BISHOP STUART UNIVERSITY

EVALUATION AND ADOPTION OF BIOFORTIFIED BEAN VARIETIES IN SHEEMA AND NTUNGAMO DISTRICTS, SOUTH WESTERN UGANDA.

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18/BSU/MSC.A/004

A DISSERTATION SUBMITTED TO THE DIRECTORATE OF GRADUATE STUDIES, RESEARCH AND INNOVATION IN PARTIAL FULFILMENT OF THE MASTERS OF SCIENCE IN AGRONOMY OF BISHOP STUART UNIVERSITY

FEBRUARY 2023

Declaration

I Kanyesigye John, hereby declare that this research report titled “Evaluation and Adoption of Bio fortified bean varieties in Sheema and Ntungamo Districts, Western Uganda” is my original work and has never been submitted to any institution before for any award.

Signature…………………………………………… Date 18th February, 2023

Kanyesigye John

Approval

This research report titled "Evaluation and Adoption of Bio fortified bean varieties in Sheema and Ntungamo Districts, South Western Uganda" has been submitted to the university with our approval as the Supervisors for examination.

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Prof. Ssemakula Edward

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DR. Rebecca Kalibwani

Acknowledgement

In the first instance, I wish to extend my sincere thanks to my supervisors who successfully guided me throughout my research. I am great full to all the Bishop Stuart University Lecturers under the Faculty of Environment Agriculture and Technology for their continued guidance and encouraging remarks during this course of study.

I great fully acknowledge the assistance provided by Tumwekwatse Clare my wife that facilitated the accomplishment of the programme.

Special thanks go to my mum Basiimwa Dinavence for her constant financial support, encouragement and understanding during the time spent on this study. Evarist and Hellen plus the entire John Karongo family deserve mention.

In a special way, I wish to extend my special gratitude to my beloved daughters; Queen Bridget, Adellah Arikiriza, Angel Kemigisha,Violeta Ainebyoona and sons Kanyesigye Peter and Kanyesigye Edward for the Prayers, love, continuous support, and patience. You have been so wonderful to me. In a special way, I dedicate this thesis to all Teachers and Agriculturalists in Uganda and the world at large.

Lastly but not least, special thanks go my brothers Joshua, Yoweri, Samuel and their wives for constant support, encouragement and understanding during the time spent on this study.

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List of acronyms

AU	African Union
DRC	Democratic Republic of Congo
DREA	Department of Rural economy and Agriculture
FAO	Food Agriculture Organization
GDP	Gross Domestic Product
IDA	Iron deficiency anemia
ISSD	Integrated seed sector development
KAZARDI	Kachwekano Zonal Research and Development institute.
NaCCRR1	National Agricultural Crop resources research institute.
OFSP	orange-fleshed sweet potato
PCI	Participatory Crop Improvement
PPB	Participatory plant breeding
PVS	Participatory varietal selection
RAB	Rwanda Agriculture Board
SCC	Seed Coat color
SS	Seed Size
STC	Specialized Technical Committee
UBOS	Uganda Bureau of statistics
UMSFSNP	Uganda Multi Sectoral Food Security and Nutritional Programme

Abstract

The study's main objective was to evaluate the adoption of biofortified bean varieties in Sheema and Ntungamo Districts, Southwestern Uganda. It was limited to identifying the social and economic factors that affect the adoption of biofortified bean varieties, determining how farmers perceive the chosen traits of biofortified bean varieties, and determining how effective the interventions in place have been at encouraging farmers to adopt biofortified bean varieties. 214 respondents provided primary data for the study, which used a cross-sectional, descriptive research approach. 193 were bean farmers randomly selected and 21 key informants were purposively selected. The study findings established the following social economic factors significantly affected the adoption of biofortified bean varieties; access to credit P=0.00 and SD= 0.00, market access P=0.00 and SD=0.02892, household size P=0.00 and SD= 0.14047, access to extension P=0.00 and SD= 0.19475, gender P=0.00 and SD= 0.30575, education level p=00 and SD=0.31439, farmers perception P=0.00 and SD=0.34305, farm size P=0.00 and SD=0.34837, farmers income P=0.39167 and farmers age was not significant since P=0.997 was greater than P=0.05hence such factors which are significant should be put into consideration in design of any related project or programme so that malnutrition is minimized using these biofortified bean varieties. The study findings established that farmers liked NAROBEAN 2 109 (51%) and NAROBEAN 3 62 (29%) due to their traits especially market class, early maturing, high with cubiod shape, yielding, and bush type and short cooking time, market class respectively. The study established that most farmers 175 (81.8%) were still growing local bean varieties since they perceived biofortified bean varieties to require additional inputs especially fertilizers and pesticides and these forced even those growing to abandon them. The study further established that a reasonable number of farmers 87 (40.7%) have ever grown biofortified bean varieties but only 39 (18.2%) were still growing them since the nutritional programme that used to provide seeds to them was no longer supplying and even such biofortified bean varieties were not available in the visited stores. It was established that creation of markets like promotion of school feeding programme significantly influences adoption of boifortified bean varieties P=0.00 on the other hand construction of storage facilities P=0.253, provision of post-harvest inputs like tarpaulins P=0.709 and strengthening farmer groups P=0.931 did not significantly influence the adoption of biofortified bean varieties. However the level of benefiting from the interventions is still low with the highest 17% benefiting from free distribution of quality seeds and the least (2%) benefiting from strengthening farmer groups. The study recommends that all the social economic factors established in this study should be put into consideration while designing any project related to minimization of malnutrition, the need to include farmers’ preferences and empowering farmers to select new varieties under their own management and social economic conditions through interventions like free distribution of biofortified bean seeds, construction of storage structures accessible by farmers.

Key words; evaluation, Biofortified bean varieties, Adoption

CHAPTER ONE

I.1. Study Background and Introduction

In many parts of Africa, Latin America, and southern Europe, the common bean (Phaseolus vulgaris L.), sometimes known as the common bean, is the most frequently produced grain legume for direct human consumption (Blair and Izquierdo, 2012). It is a substantial source of nutrition for more than 300 million people, providing 65% of the total protein consumed, 32% of the energy, and a large number of micronutrients like iron, zinc, thiamin, and folic acid (Petry *et al.*, 2015). According to Bashir *et al*. (2013), iron is a crucial micronutrient for almost all living things. Iron deficiency is the most common micronutrient deficiency globally, disproportionately affecting the most vulnerable and poor populations in environments with limited resources and resulting in Iron Deficiency Anemia (IDA).

It is sometimes referred to as “poor men’s meat” due to its high protein, mineral, and vitamin content (Petry *et al*. 2015), (Larochelle *et al.* 2014). Many efforts are being made to increase the iron content of staple foods like rice, maize, wheat, and legumes using the biofortification technique, which involves breeding or genetic engineering to increase nutrient content in a crop. This is because treating IDA with iron supplements or processed foods is difficult, and there are currently no effective treatments for IDA (Blair and Izquierdo, 2012).

Due to its focus on daily consumption of staple foods, biofortification is regarded as a viable and affordable method of addressing malnutrition in underdeveloped nations (Pandey *et al.* 2015).

Nearly all rural households in East Africa, including Rwanda, plant beans, according to Larochelle *et al.* (2014) research. In many farming systems, beans are cultivated twice annually.

They are grown under various agro-ecological settings and intercropped with other crops like banana, cassava, maize, and peas. Two bean technologies (bush and climbing beans) are offered to farmers to account for this environmental variation. Bush beans are typically planted in mid- and low altitudes, whereas climbing beans are grown in high and medium altitudes.

In contrast to bush beans, climbing beans grow vertically, require staking material, and are harvested over a longer period. Because of their habit of growing vertically, climbing beans produce more beans per acre than bush beans and are less likely to be intercropped (Birol *et al.* 2011).For usage in the home, for dietary purposes, and to generate revenue, beans are cultivated. They are essential for reducing hunger intervals and for generating quick money because they are a crop with a short duration (2.5–4 months) (Asare-Marfo, *et al.*, 2017).

Their early maturity and ability to supply a variety of food products (including leaves as well as fresh pods and dried grain) also contribute to helping vulnerable communities (including children under five, expectant women, and those with chronic illnesses) have more balanced diets (Larochelle, *et al.*, 2014). Because animal proteins are becoming more scarce and there is a greater need for food in both urban and rural areas, bean consumption has increased recently (Birol *et al.* 2011). Small-scale farmers are the principal growers of beans, using only seed as their main input (Birol *et al.* 2011).

In comparison to conventional bean varieties, biofortified bean types have a high iron content (40 percent more iron), are highly adaptable and tolerant to a variety of soil conditions, are high yielding, and (Larochelle *et al.* 2016). Farmers should embrace best practices, use enhanced inputs, and actively participate in farmer group activities for easier access to inputs, credit, and markets to increase output of biofortified beans and increase income on their current land holdings (Birol *et al.* 2011).

NaCRRI first released five bean varieties in Uganda in 2016 that were high in iron and zinc. These variants contained two climber growth types and three bush growth types (Ebinu *et al.* 2016).16 distinct bean types were tested before being released to determine their productivity potential, capacity to store micronutrients like iron and zinc, and farmer preferences. Five kinds were chosen for release that met every test condition. The NAROBEAN 1, 2, 3, 4C, and 5C cultivars are great sources of iron (Ebinu *et al.* 2016). Communities can now purchase and plant these bean types to improve nutrition and reduce anemia (a serious health issue in Uganda), knowing that they will still obtain a harvest despite drought (Ebinu *et al.* 2016).

The ISSD Uganda program was established in 2012 and is currently based on agro-ecological zones, active in the three geographical regions of the West Nile, Northern Uganda, and Western Uganda promoting the sale of locally grown bean seeds from recently released research organizations. In an effort to address concerns with low productivity, iron deficiency, and zinc inadequacies, it has also advanced in its promotion of bio-fortified bean varieties to smallholder farmers. Farmers base their decisions when choosing and implementing new bean varieties on a variety of attributes. The capacity to adapt to low soil fertility, seed size, marketability, taste, quicker cooking times, tolerance to heavy rain, resistance to common bean diseases, and shorter production cycles are a few examples of these qualities (ISSD Uganda, 2015).

Despite extensive efforts and financial commitments made by MAAIF under the Uganda Multi-Sectoral Food Security and Nutrition Program to disseminate information on biofortified bean varieties in Sheema and Ntungamo districts in Southwestern Uganda, the majority of farmers continue to be uncertain about the desired traits.

1.2 Problem statement

Researchers have developed high-yielding cultivars with a high iron and zinc nutritional content (Birol *et al*. 2013).In 2016, NaCRRI released five bean varieties—all of them high in iron and zinc—for the first time in Uganda (Ebinu *et al.* 2016).These kinds, often referred to as NAROBEAN 1, 2, 3, 4C, and 5C, are a superior source of iron. Communities may now purchase and cultivate these beans instead of spending a lot of money on expensive supplements to improve nutrition and lower anemia, which is a serious health issue in Uganda. These beans are also high producing and early maturing, so they can survive drought (Ebinu *et al.* 2016). Farmers base their selection and adoption of bean varieties on a variety of features (Ebinu *et al.* 2016)

In the process of releasing the major traits based on adaptability to low soil fertility, seed size, marketability, taste, shorter cooking time, resistance to common bean diseases, tolerance to heavy rain, shorter production cycles, and nutritional content of zinc and iron (ISSD Uganda, 2015), farmers were reported to show higher preference for seed color, seed size, drought tolerance, disease and pest resistance relative to yield (Gurmu, 2013).

