coffee production?

.....

.....

13. If no (No.11 above), why did you abandon chemical fertilizers use?

.....

.....

14. Do people have differing attitudes and perceptions towards chemical fertilizers use in coffee production?

(a) Yes ☐

(b) No ☐



15. How do you perceive the use of chemical fertilizers in coffee production? (A-Agree, NS-not sure, D-Disagree)

Option	Farmers perception and attitude on the use of chemical fertilizers in coffee production	Agree	Not sure	Disagree
1	Chemical fertilizers are basically used in high commercial crops like tea and coffee.			
2	Chemical fertilizers applied to in coffee do not provide optimal economic returns to farmers			
3	The decisions on chemical fertilizers use are based on access to information and market prices (cost).			
4	Chemical fertilizers use ensure high productivity and yields of coffee			
5	Chemical fertilizers use alters the soil properties (both physical and chemical) spoiling the soil.			
6	Chemical fertilizers are applied by farmers with large coffee plantations			
7	Fertilizers use is influenced by agro-climatic and farm characteristics.			
8.	Chemical fertilizers are not suitable for use in coffee.			

SECTION C: COFFEE FARMERS' KNOWLEDGE ON THE USE OF CHEMICAL FERTILIZERS

16. What method of fertilizer application do you use while supplying your coffee crops?

.....

.....

17. Which source did you acquire chemical fertilizers from?

- (a) Operation Wealth Creation ☐ (b) NGOS ☐ (c) Farmers associations ☐
 (d) Input suppliers ☐ (e) Faith based organizations ☐
 (f) Agriculture cooperatives ☐

18. Have you acquired any training on the use of chemical fertilizers?

- a) Yes ☐ b) No ☐



19. If yes, who provided you with the training?

- (a) Extension workers ☐ (b) Fellow farmers ☐ (c) Input suppliers ☐
 (d) Media platforms ☐ (e) others specify

20. What information did you acquire from the trainings?

Option	Type of information acquire from the trainings	Yes	No
1.	Chemical Fertilizer Application methods		
2.	Chemical Fertilizer application rates with crop stages		
3.	Types of chemical fertilizers available for use in coffee		
4.	Benefits of chemical fertilizers use		
5.	Sources of chemical fertilizers		
6.	Effects of chemical fertilizers to the environment and human health		
7.	Bests practices and equipment while using chemical fertilizers		

SECTION D: FARM-BASED CHALLENGES LIMITING ADOPTION OF CHEMICAL FERTILIZERS USE IN COFFEE PRODUCTION IN THE STUDY AREA

21. What is the size of land under agriculture in acreages?

.....

22. What is the size of land under coffee production in acreages?

.....

23 Type of land ownership (how you acquired and the rights you have in using the land)?.....



24. What are the farm-based challenges limiting the adoption of chemical fertilizers use in coffee production? (A-Agree, N-Not sure, D- Disagree)

Option	Farm based challenges that limit the adoption of chemical fertilizers use in coffee production	Agree	Not sure	Disagree
1	Insecure land tenure (rights to own and use)			
2	Integrated coffee-based farming system			
3	Geographical location of the farm			
4	Small plots of land under coffee production			
5	Long Plot distance in relation to chemical fertilizer distribution channels			
6	land fragmentation			

SECTION E: POSSIBLE STRATEGIES TO IMPROVE ON THE ADOPTION AND USE OF CHEMICAL FERTILIZERS IN COFFEE PRODUCTION

25. Are there possible strategies of improving on the adoption and use of chemical fertilizers in coffee production?

(a) Yes ☐

(b) No ☐



26. What are the possible strategies of improving on the adoption and use of chemical fertilizers in coffee production? A-Agree, D-Disagree, and N-not sure)

Option	Possible strategies of improving on the adoption and use of fertilizers in coffee production	Agree	Not sure	Disagree
1	Designing a fertilizer promotion strategy			
2	Conducting a chemical fertilizer yield response and profitability studies for a range of crops			
3	Considering the potential for public-private partnerships to deliver fertilizer to farmers			
4	Stabilizing prices for both agricultural inputs and crop outputs without direct government intervention in the market.			
5	Establishing a Fertilizer subsidies programs			
6	Constant training on the value of fertilizers by extension workers			

27. If there is any other strategies apart from mentioned above highlight them?

.....