After release the seeds were distributed to seed companies for multiplication and distribution to farmers. In western Uganda, bio fortified been seeds are being distributed and promoted by MAAIF under UMSFSNP in the (KAZARDI) and NaCRRI in Namulonge (Saturday, 12th, may, 2018) reported by daily monitor publication. Other factors influencing adopting was awareness creation about the importance of bean crop varieties, changes in Agronomy as it was observed in Kabwohe, Sheema district and Rubaya in Mbarara district (Nankya *et al*. 2017). According to

(Awio, 2015) genetic by environment interaction affected yield results even in villages neighboring each other in Rakai and Hoima districts affecting the number of pods. Failure to access finance to facilitate buying of seeds, labour demands by the small holder farmers also limit adoption of the bio fortified varieties (Nankya *et al.* 2017). Considering variations in evaluation and selection of varieties with evidence from Rakai and Hoima districts, Awio (2015) recommends strong Researcher-farmer collaboration with a bigger courage for the future selection and development of the improved bean varieties.

Despite all the selected traits by farmers on the release of bio-fortified bean varieties including consideration for nutrient content, the dissemination of related information about such selected bean varieties by different stakeholders especially developers, extension workers and health workers is not uniformly done and the selected traits cannot be generalized across all districts with in the regions hence affecting their adoption. Similarly, limited access and availability of confirmed bean varieties in different input shops and limited communication channels used by extension workers in disseminating information related to yields, pest and disease resistance, marketability and nutritional contents of such bean verities is still inadequate among farmers. Additionally, there was limited knowledge of the demand side and important farmer level elements that would influence their uptake at the time of their release. Therefore, it is against this background that this research evaluated adoption of bio fortified bean varieties in Sheema and Ntungamo districts, Southwestern Uganda.

1.3 Main objective and purpose of the study

The main objective and purpose of the study was to evaluate the adoption of biofortified bean varieties and provide literature on how they can be absorbed in farming communities in Sheema and Ntungamo Districts, Southwestern Uganda.

1.4 Objective of the study

(i) To determine the social economic factors that influence adoption of bio-fortified bean varieties in Sheema and Ntungamo Districts, Southwestern Uganda

(ii) To establish farmers' perception of the selected characteristics of bio-fortified bean varieties in Sheema and Ntungamo Districts, Southwestern Uganda.

(iii)To establish the extent to which the interventions put in place have reached in motivating farmers to adopt bio-fortified beans in Sheema and Ntungamo Districts, Southwestern Uganda.

1.5 Research questions

(i) What are the social economic factors that influence adoption of bio-fortified bean varieties in Sheema and Ntungamo districts?

(ii) What are farmers' perceptions of the selected characteristics of bio-fortified bean varieties in Sheema and Ntungamo districts?

(iii)What is the extent to which the interventions put in place have reached in motivating farmers to adopt bio-fortified bean varieties in Sheema and Ntungamo districts?

1.6 Scope of the study

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

1.6.1 Geographical scope

The study was conducted in Sheema and Ntungamo district. In Sheema district the study focused in Rugarama, Kigarama, Kasaana, Kyangyenyi Sub-county and Shuuku Town Council whereas in Ntungamo District the study focused to the major bean growing areas of Nyakyera, Rweikiniro, Rugarama, Rubaare, Kibatsi and Bwongyera sub counties.

1.6.2 Content scope

The study focused on evaluation and adoption of biofortified bean varieties in Sheema and Ntungamo districts, Southwestern Uganda. It was restricted to; determining the social economic factors that influence adoption of bio-fortified bean varieties, establishing farmers' perception of the selected characteristics of bio-fortified bean varieties and establishing the extent to which the interventions put in place have reached in motivating farmers to adopt bio-fortified bean varieties.

1.6.3 Time scope

The study was based on the period of twelve years' time frame (2010-2022). This is the time when different government and different NGOs have been encouraging farmers to adopt bio-fortified beans to reduce on the problem of hidden hunger among communities.

1.7 Significance and justification of the study

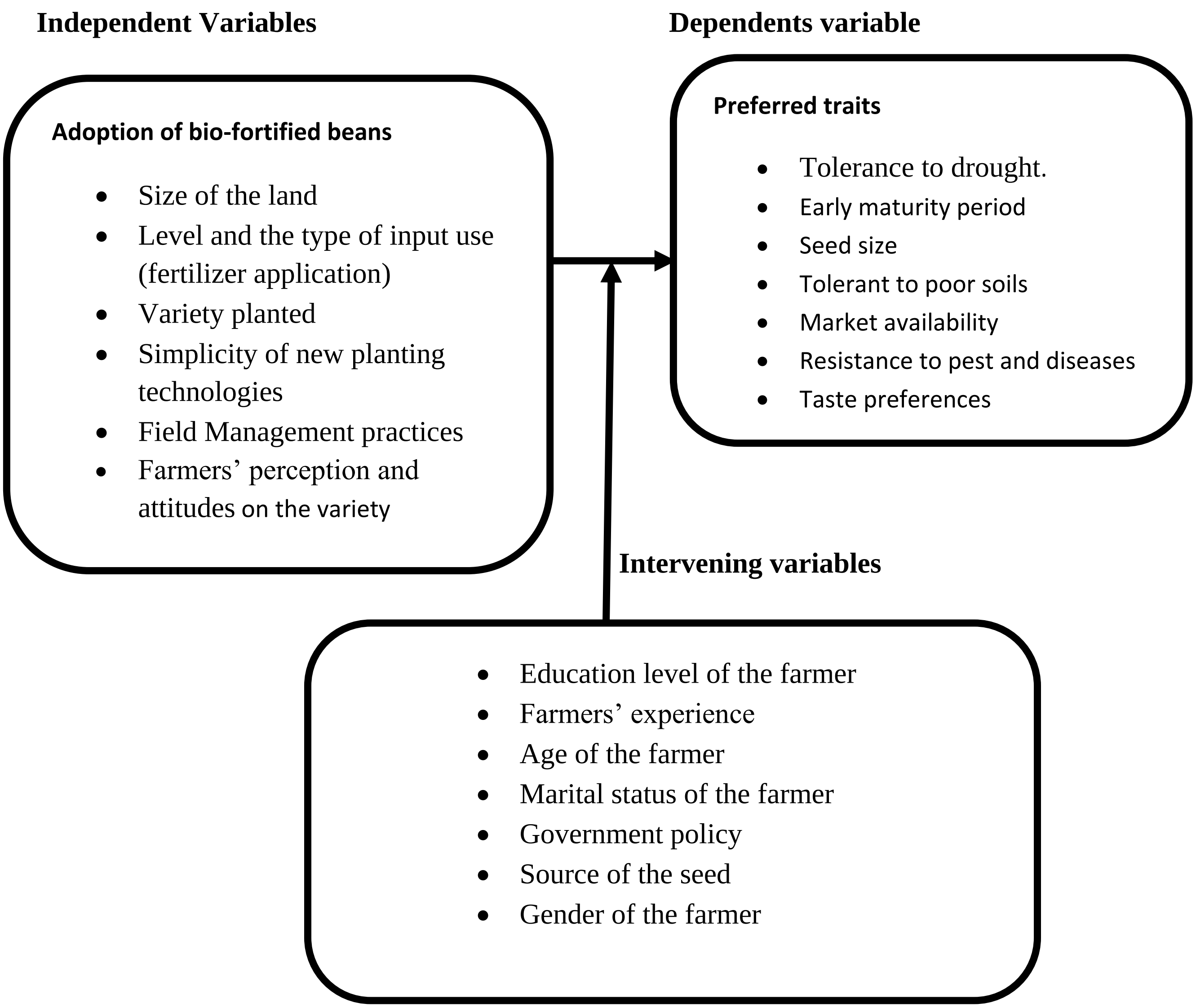
Based on the research conducted by Masresha (2017) the key factors that influence the adoption of improved beans, it is ideal to heed his recommendations, which include taking appropriate steps to strengthen extension services, such as offering relevant trainings, enhancing current infrastructures, involving other NGOs (stakeholders) in the area, providing the necessary inputs like seeds in time and quantity, and taking steps to reduce risks on output.

1.8. Extension theory

Based on the research Masresha (2017) conducted on the key factors that influence the adoption of improved beans, it is ideal to heed his recommendations, which include taking appropriate steps to strengthen extension services, such as offering relevant trainings, enhancing current infrastructures, involving other NGOs (stakeholders) in the area, providing the necessary inputs like seeds in time and quantity, and taking steps to reduce risks on output.

1.9 Conceptual framework of the study

A Conceptual Framework to evaluate Adoption of beans under Agriculture, Multiple Drivers and Institutional Deficiencies was suggested by Chinseu *et al.* (2019). The particular conceptual framework is based on a three factor model of variables analysis (i) we have the independent variable in the form of adoption of bio fortified beans (ii) there is also the dependent variable which are essentially the outcomes of the independent variable and (iii) there is a group of intervening variables which all variables take place, including policies, infrastructure and access to technical advice and inputs. The conceptual framework (figure 1) below describes evaluation of the adoption of bio fortified bean varieties.



Source: (Researcher, model 2020)

Figure 1: Conceptual framework of the study

Crop variety adoption is derived from farmers' demand for the variety. Therefore, farmers are unlikely to adopt these varieties if they fail to offer the attributes that the farmers demand. For example, size of the land available to the farmer, level, and type of input to be used in the production process, variety to be planted and field management practices required for the proper management of the bean garden. Farmers' perceptions about the characteristics embedded in the bio-fortified beans and socioeconomic characteristics could be incorporated into the analysis of early-stage adoption decisions. Therefore, favourable conditions like presence of enough land and availability of enough capital to acquire inputs like fertilizers and the planting materials would motivate farmers to adopt bio-fortified bean varieties, hence ensuring increased yields.

Other factors like education level of the farmer, farmers' experience, age of the farmer, marital status of the farmer and government policy can also affect the rate of adoption of a technology. For example, technically, information acquisition, as well as the capacity to process, understanding and using the technical aspects and returns related to alternative and complementary technologies, is largely determined by formal education and indigenous knowledge. Hence, educated farmers are often more likely to adopt a new technology like bio-fortified bean varieties than the uneducated ones.

The age of farmers may also have different effects on adoption. Older farmers may have greater resources, experience, or power, giving them more options when experimenting with new technologies. They might have more farming expertise, more native knowledge, and superior abilities to evaluate the features of contemporary technologies. But it's also possible that elderly farmers are more traditional (risk averse).They could prefer to stick with outdated approaches and tactics while placing less importance on tried-and-true farming methods. Since any of the aforementioned moderating factors could have an impact on the adoption rate of bean varieties, favorable characteristics ensure a higher adoption rate than unfavorable ones.

CHAPTER TWO

LITERATURE REVIEW

2.1 Importance of bio-fortification

To increase the micronutrient density of meals and enhance human health, biofortification of staple crops is a viable technique (Bouis *et al.* 2013).One of the most important strategies to alleviate micronutrient deficiencies in low- and middle-income countries is biofortification, according to the Copenhagen Consensus of 2008 and the Lancet series on maternal and child malnutrition released in 2013 (Ruel and Alderman, 2013).Traditional or conventional plant breeding, agronomic techniques including soil fertilization, and genetic engineering are all employed, with traditional plant breeding accounting for most of the biofortification (Saltzman *et al.* 2013).

The success of bio-fortification as a strategy largely depends on the willingness of consumers and producers to accept the newly bred crop varieties (Saltzman *et al.*2013). Adoption of bio-fortified crops by producers will largely depend on factors such as yield, disease resistance, drought tolerance, and marketability. For consumers, the change in sensory traits in bio-fortified crops can be an important factor that influences adoption; for example, in pro vitamin A–rich crops, such as OFSP, orange maize, and yellow cassava, there will be a change in color.

The factors that affect consumer adoption of biofortified crops (reflecting the intention, initial decision, or action to try a new intervention) and consumer acceptance of biofortified crops (reflecting the perception among producers and consumers that an intervention is agreeable (Hummel, 2020) can be determined using a variety of various techniques. Preference tests and sensory studies provide details on sensory characteristics that affect consumer acceptance. Surveys using cross-sectional questionnaires reveal attitudes, barriers, and factors that help or hinder consumer or producer adoption of biofortified cultivars. Effectiveness studies, which frequently contrast intensive and less intensive interventions, can demonstrate whether biofortified crops are acceptable and are adopted over a specific period (Hummel, 2020). Experimental auctions can reveal whether customers are ready to pay more for a biofortified crop than, say, a locally accessible, non-biofortified crop, highlighting the necessity for a discount when introducing bio-fortified cultivars to secure adoption (Birol *et al*. 2011).

2.2 Social economic factors influencing the level of adoption of bio-fortified beans.

Researchers have offered various explanations for how the age of the household head influences behavior. According to a study by Atibioke *et al.* (2012), the age of the household head has a detrimental effect on the adoption of technology. This suggests that younger farmers are more willing than older ones to take risks.

According to Katengeza *et al.* (2012), married members of the group adopted fertilizer at a higher rate than single individuals (unmarried, widows and divorced).They emphasized that married members had more labor available than singles, widows, and other groups, which was necessary for applying fertilizer. The presence of a spouse makes it possible to share obligations. Just as pointed out by Nyamonge *et al.* (2017) in a marriage situation, the work output that each person produced was much more than when each person worked independently.

Education of the household head has a positive influence on adoption of new technology. Education and years of bean farming experience of the respondent are expected to speed adoption to majority of the farmers under readoption while slowing dis adoption by improving household access to information and ability to process that information, like the expected role of extension (Chete, 2021). Educated respondents may be more aware of the nutritional benefits/needs of their families and the nutritional benefits of biofortified crops, which would make them more likely to adopt quickly and continuously grow biofortified beans (Chete, 2021). Just as Nyamonge *et al.* (2017) noted, when two people work together as a married couple, the amount of work productivity is significantly higher than when they each work individually.

Adoption of new technology is positively impacted by the household head's education. It is anticipated that the respondent's education and years of experience growing beans will help most farmers undergoing re adoption adopt more quickly, while slowing disadoption by enhancing households' access to and capacity for processing information, much like the expected role of extension (Chete, 2021). Farmers with higher levels of education may be more cognizant of their families' nutritional requirements and advantages, as well as those of biofortified crops, increasing their propensity to swiftly and consistently grow biofortified beans (Chete, 2021).

Education and farming experience may also improve the household's capacity to produce beans with biofortified iron at their maximum yield. Although it is difficult to predict the relationship between gender and adoption of iron-biofortified beans, women may be more resource-constrained but may also value the traits of iron-biofortified beans, particularly since they were developed to incorporate women's preferences. Gender has been found to affect production preferences and access to resources (Mukankusi *et al.* 2015). Because most cultures men control the productive resources like land, labor, and capital that are essential for the adoption of new technology, male-headed families' adoption is positively influenced by this (Murray-Kolb *et al*. 2017).

The number of dependents in the family, the distance to market, and the nutritional perception of biofortified beans all had a negative impact on the adoption of the crops (Katungi *et al*. 2010). As dependents provide family labor, their preferences for bean varieties may be geared toward their preferred nutritional value (Kalinda *et al.* 2014. Since the farmer has the financial means to pay when they implement technological adoption, such as timely planting those results in higher yields, other sources of revenue (non-farm income) also play a beneficial influence on the intensity of adoption in relation to additional hired labor.

Both positive and negative factors can affect adoption depending on how much land the household head has. Farm size is frequently one of the first variables examined when modeling adoption processes, according to a study by Kalinda *et al.* (2014).The literature demonstrates that the impacts of farm size vary depending on the type of technology being introduced and the institutional context of the local community. Rather than always having the same impact on adoption, farm size is not necessarily a constant factor (Kalinda *et al.* 2014).

The size of the farm (the total amount of land designated for beans) is highly correlated with the adoption status of white haricot beans, with a higher farm size (the total amount of land designated for the crop) indicating a higher likelihood of adoption. A study by Katengeza *et al.* (2012) on adoption varieties also reveal that farm size with respect to land allocation to various crops is positively related to the decision to adopt. Farmers who previously devoted larger size of land for biofortified beans cultivation in general are likely to adopt beans variety than farmers who cultivated traditional beans on small pieces of land (even though they currently own larger size of land).

Low income indicates difficulties acquiring agricultural inputs like better seed, fertilizer, and herbicides. Income can increase labor and purchasing power (Diiro, 2013). However, not all technologies have shown a positive relationship between income and their adoption. Many studies report that household adoption of recommended agricultural practices, such as the use of improved seed varieties, fertilizer application, spacing, weeding, and pest management, is positively influenced by income (Lividini and Fiedler, 2015).

All rural farming communities must modernize and commercialize their operations to advance their economies, and agricultural financing is a key component of this process. According to Idrisa *et al.* (2010), innovative agricultural technologies are crucial for regional and societal development. If farmers have access to financing to purchase technical inputs like biofortified bean seed, the adoption of new technologies while enhancing their economies is feasible (Ochieng, 2022). However, in rural households, farmers have insufficient access to credit services to adopt technologies and increase their productive capacity. Rural communities have a high demand for financial services, but financial service providers, such banks and microfinance institutions, are hesitant to provide these demands because present yield levels make it difficult to repay loans smoothly Awotide (2015). Poor and low-income households mostly lack sufficient collateral which prevent them from borrowing according to their income and limits their access to formal credit (Chandio, 2020).

Due to high transaction costs and inaccurate information, traditional banks are hesitant to offer credit to low-income households without adequate collateral, which is one of the reasons why access to financing is frequently seen as one of the barriers to the adoption of agricultural technology in most farming communities (Oparinde *et al*. 2016). Because of this, smallholder farmers might not be able to invest in new technologies like the adoption of biofortified beans or successful business ventures (Raphael, 2014). According to the production and financial structure hypothesis, farm families with limited financial resources could operate more productively overall if they had access to loan options, especially at low interest rates. Farmers in developing countries, including Uganda, primarily rely on the formal and informal credit sectors because they lack savings (Teye and Quarshie, 2022).

2.3 Farmer acceptability of bean technologies

Generally, the acceptability of bean variety is highly dependent on the supply of the traits preferred by farmers. In Africa, greater adoption of improved bean varieties released in the 1980s and 90s can be attributed to farmer preference taken care off (Godfray and Garnett, 2014).

The selection criteria of farmers for improved varieties vary among communities and households (Asfaw *et al.* 2011).In common bean array of traits are reported to constitute farmers varietal selection criteria; 13 traits were identified in Rwanda and 33 attributes in Ethiopia (Asfaw *et al.* 2011). Farmers were reported to show higher preference for seed colour, seed size, drought tolerance, disease, and pest resistance relative to yield (Gurmu, 2013). A bright mottle-coloured bean is an important attribute preferred by farmers (Asfaw *et al*. 2011). The black colured seeds are rejected due to unattractive colour and the low market demand (Asfaw *et al.* 2011).

The availability of the features that farmers value most greatly influences how well-liked a bean variety is received. Due to farmer preference, better bean varieties introduced in the 1980s and 1990s were adopted more widely across Africa (Raphael, 2014). Farmers' varietal selection criteria for common beans are said to include a variety of features; 13 traits were found in Rwanda and 33 in Ethiopia (Asfaw *et al.* 2011).According to reports, farmers prioritize seed size, color, and disease, insect, and drought resistance relative to production (Gurmu, 2013).Bright beans with mottles are a key characteristic that farmers favor (Asfaw *et al.* 2011). Due of their unappealing color and poor market demand, the seeds with a black color are rejected (Asfaw *et al.* 2011).

2.4 The level of adoption of bio-fortified beans

Farmers may be hesitant to grow bio-fortified seed varieties if there are few market opportunities and local consumers are skeptical of the technology (Bailey *et al*. 2014).The acceptability of biofortified crops by consumers can be influenced by a variety of factors. The socioeconomic situation, culture, and eating customs all influence what people eat. Studies have revealed that many consumers value the flavor, color, and aroma of local food more than the more superior alternative (De Groote *et al.*2014).Additionally, customers are inclined to reject food whose characteristics differ from those of the local variety (Xu *et al.* 2016).Therefore, it is unclear if consumers will accept the highly nutritious biofortified beans, especially when they have a different sensory quality. The adoption rate is impacted by this.

Kafle, (2010) claim that adoption of any new technology entails a certain amount of risk due to a lack of knowledge and expertise with the technology. Agriculture adoption models highlight the importance of risk and uncertainty in adoption choices and show how yield mean and variance can be traded off (Bailey *et al*. 2014). Farmers may decide to diversify their crop portfolio with lower-yielding conventional crops rather than widely implementing new kinds, depending on how they assess the tradeoff between yield and variance (Bailey *et al*. 2014).

Farmers can increase their output and productivity with the help of developing agricultural technologies (Hummel, 2020). Most farmers acknowledge the significance of current technology advances, but they still favor using their native expertise because it is accessible and affordable (Hall *et al*. 2017). At several stages of agricultural production, mechanisms that farmers have modified based on their indigenous knowledge are employed. Early planting techniques, for instance, could lower insect and disease occurrences while also increasing output yield by Hall *et al*. (2017). Idrisa *et al*. (2010) claim that farmers' perceptions of the relative economic benefits of different new technologies have a significant impact on their decisions to accept and use new technology. Meanwhile, their financial concerns and near-term profitability also have an impact on whether they adopt a particular technology (Godfray and Garnett, 2014).

According to Bazuin *et al.* (2011), besides improving the sensory attributes which are important to consumers, certain attributes are considered by the farmers before they could adopt the new seeds. For the ABS crop, although the addition of extra nutrient to the local cultivar can make the biofortified sorghum more attractive, the possible changes in other agronomic attributes like maturity date, yield, seed source and cost could influence the farmers' adoption. It is therefore pertinent that all these agronomic attributes are considered in the investigation of farmers' adoption of the transgenic biofortified sorghum (Hall *et al*. 2017).