Thanks for your response



Appendix III: Interview guide for agriculture extension workers, input sellers and local leaders

Dear Sir/Madam,

My name is **Natukunda David**, a student from Bishop Stuart University pursuing a Master of Agriculture and Rural Innovations. I am carrying out a study titled “*Adoption of chemical fertilizers use in coffee production in Kikyenye Sub-County, Ibanda District.*” You have been selected to participate in this research by providing information in regard to this topic as an informant due to your role in coffee growing communities. The ideas shared with me in this interview will be used specifically in my dissertation and not for any other purpose.

1. Are coffee farmers aware of inorganic fertilizers?
2. Do coffee farmers in Kikyenye sub-county use chemical fertilizers?
3. What types of fertilizers are commonly used by coffee farmers?
4. What are the factors that promote use of chemical fertilizers in coffee production in the sub-county?
5. What challenges limit the use of chemical fertilizers in coffee production in the sub-county?
6. How do people in the community perceive the use of fertilizers in coffee production?
7. What are the farm-based challenges limiting the adoption of chemical fertilizers use in coffee?
8. What are the possible strategies of improving on the adoption and use of fertilizers in coffee production?

Thank you.



Appendix IV: Proposed budget

S/N	ITEMS	QUANTITY	UNIT COST	AMOUNT
1.	Stationary	3 reams	25,000	75,000=
2.	Typing and printing			150,000=
3.	Computer software			150,000=
4.	Internet data bundles	20 GBs	5,000	100,000=
5.	REC clearance fees			200,000=
6.	Air time			100,000=
7.	Transport			300,000=
8.	Research Assistants (data collection)	2 persons	100,000	200,000=
9.	Incentives (for respondents)	124 respondents	Airtime worth 2,000	248,000=
10.	Lunch (during data collection)	3 people x 30 days	3,000	270,000=
11.	Research reports binding	3 books	15,000	45,000=
12.	Miscellaneous			300,000=
	Total			2,138,000=

Appendix V: Proposed work plan of the study

Activity	2022					2023		
	Jan.	March	April	Sept.	Dec.	Feb.	June- August	August
Identification of research topic								
Presentation of research concept								
Allocation of research supervisors								
Presentation of research proposal								
Ethical clearance by REC								
Data collection								
Report writing								
Research report submission								

Appendix VI: Research Ethics Committee clearance letter

BISHOP STUART UNIVERSITY P.O BOX 9, MBARARA	
Tel: 0772 512551	 Website: www.bsu.ac.ug E-mail: rec@bsu.ac.ug / info@bsu.ac.ug
RESEARCH ETHICS COMMITTEE	

To: David Natukunda 13/01/2023

o779410506

Type: Initial Review

Re: BSU-REC-2022-33: ADOPTION OF CHEMICAL FERTILIZERS USE IN COFFEE PRODUCTION IN KIKYENKYE SUB-COUNTY IBANDA DISTRICT., one, 2022-10-25

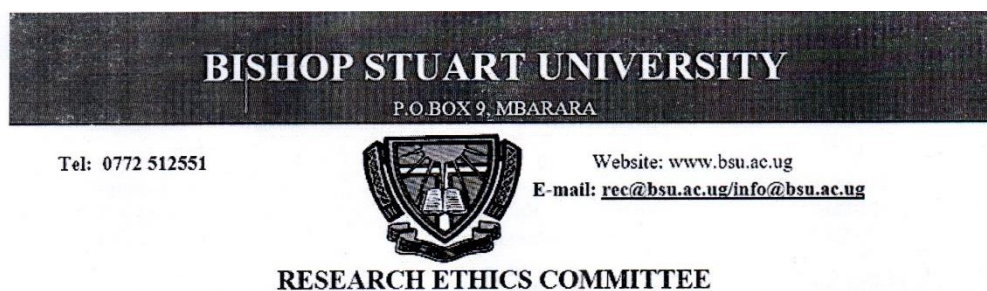
I am pleased to inform you that at the 7 convened meeting on **12/01/2023**, the Bishop Stuart University (BSU) REC, committee meeting, etc voted to approve the above referenced application.
Approval of the research is for the period of **13/01/2023** to **13/01/2024**.