2.5 Interventions put in place to motivate farmers in adopting bio-fortified beans

This has also been proven empirically through a modification of the Disability Adjusted Life Years (DALY) (Lividini and Fiedler, 2015). Better still, unlike other interventions, repeated purchase are not necessary, thus a one-time investment in the biotechnology can be sustained by farmers for many years (Saltzman *et al.* 2013).When biofortified seeds are controlled by the private institution and farmers have limited right over the seed, it is unlikely they will adopt it (Marques *et al.* 2021) and therefore making it accessible to farmers in their localities can improve biofortified bean seed uptake. Most farmers in developing courtiers is small scale and constrained by high illiteracy, limited finance and poor capacity (Bazuin *et al.* 2011). Their access to such patented seed like the variety, therefore, depends on subsidies and strong extension service. As these facilities are grossly inadequate in SSA, a strong marketing strategy is very necessary to encourage farmers to repurchase the biofortified seeds (Lividini and Fiedler, 2015).

Nankya *et al*. (2017) lists other factors influencing adoption, awareness creation and the importance of bean crop varieties, changes in Agronomy as it was observed in Kabwohe, Sheema district and Rubaya in Mbarara district. According to Jaiswal *et al.* (2022), adoption of the bio fortified varieties is hampered by smallholder farmers' labor demands and their inability to obtain financing to make seed purchases easier.

Interventions in the dissemination and promotion of current technologies, the development and promotion of drought-resistant varieties, the strengthening of market information, and informal seed systems where biofortified beans fall were key to adoption (Katungi *et al.* 2010). For instance, access to seeds for market-requested varieties increased from less than 20 to 60% across major bean growing areas by Katungi *et al.* (2010).

The likelihood of a continent-wide adoption of this significant nutrition-sensitive agriculture modification is rising. The AU Member States continue to increase access to biofortification of various crops and to include it in their policies, strategies, and investment plans, as well as in their farmer input support programs and other subsidy and procurement programmes, as well as in their activities and programs related to health and nutrition (Jaiswal *et al.* 2022). This success prompted the Specialized Technical Committee (STC) on Agriculture and Rural Development, Water and Environment, an African Union policy body, to support biofortification as a clear strategy for enhancing household food security and nutrition, complementing industrial fortification, supplementation, and dietary diversity, and helping to achieve the Malabo targets for lowering malnutrition at its second meeting in early October 2017 (Jaiswal *et al.* 2022).

This large nutrition-sensitive agriculture innovation is increasingly likely to be adopted over the entire continent. The AU Member States continue to expand access to biofortification of different crops and to incorporate it into their investment plans, investment strategies, farmer input support programs, and other subsidy and procurement programs, as well as their activities and programs for nutrition and health (Jaiswal *et al.* 2022). At its second meeting in early October 2017, the Specialized Technical Committee (STC) on Agriculture and Rural Development, Water and Environment, an African Union policy body, decided to support biofortification as a clear strategy for improving household food security and nutrition, complementing industrial fortification, supplementation, and dietary diversity, and aiding in the achievement of the Malabo targets for lowering malnutrition.

At its meetings in 2018 and 2019, the African Task Force on Food and Nutrition Development and the 2019 CAADP Partnership Meeting both discussed biofortification. If there is a guaranteed market, farmers will produce more biofortified crops. In order to increase demand for biofortified seeds from both public and private sources, demand for rural output, demand for seed and grain, and household consumption, marketing initiatives are essential (switch to biofortified food) (Jaiswal *et al.* 2022). It can be challenging for farmers and consumers to tell biofortified varieties apart from their non-biofortified counterparts when it comes to crops with non-visible traits (Obi, 2017). The effectiveness of biofortification depends on the involvement of all key sectors, including research, government which includes extension personnel academic institutions, the private sector which includes farmer-led cooperative societies, farmers, civil society organizations, and consumers (Obi, 2017).

CHAPTER THREE

METHODOLOGY

3.1. Introduction

This chapter provides an explanation of the numerous sub-sections that make up the study's methodology, along with the rationale for each one that the researcher used to carry it out. It includes the research design, study population, selection of the sample size, sampling methods, data collection tools, pretesting (validity and reliability), data collection procedure, data analysis, variable measurement, ethical considerations, and restrictions.

3.2. Area of study

The study was conducted in Sheema and Ntungamo District. In Sheema district the studywas concentrated in the areas of Rugarama, Kigarama, Kasaana, Kyangyenyi Sub Counties and Shuuku Town Council. Ntungamo district the study concentrated in the major bean growing areas of Nyakyera, Rweikiniro, Rugarama, Rubaare, Kibatsi and Bwongyera Sub Countries.

3.3. Research Design

3.4. Study Population

The study was cross-sectional because the researcher selected a cross-section of respondents, as stated by (Rahi *et al*. 2019).Although the researcher holds a positivist personal philosophy, a qualitative technique was used for triangulation.214 respondents (including 193 bean farmers, 2 agriculture officers, 2 district agriculture officers, and a district production officer), 6 farmer groups or organizations, 7 produce dealers, and 4 local leaders provided both quantitative and qualitative data. This suggests that much of the current investigation was quantitative. Since the researcher was interested in a systematic description of whether farmers participate in the selection of biofortified beans based on different features, a survey was used since it permitted evaluation and adoption of fortified bean varieties in the Sheema and Ntungamo Districts.

3.4 Study population

Gupta *et al.* (2017) defined the study population as a collection of people chosen from the broader community who share a particular trait. In other words, you look for those organizations or people who can respond to the questions and to whom the survey's findings pertain. An ideal representation of a target population would be a list of all its members. To be able to achieve the objective 193 bean farmers, the researcher went ahead to probe information 2 extension workers, 4 local leaders, 2 district agricultural officers and production officers, 7 produce dealers and 6 farmer groups/organizations were selected for the study. Because they were directly involved in the production of beans, bean farmers were chosen for the study because they had knowledge of the phenomenon under investigation. The selection of extension agents, district production officers, district agriculture officers, and produce dealers assumed that these individuals are in charge of disseminating the various information regarding the adoption of bio-fortified beans and, consequently, accurate data on the rate of adoption of bio-fortified bean varieties by farmers.

3.5. Determination of the Sample Size

The sample size was computed from

3.6 Computation of the sample size.

The sample size is consistent with Kothari (2010), who thinks that the ideal sample size should satisfy the criteria for effectiveness, representativeness, dependability, and adaptability. To accurately represent a bigger group, a researcher must select a number of individuals from a community.

The sample unity was farmers' household heads. The sample size was derived from a formula by Anderson *et al*. (2017) as follows:

$$N=\frac{z^2pq}{d^2}$$

Where n is the required sample size, Z is 1.95 at a 95% confidence level, and P is the population proportion, we can estimate that 85% of the area's population is engaged in bean production.

While q is a weighting variable calculated as follows, and d is the margin of error (acceptable mistake), which is 0.05, (1-P).

$$n=\frac{1.95^2x(0.85x0.15)}{(0.05)^2}$$

=193

Accordingly, a minimum sample size calculated is 193 households as shown above

Table 3.1: Composition of the Sample Size of the Study

Categories of respondents	Number	Sampling techniques	Sampling method
Beans farmers	193	Random sampling	Questionnaire
Agriculture extension worker	2	Purposive sampling	Interview guide
District agriculture officers/ District production officers	2	Purposive sampling	Interview guide
Farmer groups/organizations	6	Purposive sampling	Interview guide
Produce dealers	7	Purposive sampling	Interview guide
Local leaders	4	Purposive sampling	Interview guide
Total	**214**		

Primary data, 2021

3.6. Sampling Techniques and Procedure

The right sample for the study was chosen using a variety of techniques. Simple random sampling and selective samplings were among them Key informants was chosen using a purposeful sampling technique. Simple random selection was used to choose the bean farmers in the sub counties from each district. Bias was prevented by using simple random sampling. When gathering information from district production officers, district agricultural officers, sub-county agriculture officers of the chosen sub-counties, and local leaders, purposeful sampling was used.

3.7 Data Collection Methods

The main primary data gathering techniques used was observation, interviewing, and questionnaires. Primary data was obtained through field results.

By using the observation approach, it was feasible to get details on the bean fields, the amount of land planted with beans in various regions, and to collect data in its current state without the respondents' active participation. It assisted the researcher in obtaining personal knowledge of the

District agriculture officers, district production officers, sub-county agriculture extension workers, and local leaders were specifically chosen and interviewed using a standardized questionnaire. Due to the flexibility of interviews; the researcher was able to modify the interview to suit the various field conditions.

3.8. Data Collection Instruments

In this study, structured interview guides, questionnaires, and observation checklists were the primary data gathering tools.

3.8.1. Observation checklist

Observation checklists helped the researcher collect data directly seen on size bean of gardens, varieties planted and varieties of beans stored.

3.8.2. Interview guide

An interview guide helped the researcher to understand the perceptions of the respondents better. The interview guide helped the researcher to collect data from district production officers, district agriculture officers, and sub-county agriculture extension workers and produce dealers.

3.8.3. Questionnaire

A questionnaire designed in structured and unstructured was prepared for administering to the respondents.

3.9.1. Content validity of instruments

The questionnaire's format, contents, clarity, consistency, and relevance in relation to the research objectives were discussed with coworkers and the supervisors.

The investigation was conducted among farmers in a rural environment.

The content validity index (C.V.I.) was calculated by dividing the total number of valid items by the total number of items in the questionnaire. The questionnaire was handed to two expert researchers (supervisors) for evaluation of the validity of the items therein.

3.9.2. Reliability

A questionnaire was created with appropriate phrasing that was clear, concise, and familiar to the responders in order to assure reliability. Items in the questionnaire and interview guide that were misleading, dependent on assumptions, or double-barreled were avoided. Farmers made their choices impartially at the same time. Ten bean farmers who were chosen for the study but who were located in the same districts participated in a pilot study to pre-test the research tool. This was done to evaluate the effectiveness of the instructions and the clarity of the questionnaire's items. The Cronbcks Alpha Coefficient of 7-0.8 was calculated using the results of the pretest and retest.

3.10. Procedure of Data Collection

Five research assistants were recruited, trained to collect data from bean farmers in the districts using a detailed questionnaire and observation. Data from District Production Officers, District Agriculture Officers and Sub- County Agriculture Extension Officers were collected using guided interview. An accompanying letter assuring the respondents the confidentiality of the information and its use for academic purpose was issued.

3.11. Data Analysis

For cleaning, management, storage, and later analysis using the computer statistical application SPSS, the obtained data was loaded into Microsoft Excel sheets. Based on the goals, the data was examined;

A linear regression analysis was used to determine the social and economic factors (household head's age, marital status, sex, income, amount of land owned, and number of household members working on the farm, and farming experience) that affect the adoption of bio-fortified bean varieties in the Sheema and Ntungamo districts.

Descriptive statistics and linear regression analysis on the objective of establishing farmers' perception on the selected characteristics (adaptability to low soil fertility, seed size, marketability, flavor, faster cooking time, tolerance to heavy rain, resistance to common bean illnesses, shorter production cycles, and zinc nutritional content) was done by getting number of farmers with corresponding preferred traits in terms of percentages to come out with rankings of preferred traits. This resulted from responses from questionnaires farmers ranked through selection of traits.

The extent to which interventions have been put in place by Government and NGOs (Operation Wealth Creation, nutrition Programmes, NAADS, NGO programmes) for poverty eradication, wealth eradication and reducing malnutrition with a target of motivating farmers to adopt bio-fortified bean varieties of farmers participating in the interventions available in the districts was determined by using linear regression analysis.

CHAPTER FOUR

DATA PRESENTATION, ANALYSIS, AND INTERPRETATION

4.0 Introduction

This chapter contains the findings from the data analysis and provides the most extensive discussion of the findings. In Sheema and Ntungamo districts, the study looked at the adoption and evaluation of biofortified bean types. Data was collected from 214 respondents who were farmers, extension workers, produce dealers, local leaders and the findings are presented in the following tables.

4.1: Biographic data of the respondents

Responses on demographic information of the respondents were recorded in table 4.1.1, 4.1.2, 4.1.3, 4.1.4and 4.1.5 below

4.1.1 Gender of respondents

Gender is one of the factors that influence adoption of technologies. Gender in different cultures affects the adoption decision since most of the resources that influence farmers to adopt a technology are owned and controlled by men compared to their women counterpart as highlighted by studies conducted by Raphael (2014) where many control resources in the household and majority of people in bean production are women hence affecting adoption. The gender of the respondents was recorded in table 4.1.1 below.

Table 4.1.1: Gender and age of the respondents

Gender	Frequency	Percent
Male	96	44.9
Female	118	55.1
Total	**214**	**100**
Age	**Frequency**	**Percent**
18-35	35	16.4
36-55	135	63.1
56 and above	44	20.6
Total	**214**	**100**

Source: Field data, 2021

Table 4.1.1 indicates that majority of the respondents118 (55.1%) who were involved in bean production were female farmers compared to their male countered parts. This was because female farmers involved in production of beans for household food security compared to men and they attended in large numbers than males during the focus group discussions.

Age of the respondents

In smallholder agriculture, where farmers rely heavily on the pool of family labor to meet the labour requirement for their farm operations such as land preparation, planting, weeding, and harvesting, to name just a few that are typically performed manually, age is an important socio-demographic variable as it relates to labor input. A technology's adoption may be influenced positively or negatively by the farmers' age. The level of experience a farmer has in managing a specific enterprise is determined by their age. The following Table 4.1.1 lists the responses to the question about respondents' ages. (63.1%) were 36-55 years and 44 (20.6%) were 56 years and above. This suggests that respondents were of an appropriate age to respond to inquiries. Years of agricultural experience can be accounted for by age because older farmers are better able to recognize and handle conditions that will increase their production. However, because Ugandan agriculture is labor-intensive and might need more spirited individuals, young people are better able to handle stress and spend more time working in agricultural operations, which might increase output. This suggests that elderly people will be less productive in terms of labor input to agriculture.

4.1.2 Marital status of the respondents

Marital status of the respondents is very critical in decision making and adoption of some technologies to be used in agriculture production. Responses on marital status of respondents were recorded in Table 4.1.2

Table 4.1.2 Marital status of the respondents

Marital status of the respondent	**Frequency**	**Percent**
Single	26	12.1
Married	148	69.2
Widowed	30	14.0
Separated	10	4.7
Total	**214**	**100**

Source: Field data, 2021

According to Table 4.1.2 majority of the respondents 148 (69.2%) were married. The high participation in bean production by married couples can be attributed to the concern for household food security, welfare and incomes following marital responsibilities. Married couples especially those from rural areas enjoy greater involvement in work roles farming to have opportunities of becoming economically independent. Marriage describes family responsibilities to farmers and therefore farmers become more serious in terms of their participation in agricultural technologies that would give them access to more food and income to meet their responsibilities.

4.1.3 Education level of the respondents

Most of the respondents (60%) had secondary education (Table 4.1.3) for agricultural production.

In this study education is important when it comes to implementation of production technologies including adoption of biofortified bean varieties.

Table 4.1.3 Education level of the respondents

Education of the respondents	Frequency	Percent
Tertiary level	38	17.7
Primary	41	19.2
Secondary	130	60.0
Informal	5	2.4
Total	**214**	**100**

Source: Field Data 2021

Study findings from Table 4.1.3 above indicate that majority of the respondents had attained a certain level of education where the highest percentage (60.7%) had completed secondary education. This implies that most of the respondents had moderate knowledge necessary for adopting different bean management practices that would ensure increased yields after adopting biofortified bean varieties. Also, the level of education assisted them in accessing appropriate information on the availability and roles of biofortified bean varieties in ensuring food security and nutritional contents.

4.1.4 Time spent while carrying out bean production

The time spent while carrying out bean production (Table 4.1.4) indicates the level of farmer's experience and the intensity of technology adoption in improving productivity.

Table 4.1.4: Time spent while carrying out bean farming

Experience in bean growing in years	Frequency	Percent
1-4	116	54.2
5-10	72	33.6
11 and above	26	12.1
Total	**214**	**100**

Source: Field Data 2021

It was established that majority of the respondents 116 (54.2%) had spent between 1-4 years while practicing bean farming. This implied that majority of farmers had experience in bean production, and they could compare the advantages of adopting different bean varieties including biofortified bean varieties to enable them increase on their yields and consume them to reduce malnutrition.

4.2 Social economic factors influencing the adoption of bio-fortified bean varieties.

Any new technology adoption involves some risk due to the lack of knowledge and experience with the technology. Farmers may decide to diversify their crop portfolio with lower-yielding conventional crops rather than widely implementing new kinds, depending on how they assess the tradeoff between yield and variance. The productivity, household income, and living conditions of farmers could all be improved by the usage of biofortified bean cultivars. Households contrast the advantages and disadvantages of improved varieties with traditional varieties because farmers have various attitudes and opinions about whether they should adopt biofortified bean varieties.

4.2 Size of land allocated to beans

The size of land allocated to beans indicates the level of technologies that can be used and adopted, and the level of output (yields) harvested at the end of the season. Respondents were asked about the size of land under allocated to beans and their responses were recorded in Table 4.2.1 below.

Table 4:2.1 Size of land allocated to beans.

Land available	Land allocated to beans	Frequency	Percent
1-2 acres	1 acre and below	108	50.5
2-3 acres	Above 1 acre to 2 acres	60	28.0
3 and above	2.5 acres and above	46	21.5
	Total	**214**	**100**

Source: Field Data 2021

It was established that majority of the farmers (108 %) were planted beans on land of 1acre acres and below. Due to land fragmentation, majority of the farmers were planting beans on less 1 acre and most of them were integrating it with either banana plantations or coffee. This limited them to adopt some of the bean accompanying management practices like fertilizer application and disease control. This is in line with Kalinda *et al.* (2014) who state it clearly that famers with more land holding tend to provide enough for been growing and sustaining its production seasonally.

Table 4.2.2 Social economic factors influencing the adoption of biofortified bean varieties

Variable	B	Std. Error	Standard deviation	Sig.
Constant	6.408	1.3021		.000
Education	2.037E-8	.02462	.31439	.000
Household size	7.412	.01147	.14047	.000
Farm size	-4.146E	.2664	.34837	.000
Access to extension	1.278E-8	.01574	.19475	.000
Access to market	1.584E-8	.38802	.41684	.000
Farmers age	-4.004E-9	.03032	.041684	.997
Farmers perception	3.595E-8	.32631	.34305	.000
Access to credit	5.388	.0000	.000	.000
Farmers income	-9.166E-9	.2911	.39167	.000
Gender	-3.055E-8	.02388	.30575	.000

The adoption of biofortified bean varieties was influenced by different factors (Table 4.2.1). These factors work hand in hand for the effectiveness of management and performance of different field practices. The table indicates a linear regression model relating to farmers awareness and adoption of biofortified bean varieties basing on different social economic variables. This relationship was highly significant (p=0.0000). The adoption of biofortified bean varieties in the Ntungamo and Sheema regions of southwest Uganda was considerably influenced by farm and farmer characteristics. This reinforced the idea that farmers' adoption decisions may be influenced by their availability to information that is dependent on the socioeconomic context of the farm and farmer qualities. This is consistent with prior studies on the adoption of new inventions that linked adoption to socio-economic factors (Kalinda *et al.* 2014).

The adoption of biofortified bean varieties was statistically influenced by the farmers' income and education out of all the various farm and farmer qualities listed in Table 4.2.2.The odd ratio of adopting biofortified beans is predicted to fall on average by 9.166E-9 for every 50 unit decline in farmer income, according to the regression coefficient of farmers' income, which is 9.166E-9.Income from the household is required since it makes it easier to buy the many supplies and inputs needed to manage the fields of biofortified beans. Farmers who earned money from their farms used some of it to buy farm inputs. Low income levels make it harder to buy farm inputs like biofortified seeds, which has an impact on their adoption, as stated clearly by (Diiro, 2013). They were able to afford the costs involved in purchasing inputs for the adoption of biofortified bean varieties. For example, the establishment of biofortified bean gardens requires some fertilizers to enhance the fertility of the soils since most of the soils have lost fertility due to erosions and surface runoff. This implies that households with higher incomes could adopt biofortified bean varieties and their management practices faster compared to those with lower incomes. One of the agriculture extension personnel stated the following in an interview:

"Households with higher incomes acquire almost all the inputs required in the management of biofortified bean practices than those with low incomes since they have the capacity to purchase all the necessary resources" (interview with one of the agriculture extension workers held on 23rdDecember, 2020 at Rugarama sub-county headquarters).

Since income earned can be used to finance the uptake of innovation, off-farm income has a bearing on how new technologies are adopted. High income encourages the early stages of innovation testing since it enables the farmer to put a relatively small amount of their income into an uncertain venture. The adoption of suggested agricultural techniques such the planting of improved seed, the use of fertilizers, spacing, weeding, and pest management by households is influenced by household income levels, according to Diiro (2013). However, not every technology has demonstrated a favorable correlation between income and adoption.

Like this, the farmer's education level had a favorable and significant impact on the adoption of biofortified bean types. If a farmer had no education or little education and no access to extension services, there was a 2.037E-8 drop in the likelihood that they would choose to grow at least one biofortified bean variety. This is likely because education helps farmers to communicate with one another to learn about new or improved technologies and to understand information about those technologies from a variety of sources. As a result, education promotes farmers to accept and employ tested technologies. Farmers can get knowledge about the justification for managing land through better farming practices and other social economic issues through education.

Most farmers have little formal education and mostly engage in traditional agricultural methods; the more complex the technology to be used, the more probable it is that education will be a key factor.

During an interview, one of the agriculture extension workers revealed that.

"*Education helps most farmers in accessing informing, interpreting it, and using it in implementing different technologies. Therefore, farmers with high level of education may quickly acquire information from different information sources hence enabling the farmer to adopt such practices*" (interview with all the agriculture officers held 23rd December 2020 at their Sub County headquarters).

This was in line with Kafle (2010) who pointed out that adoption of new technology is positively impacted by the household head's education. The explanation for this was because household heads with higher levels of education were better able to comprehend and acquire new technologies in less time.The ability of a farmer to receive, process, and utilize knowledge pertinent to adoption is thought to rise with education level.