As Principal Investigator of the research, you are responsible for fulfilling the following requirements of approval:

1. All co-investigators must be kept informed of the status of the research.
2. Changes, amendments, and addenda to the protocol or the consent form must be submitted to the REC for re-review and approval **prior** to the activation of the changes.
3. Reports of unanticipated problems involving risks to participants or any new information which could change the risk benefit: ratio must be submitted to the REC.
4. Only approved consent forms are to be used in the enrollment of participants. All consent forms signed by participants and/or witnesses should be retained on file. The REC may conduct audits of all study records, and consent documentation may be part of such audits.
5. Continuing review application must be submitted to the REC **eight weeks** prior to the expiration date of **13/01/2024** in order to continue the study beyond the approved period. Failure to submit a continuing review application in a timely fashion may result in suspension or termination of the study.
6. The REC application number assigned to the research should be cited in any correspondence with the REC of record.
7. You are required to register the research protocol with the Uganda National Council for Science and Technology (UNCST) for final clearance to undertake the study in Uganda.

The following is the list of all documents approved in this application by Bishop Stuart University (BSU) REC:

Appendix VII: Research Ethics Committee



To: David Natukunda

0779410506

Type: Initial Review



13/01/2023

Re: BSU-REC-2022-33: ADOPTION OF CHEMICAL FERTILIZERS USE IN COFFEE PRODUCTION IN KIKYENKYE SUB-COUNTY IBANDA DISTRICT., one, 2022-10-25

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6. The REC application number assigned to the research should be cited in any correspondence with the REC of record.
7. You are required to register the research protocol with the Uganda National Council for Science and Technology (UNCST) for final clearance to undertake the study in Uganda.

The following is the list of all documents approved in this application by Bishop Stuart University (BSU) REC:

No.	Document Title	Language	Version Number	Version Date
1	compliance report	English	one	2022-12-12
2	Data collection tools	Runyankore Rukiga	two	2022-12-12
3	Clearance from university authorities	English	one	2022-10-25
4	Supervisor's clearance	English	one	2022--26
5	REC forms	English	one	2022-10-25
6	Data collection tools	English	one	2022-10-25
7	Covid 19 mitigation measures	English	one	2022-10-25
8	Informed Consent forms	Runyankore Rukiga	one	2022-10-25
9	Informed Consent forms	English	one	2022-10-25
10	Protocol	English	one	2022-10-25

Yours Sincerely



Godfrey Rukundo
For: Bishop Stuart University (BSU) REC



Appendix VIII: Introductory letter

BISHOP STUART UNIVERSITY

P.O.BOX 9 MBARARA



Tel:
Mob: 0772-590865

Website: www.bsu.ac.ug

E-mail: pgd@bsu.ac.ug/dgrio@bsu.ac.ug

DIRECTORATE OF GRADUATE STUDIES, RESEARCH AND INNOVATIONS.

3rd January, 2023

To Whom It May Concern,

Dear Sir/Madam

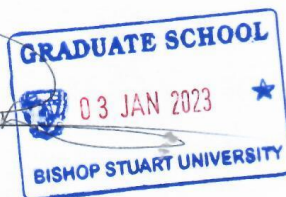
RE: INTRODUCTORY LETTER FOR MR. NATUKUNDA DAVID

This is to introduce to you Mr. Natukunda David Reg. No. 20/BSU/MARI/2797 a student of Bishop Stuart University who is conducting research in Kikyenkye Sub-county, Ibanda District.

His research topic is; Adoption of Chemical Fertilizer Use in Kikyenkye sub-county, Ibanda District.

Any assistance rendered to him is highly appreciated.

Yours faithfully,



Assoc. Prof. Gershom Atukunda-PhD
Ag. Director, Graduate Studies, Research and Innovations.
BISHOP STUART UNIVERSITY

Appendix IX Acceptance Letter

KIKYENKYE SUB COUNTY

P.O BOX 388,

IBANDA.

09/02/2023

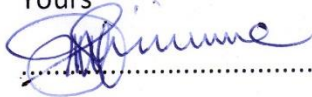
Director Graduate Studies Research and Innovations

BISHOP STUART UNIVERSITY

RE: MR. NATUKUNDA DAVID

I am pleased to inform you that your request to conduct a research in this institution has been accepted and we will afford you all the necessary assistance as you will require making your research successful

Yours



Asiimwe Joseph Santo



Sub County Chief - Kikyenkye