The adoption of biofortified bean varieties is predicted to increase by 1.278E-8 for every 50 units increase in access to extension services, according to the regression coefficient for this variable. Adoption of biofortified bean varieties was marginally positively and significantly influenced by access to extension services. If a farmer had access to extension services, the likelihood that they would adopt at least one biofortified bean variety increased by 1.278E-8 times.

Extension is a service or system that aids farmers through educational procedures, in improving farming methods and techniques, increasing production efficiency and income, improving their standards of living, and lifting social and economic standards. Extension officers provided technical advice on the use of different inputs during extension visits and attendance to on-farm demonstrations, encouraging the farmers to adopt proven technologies. Farmers can enhance their agricultural practices through knowledge, innovation, and skills by using an extension service. Farmers can boost their output and income while lowering environmental issues in their farms with the aid of extension services.

During an interview one of the agriculture extension workers confirmed this when he said that "*Farmers' access to a variety of information sources facilitates their adoption of new innovations by providing them with knowledge on enhanced technologies. The provision of varied agricultural information is facilitated by conducting numerous extension events, which also improves the* *utilization of the acquired information (interview with one of the agriculture extension workers held on 23rd December 2020 at Kasaana Sub County headquarters).”*

The purpose of an extension agent is to equip smallholder farmers with the agricultural and animal production information and skills they need to increase production, which eventually improves their socioeconomic standing. The same source asserted that extension workers’ skill levels are directly proportional to how widely improved agricultural technologies and practices are adopted.

Farmers’ ages had a regression coefficient of -4.004E-9.

At the 5% level of significance ($p>0.05$), the computed p-value of 0.997 (Table 4.2.2) revealed no significant association between farmers’ ages and adoption levels. Therefore, the age of the farmers had no bearing on whether biofortified bean varieties were adopted. Farmers’ ages had little bearing on whether they adopted biofortified bean cultivars. Farmers of various ages had low adoption rates for biofortified bean cultivars. This is in contrast to Atibioke *et al.* (2012) findings in West Africa, which suggested that older farmers might have had preferential access to new technologies through increased contact with technology promoters and other local development projects, thereby increasing their likelihood of adopting those technologies—both those from the interviews with local leaders and new agricultural technologies—in the region;

“*Compared to younger farmers, older farmers have a tendency to be risk averse and may resist innovations in an effort to reduce the risk involved with the endeavor. Farmers become more resistant to change as they get older and feel more conservative. (interview with one of the local leaders held on 24th December, 2020 at Kishabya trading Centre, Shuuku town council, Sheema district)’’.*

The adoption of biofortified bean varieties was found to be significantly influenced by gender at the 5% level of significance. Among bean producers, female farmers (55.1%) adopted biofortified bean cultivars at a high rate. These results go against the conventional wisdom that women are economically underprivileged and may not be able to afford the fees associated with adopting new farming technologies. Unlike their male counterparts, female farmers typically have a lower propensity for testing out new ideas. Since they would be anticipated to adopt new agricultural technologies later than male farmers, this study found that this was not the case.

The findings may be explained by the fact that female farmers were more inclined to use the advised biofortified management practices because bean production was primarily their duty to guarantee the nutrition and food security of the household. At the 5% level of significance, the computed p-value of 0.000 (Table 4.2.1) indicated a significant and positive association between the gender of the farmers and the adoption of biofortified bean types. Women perform the majority of farm labor, in contrast to their male counterparts, who often make more reliable farming decisions. A study found that women adopt new agricultural technologies more quickly than men because bean production is the main agricultural sector that supports them. Males with higher education levels than females have more alternatives for jobs outside of agriculture. Low levels of education among females generally tend to limit their chances of being absorbed in off-farm employment. They are mostly confined in the farms and are expected to be more likely to adopt new agricultural technologies that provide high yields, due to their obligations of meeting household food and nutrition security. All these findings are in line with Asare-Marfo *et al.* (2017) who pointed out that farmers with high level of education tend to understand better new technologies as well as farmers with a reasonable number of years in bean production.

Because bean production is the primary agricultural industry that supports women, a study indicated that they adapt new agricultural technologies more quickly than males. Males with higher levels of schooling than girls have a wider range of employment options outside of agriculture. Females with low levels of education typically have less opportunities to find employment outside of agriculture. Due to the need to ensure family food and nutrition security, they are largely restricted to the farms and are expected to adopt new agricultural technologies that produce high yields. All of these results are consistent with those of Asare-Marfo *et al.* (2017) who noted that farmers with higher levels of education tend to learn new technologies better, as do farmers who had a sufficient number of years producing beans.

4.3.0 Farmers' perception of the selected characteristics of bio-fortified bean varieties

Farmers have different perceptions on different characteristics of biofortified bean varieties that motivate them to adopt and include them in the planting season.

4.3.1 Whether farmers have ever grown biofortified bean varieties

Respondents were asked whether they have ever grown biofortified bean varieties and their responses were recorded as shown in Table 4.3.1

Table 4.3.1 **Biofortified bean varieties**

Parameters	Response	Frequency	Percent
Ever grown biofortified bean varieties	Yes	87	40.7
	No	150	59.3
	Total	**214**	**100**
Still growing biofortified bean varieties	Yes	39	18.2
	No	175	81.8
	Total	**214**	**100**

Source: Primary Data, 2021

From Table 4.3.1 above, 87(40.7%) of the respondents agreed that they had ever grown biofortified bean verities although only 39(18.2%) were planting them not knowing that they are biofortified bean varieties. This was because most of the biofortified bean varieties were released by researchers and few farmers were usually involved during the time of release. The results are in agreement with Awio (2015) who recommended a stronger researcher-farmer relationship for future adoption of all bean varieties realized. Therefore, according to the results not all respondents had knowledge on biofortified bean varieties. During an interview, one of the local leaders had to say;

"I adopted biofortified bean verities from nutrition program, but its performance was low due to heavy rains I decided to abandon them and remain with our local varieties which are somehow tolerant to different climatic conditions".

4.3.2 Bean varieties mostly grown by farmers

Although research stations release different bean varieties, the adoption of such varieties depends on farmers' access to such varieties and information concerning the performance of such verities and different traits the varieties possess. Respondents were asked about the bean varieties mostly grown by farmers and their responses were recorded in Table 4.3.2 below.

Table 4.3.2 Bean varieties still grown by farmers

Bean varieties grown by farmers	Frequency	Percent
NABE 15	8	3.7
NABE 17	13	6.1
NABE 4	15	7.0
NAROBEAN 2	62	29.0
NAROBEAN 4C	8	3.7
Bean Grain	108	50.5
Total	**214**	**100**

Source: Primary Data, 2021

The study findings established that majority of the farmers 108 (50.5%) were still growing grain going to stores and buy mixture of beans and use for planting, 62 (29%) were still growing NARO BEAN 2, 15 (7%) were still growing NABE 4, 13 (6.1%) mentioned NABE17 and 8 (3.7%) mentioned NARO BEAN 4C and NABE 15.

This shows that even after the introduction of biofortified beans, the majority of farmers continued to grow native bean types. This was because most farmers lacked access to enhanced bean seed. Table 4.3.1 shows low levels of absorption of the newly released varieties when looking at the two biofortified bean varieties NARO BEAN 2 62 (29%) and NARO BEAN 4 C 8 (3.7%).

4:3:3 Reasons for motivating farmers to continue growing biofortified bean varieties and others abandoning them.

With the implementation of different programmes in Uganda like NAADS and Uganda multi sectoral food security and nutrition project, farmers adopted biofortified bean varieties. Some farmers have abandoned them with time after they had adopted them while others were still growing them for different reasons. Respondents were asked why some farmers have abandoned biofortified bean varieties and why others were still growing them (Table 4.3.3 below).

Table 4.3.3: Reasons for motivating farmers to continue growing the biofortified bean varieties

Variety	Most traits preferred	Frequency	Percent
NAROBEAN 1	Not known	0	0
NAROBEAN 2	Market class, early maturing, High yielding, and bush type	109	51
NAROBEAN 3	Short cooking time, market class	62	29
NAROBEAN 4C	High yielding, climbing, medium size	18	8.4
NAROBEAN 5C	Not known	0	0
None Response		25	11.6
Total		**214**	**100**

Source: Primary Data, 2021

The results of the study show that 109 (51%) of the respondents cited the superior qualities of NAROBEAN 2—such as market class, early maturing, high producing, and bush type as the main justifications for cultivating beans, including biofortified bean types. Bean production in this area would be encouraged by having access to biofortified bean varieties with farmers' preferred production characteristics and tolerance to most abiotic and non-abiotic restrictions. This was due to the fact that beans were the main ingredient in sauce, necessitating the emphasis of cooking quality attributes since they were more crucial in the adoption of new bean types. For instance, taste, food color, texture, and flavor were among the most significant bean consumption features.

This is consistent with Gurmu (2013) expression of the same attributes in relation to farmers' preferences, as well as Asfaw *et al.*(2011) observation that farmers prefer seeds that are not black, have a larger seed size, and are more drought-tolerant, among other traits. The size of the bean's seeds and its resistance to diseases and pests are desirable production characteristics.

In an interview with one of the farmers had this to say;

"Releasing of new bean varieties which are tolerant to drought, tolerant to diseases, with large seed size and additional nutritional values would motivate farmers to adopt them if and only if such varieties have also consumption attributes like taste and flavor in combination with other tolerance attributes"

4.3.4 Source of biofortified bean varieties

Farmers acquire planting materials from different sources (Table 4.3.4 below).

Table 4.3.4 Source of biofortified bean varieties

Source of biofortified bean varieties	Frequency	Percent
Neighbor	25	24.0
Seed companies	8	7.7
Government programmes/extension workers	55	53
Agro-input dealers	16	15.3
Total	**104**	**100**

Source: Primary Data, 2021

The study findings from Table 4.3.4 above indicates that majority of the respondents55(53%) acquired biofortified bean verities from government programmes/extension workers, 25 (24%) mentioned neighbor and 16 (15.3%) mentioned agro-input dealers and seed companies scoring 7.7 %. Further analysis established that there was no significance between farmer belonging to farmer group and the number of times bio fortified beans were cooked and consumed in homesteads in a week. This was because most of the farmers who grow biofortified beans usually sell them since they fetched high prices in the market. This forced farmers to always sell off all the harvested biofortified and consume local ones since farmers often grew both improved and local bean varieties.

A p-value of greater than 0.05 (p-value=0.0731) was obtained in relation to farmers belonging to farmer groups and how often (number of times) they cooked biofortified beans in a week. This implied that the simple linear model with farmers belonging to farmer group as independent variable was not significant to the number of times, they cook biofortified beans.

Table 4.3.5 Relationship between farmer belonging to farmer groups and the number of times farmer cooked biofortified bean.

Model	Sum of Squares	DF	Mean square	F	Sig.
1 Regression	.391	2	.391	3.243	.073a
Residual	25.558	212	.121		
Total	25.949	214			

Predictors: (constant), belonging to farmer group.

Dependent Variable: how often do farmers cook biofortified beans in their homes in a week

Interventions in place have reached in motivate farmers to adopt bio-fortified beans

There are different interventions that should be done by both government and non- government organizations in stimulating and motivating farmers to adopt biofortified bean varieties so as to improve on the livelihoods**.** The study also tested if farmers would continue growing biofortified bean varieties if some interventions are put in place.

Table 4.4.1 Coefficient Results Showing the Relationship between farmers continuing growing biofortified bean varieties when some interventions are done

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. error			
(Constant)	-1.132E-15	.062		.000	1.000
Construction of storage facilities	-.039	.034	-.077	-1.147	.253
Provision of post-harvest inputs like tarp lines	.032	.084	.028	.374	.709
Creation of markets (school feeding programme).	.426	.083	.518	5.118	.000
Strengthening farmer groups	.008	.091	.009	.086	.931

Dependent Variable: Farmers continuing growing biofortified bean varieties.

A p-value of less than 0.05 (p-value=0.000) was obtained when markets of biofortified bean varieties were created by promoting school feeding programmes. This implied that creation of markets for biofortified beans was significant in motivating farmers to fully adopt and continue growing biofortified bean varieties. Biofortified bean varieties fetched high prices in the markets and therefore farmers would benefit when linked to reliable market. This conquers with findings of Bailey *eta l* (2014) that farmers are reluctant to adopt bean varieties which they are not yet sure of the market. During an interview all the agriculture extension workers confirmed this when they said;

"*Farmers usually adopt technologies which have ready and sustainable markets in different segments to enable them earn increased incomes*"

Idrisa *et al* (2010) discovered that farmers are more interested in the economic returns from their bean projects and so then the market is guaranteed then farmers will be able to adopt the biofortified bean varieties.

A p-value of great than 0.05 (p-value=0.253) was obtained when construction of storage infrastructures was compared to farmers' continuity in growing biofortified bean varieties. This implied that farmers would even adopt biofortified bean varieties even when there were no storage facilities. Research findings also established that provision of post-harvest handling technologies like tarpaulins and production inputs like fertilizers among other interventions would motivate farmers adopt biofortified bean varieties that are an increase in provision of post-harvest handling inputs would result into 3.2 unit increases in the number of farmers growing biofortified bean varieties.

Table 4.4.2 Model Summary for the relationship farmers continuing growing biofortified bean varieties when some interventions are done

Model Summary

Model	R Square	R	Adjusted R Square	Std. Error of the Estimate
1	.518a	.268	.254	.35555

Predictors: (Constant), strengthening farmer groups, construction of storage facilities, provision of post-harvest technologies like tarplines, creation of markets like promotion of school feeding programmes.

An R-squared of 26.8% was obtained. This implied that the simple linear model with provision of different adoption strategies/interventions as the independent variable explained 2.6.8% of the variations in farmers continuing growing biofortified bean varieties.

Table 4.4.3 Relationship between farmers continuing growing biofortified bean varieties when some interventions are put in place.

Model		Sum of Squares	DF	Mean Square	F	Sig
1	Regression	9.691	0	2.423	19.166	.000a
	Residual	26.421	209	.136		
	Total	36.112	214			

Predictors: (Constant), strengthening farmer group, construction of storage facilities, provision of post-harvest inputs like tarp lines, creation of markets like promotion of school feeding programmes.

Dependent Variable: farmers continuing growing biofortified bean varieties.

A p-value of less than 0.05 (p-value=0.000) was obtained. This implied that when some interventions like provision of inputs like fertilizers, free distribution of quality seeds, construction of storage facilities were provided and established, farmers significantly adopt and continued growing biofortified bean varieties.

Table 4.4.4: shows Percentage level of availability of interventions to adoption of biofortified beans

Interventions for adoptions of biofortified beans	Responses	Beneficiaries of existing interventions.
Free distribution of quality seeds	Yes= 214 (100%)	36(17%)
Creation of markets like promotion of school feeding programmes	Yes= 105 (49.1%) No= 109 (50.9%)	11(5%)
Strengthening farmer groups	Yes= 83 (38.8%) No=131 ((61.2%)	4 (2%)
Construction of storage facilities	Yes= 43 (20.1%) No=171 (79.9%)	00 (00%)
Provision of post-harvest inputs like tarpulines	Yes=33 (15.4%) No=181 (84.6%)	17 (8%)

Statistics from the sample population, 2021.

The study findings established that all the respondents 214 (100%) suggested free distribution of quality seeds as the possible interventions that would motivate farmers to adopt biofortified bean varieties. However only 17% had benefited in such intervention especially those under UMSFNP beneficiaries. During an interview one of the farmers had this to say "UMSFNP programme started in 2018 up to know whether they give us free seed or not for me I have already adopted NAROBEAN 2 because of its market class and will continue growing it''. This is in line with Jaiswal *et al* (2022) who stated that if varieties meet farmers demand in terms of preferred attributes the farmers will like the farmers and adopt their production.

Creation of markets like school feeding programmes was also a vital element in promotion and growing of biofortified beans as research showed average of 49.1% next to free input distribution. This implies that even with creation of markets for biofortified beans adoption will continue as market for the product is available although only 5% had benefited in selling biofortified beans to school feeding programmes. This is in line with Katungi *et al.* (2010) who pointed out that promotion of existing technologies has to be in line with infrastructure development, market creation and market information dissemination.

CHAPTER FIVE:

BRIEF DESCRIPTION OF THE FINDINGS, CONCLUSION, AND RECOMMENDATIONS

5.0 Introduction

This chapter presents the summary of results, conclusion, and recommendations from the study.

5.1 Summary of results

Summary of results are presented here basing on the objectives.

5.1.1 The social factors that influenced adoption of biofortified bean varieties

Among the socio-economic characteristics of the farmers that were found to influence their adoption decision of biofortified bean varieties where the level of formal education, household income and access to extension. age of the farmer, farm size, gender, household size, market access, farmer's perception and access to credit affected their adoption decision. Adopters of biofortified bean varieties were motivated by the benefits of high yields, early maturing, market class and other associated traits with the promoted varieties. However, farmers' high costs of seed limited seed availability and lack of profitable markets among other challenges as the major factors that hinder their efforts to adopt the biofortified bean varieties.

5.1.2 Farmers' perception of the characteristics of biofortified bean varieties

Results indicated that farmers liked biofortified beans that are large seeded with cubiod shape, adaptable to existing soil conditions, tolerant to pests and diseases, high yielding, short cooking time and fetch high market value.

5.1.3 The extent to which the interventions have been put in place to motivate farmers in adoption of biofortified bean varieties.

The study findings established that there were several activities going on to motivate farmers in adopting biofortified bean varieties for example free distribution of biofortified bean varieties, construction of storage structures among others. These acted as catalyst for adoption of biofortified bean varieties and associated technologies. Hence, biofortified bean varieties were vital in improving household food, nutrition and income security. These motivations were observed Ntungamo under Agricultural Cluster development Project, creation of markets both local and international was key in adoption of biofortified bean varieties. However the level of beneficiaries on the interventions is still low with 17% being the highest in benefiting from free distribution of quality seeds and the least (2%) benefiting from strengthening farmer groups.

5.2 Conclusion

The study focused on evaluation and adoption of fortified bean varieties in Sheema and Ntungamo districts. It was restricted to; determining the social economic factors that influence adoption of biofortified bean varieties, establishing farmers' perception of the selected characteristics of bio-fortified bean varieties and establishing the extent to which the interventions put in place have reached in motivating farmers to adopt bio-fortified bean varieties.

The study findings conclude that to achieve high level of adoption of biofortified beans varieties all the social economic factors like the level of formal education, farmers' income and access to extension, age of the farmer, farm size, gender, household size, market access, farmer's perception, and access to credit must be put into consideration in design of any related project or programme so that malnutrition is minimized using biofortified bean varieties.

The study findings established that farmers prefer biofortified bean varieties with large seeds of cubiod shape, adaptable to existing soil conditions, tolerant to pests and diseases, high yielding, short cooking time and fetch high market value.

The study findings further established that for adoption to take its course some interventions like free distribution of biofortified bean varieties, construction of storage structures creation of markets both local and international were key in adoption of biofortified bean varieties.

5.3 Recommendations

The study recommends that to achieve high level of adoption of biofortified beans varieties;

All the social economic factors like the level of formal education, farmers' income and access to agricultural extension, age of the farmer, farm size, gender, household size, market access, farmer's perception, and access to credit must be put into consideration in design of any related project or programme so that malnutrition is minimized using these biofortified bean varieties.

Developing new bean varieties with iron and zinc components there is needed to include farmers' preferences and their socio-economic conditions. There is a need also to empower farmers to select new varieties under their own management and social economic conditions.

Interventions like free distribution of biofortified bean seeds, construction of storage structures accessible by farmers should be put in place.

Training stakeholders along beans value chain is critical for the sustainability of all released bean seeds especially at subcounty and parish levels.

5.4 Areas for further research

1. Need to assess economic returns of biofortified bean varieties under farmers' socio-economic conditions

2. Assess performance of biofortified bean varieties under associated technologies such as fertilizers on farm.

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Introduction letter.

BISHOP STUART UNIVERSITY
P.O.BOX 9 MBARARA

JULY 15th 2020

To Whom It May Concern,

Dear Sir/ Madam,

INTRODUCTORY LETTER FOR MR. KANYESIGYE JOHN

This is to introduce to you Mr. Kanyesigye John a Student of Bishop Stuart University doing Masters of Science in Agronomy under Reg. No; 18/BSU/MSCA/004 who is conducting his Masters Research in Sheema and Ntungamo Districts.

His research topic is: Particopatory evaluation of adoption of bio fortified bean varieties in Sheema and Ntungamo Districts.

Any assistance rendered to him is highly appreciated.

Yours faithfully,

GRADUATE SCHOOL
15 JUN 2020
BISHOP STUART UNIVERSITY

Prof. Edward Ssemakula
Coordinator, Graduate Studies and Research
BISHOP STUART UNIVERSITY

A questionnaire for bean farmers

Dear Respondent

My name is Kanyesigye John, a student from Bishop Stuart University pursuing Master of Science in Agronomy. This questionnaire is designed to study on evaluation and adoption of bio fortified bean varieties in Sheema and Ntungamo Districts south Western Uganda. The information you will provide will help me to get data about the above stated topic and will be used for academic purposes. Because you are the one who can give the necessary information, I am requesting you to respond to the questionnaire and I promise that your views shall be confidential at all times.

In the household are you the one takes care or makes decisions on the bean project? ………….If yes continues with the questionnaire, if not terminate the interview.

Sub county………………………...... District…………………………………………

SECTION A: BIOGRAPHIC DATA

1. Gender

(a). Male ☐

(b). Female ☐

2. Age in years…………………………………………………………….

3. Marital status

(a). Single ☐

(b). Married ☐

(c). Widowed ☐

(d). Separated ☐

(e).Size of the family: Adults ☐ Children ☐

4. Years of experience in bean growing

(a) Farming experience in years………………………

SECTION B: SOCIAL ECONOMIC FACTORS INFLUENCING THE ADOPTION OF BIO-FORTIFIED BEAN VARIETIES

5. Do you usually grow beans?

(a) Yes ☐

(b) No ☐

How long have you been growing beans……………………..years.

7 How much time do you allocate to bean farming per day in hours during the season of beans?...

8. How much do you spend on labour?..

9. What size of the garden of beans do you usually grow/plant in hectares?..............................

10.Have you ever grown bean varieties with additional nutritional components of iron and zinc that are promoted to solve issues of malnutrition?

Yes (b) N

11. Have you ever heard that there are bean varieties with additional nutrients or where iron and zinc have been added by researchers to solve the problem of nutrition?

(a)Yes (b) No

12. Choose the number of bean varieties you have ever grown for the last 2 years

(a)NABE 15 (b) NABE 17 (c) NABE 19

(d)NABE 4 (e) NARO BEAN 1 (f) NARO BEAN 2

(g)NARO BEAN 3 (h) NARO BEAN 4C (i) LOCAL VARIETIES

(j) Others Specify…………………………………………………………………

13. What are the major traits do you consider while selecting the bean variety for planting? (Tick the most appropriate).

NARO BEAN 1		Most appropriate	appropriate	Not appropriate
	Iron rich beans (65.8-72ppm			
	Large seeded with cuboid shape			
	Adaptability to soil fertility			

	Early maturing (60-68 days).			
	Drought resistant			
	Pest and disease resistant			
	White and blue strips seeds			
NARO BEAN 2				
	Medium seed size			
	High yielding 1600-2200kg			
	Pest and diseases resistant			
	Bush type beans			
	Drought resistant			
	Iron rich beans			
	Short cooking time			
NARO BEAN 3				
	Early maturing 58-68days			

	Medium sized seeds			
	High yielding with an average yield of 1500-2000kg/ha			
	Drought resistant			
	Bush type beans			
NARO BEAN 4C	Short cooking time			
	Iron rich beans			
	Contains zinc			
	Medium sized seed			
	Attractive seed color			
	High yield potential 2000-2500kg			
	Market class			
	Cooks fairly fast			
	Tasty and swells on cooking			

	Resistant to CBB			
NARO BEAN 5C	Iron rich beans			
	Climbing beans			
	High yielding			

14. Do you belong to any farmer group or farmer cooperative union?

(a) Yes ☐ (b) No ☐

What is the name of the group or farmer cooperative union…………………………………......

(15) List some challenges that limit you in growing bio fortified bean varieties.

…………………………………………………………………

……………………………………………………………….

……………………………………………………………………

SECTION C: Farmers' perception of characteristics of bio-fortified bean varieties

(16). Have you ever grown bio-fortified bean varieties?

Yes ☐ (2) No ☐

(17). If yes, are you still growing bio-fortified bean varieties?

Yes ☐ (2) No ☐

(18) If no, why did you stop? ___________________________

(19). what was the source of the bio-fortified bean varieties?

(i) Neighbor; ☐ (ii) Extension workers ☐ (iii) input dealers ☐

(IV) NAADs ☐ (v) others (Specify) ☐

(20).Which bean varieties are you growing?

(a)NABE 15 ☐ (b) NABE 17 ☐ (c) NABE 19 ☐

(d)NABE 4 ☐ (e) NARO BEAN 1 ☐ (f) NARO BEAN 2 ☐

(g)NARO BEAN 3 ☐ (h) NARO BEAN 4C ☐ (i) LOCAL SEED VARIETIES ☐

(j) Others Specify……………………………………………………………………

(21) Why did you choose these particular varieties(s)? ________________________________

Tolerance to drought	Tick appropriately
Performance in good season	
Early maturity period	
Pod length	
Tolerant to poor soils	
Resistant to pests and diseases	

Other reasons specify………………………………………………………………………………

(22) How often do you cook bio fortified beans in your home in a week?

(a) 1-5 times ☐ (b) 6-10 times ☐

(23) Are there factors influencing the rate of adoption of bio-fortified bean varieties?

(a)Yes (b) No

(24). If yes, what are the factors influencing the rate of adoption of bio-fortified bean varieties

…………………………………………………………………………………………

Section d: Interventions put in place to motivate farmers in adopting bio-fortified beans

(25). Do you participate in programmes that promote poverty eradication and wealth creation?

(a) Yes (b) No

If yes which Programmes

Operation Wealth Creation (b) Nutrition Programmes

(c) NAADS

(d)NGO programmes for poverty eradication and wealth eradication

(d) Others specify……………………………………………………………….

(26).Did you receive bean seed from these programmes

(a) Yes (b) No

(27). If yes which bean seed varieties did you receive?

………………………………………………..

…………………………………………………

………………………………………………………..

(28). Have you ever received inputs like fertilizers to use in planting specifically bio fortified bean varieties?

(a) Yes ☐ (b) No ☐

24. If yes what type of fertilizers did you receive?

…………………………………………………………………………………………….

(29). Since you have known that there are some improved bean varieties with added nutrients of zinc and iron produced by researchers. What can be done so that these seeds reach farmers and the problem of malnutrition is solved in the households and communities?

…………………………………………………………………………………………………

……………………………………………………………………………………………………..

(30). Do you think the outbreak of COVID 19 Pandemic has affected your participation in growing and marketing of bean crop?............,……. If yes in what ways……………………………….

……………………………………………………………………………………………..

…………………………………………………………………………………………………

Have you been keen in following up operation standard procedures in set by ministry of Health in the prevention of COVID 19……………………….

The interview schedule

The interview guide for District Production Officers, District Agricultural Officers, Extension Workers, Farmer groups, produce dealers and Local leaders (LCs).

My name is Kanyesigye John, a student from Bishop Stuart University pursuing Master of Science in Agronomy. This questionnaire is designed to evaluation and adoption of bio fortified bean varieties in Sheema and Ntungamo Districts Southwestern Uganda. The information you will provide will help me to get data about the above stated topic and will be used for academic purposes. Because you are the one who can give the necessary information, I am requesting you to respond to the questionnaire and I promise that your views shall be anonymous at all times.

Sub county…………………………..... District…………………………………………

Guide Questions.

Are you aware of the bio fortified bean varieties?.......................................

What are some of the sub counties that grow beans in the district on most households?

2. I request to know most bean varieties grown by the farmers in the district, and also bio fortified bean varieties and how you rate malnutrition status………………………………………

3. What are some of the challenges usually encountered by farmers who would wish to venture into bean farming in your area?.

4. Do you think farmers are aware of bio fortified bean varieties that were released by researchers?...

5. What could be the factors influencing adoption of bio fortified bean varieties by our farmers in the district……………………………………………………………………………………….

6. I would like to know some specific traits/ characteristics usually preferred by farmers concerning bean varieties…………………………………………………………………………...

7. What can be done so that these bio fortified bean varieties reach farmers and remain sustained within farmers?...

8. What is the level of the participation of farmers within the farmer organization and whether much is being done to promoting social economic transportation of households and communities?...

9. What are your roles in the improvement of nutritional standards of the communities where you work?...

10. Do you think the outbreak of COVID 19 Pandemic has affected your partipation in growing and marketing of bean crop?............,……. If yes in what ways……………………………….

…………………………………………………………………………………………………..

Have you been keen in following up operation standard procedures in set by ministry of Health in the prevention of COVID 19……………………….

OBSERVATION CHECKLIST

BISHOP STUART UNIVERSITY MBARARA

OBSERVATION CHECK LIST

Cooperation of family members in management bean project.

Presence of bio fortified bean varieties in stores.

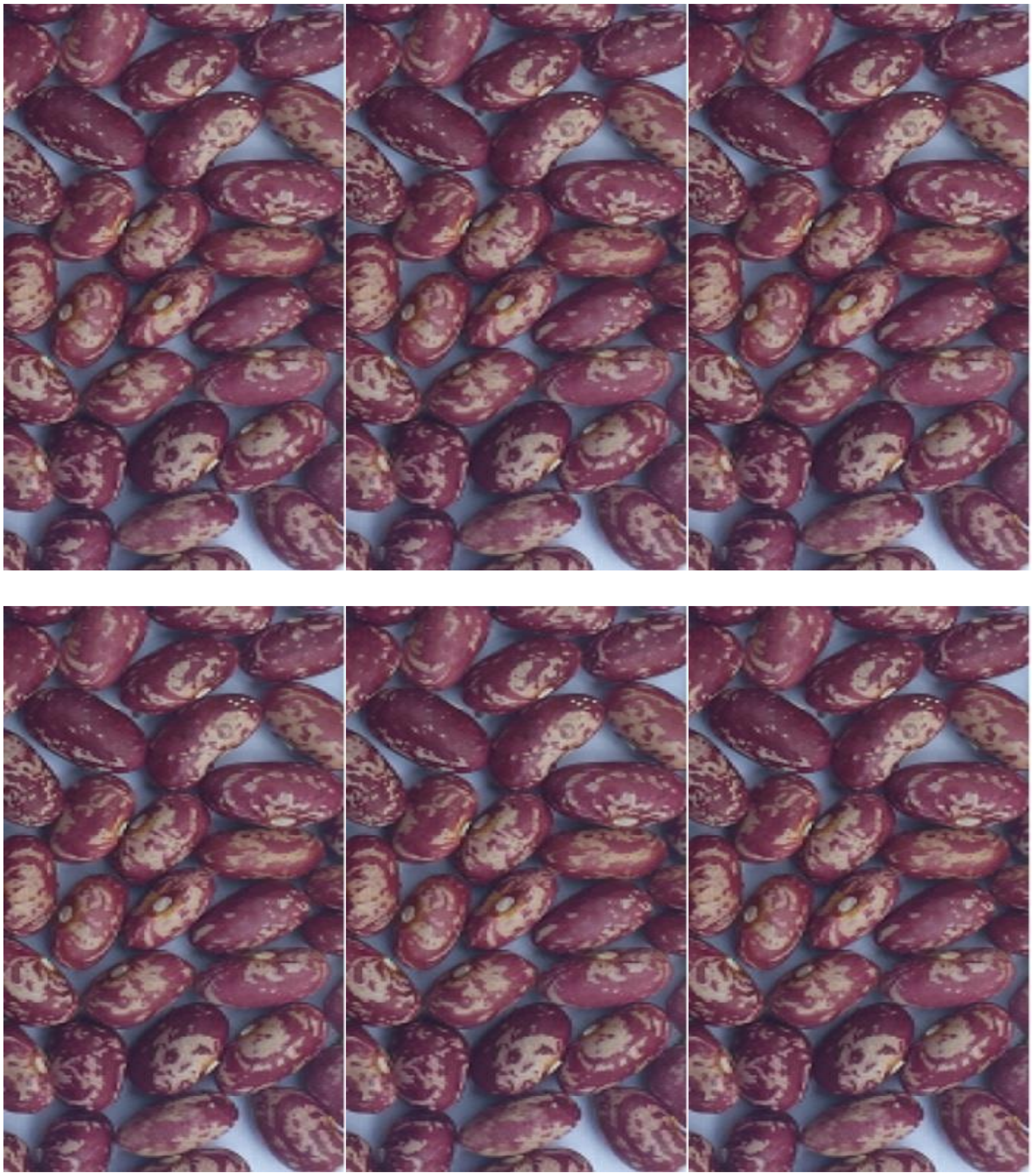
Commitment of farmer groups in bean projects to growing bio fortified bean varieties.

Participation of youth and women in bean business.

Farmers following up the standard operating procedures/guidelines set by Ministry of Health in prevention of COVID 19 pandemic.

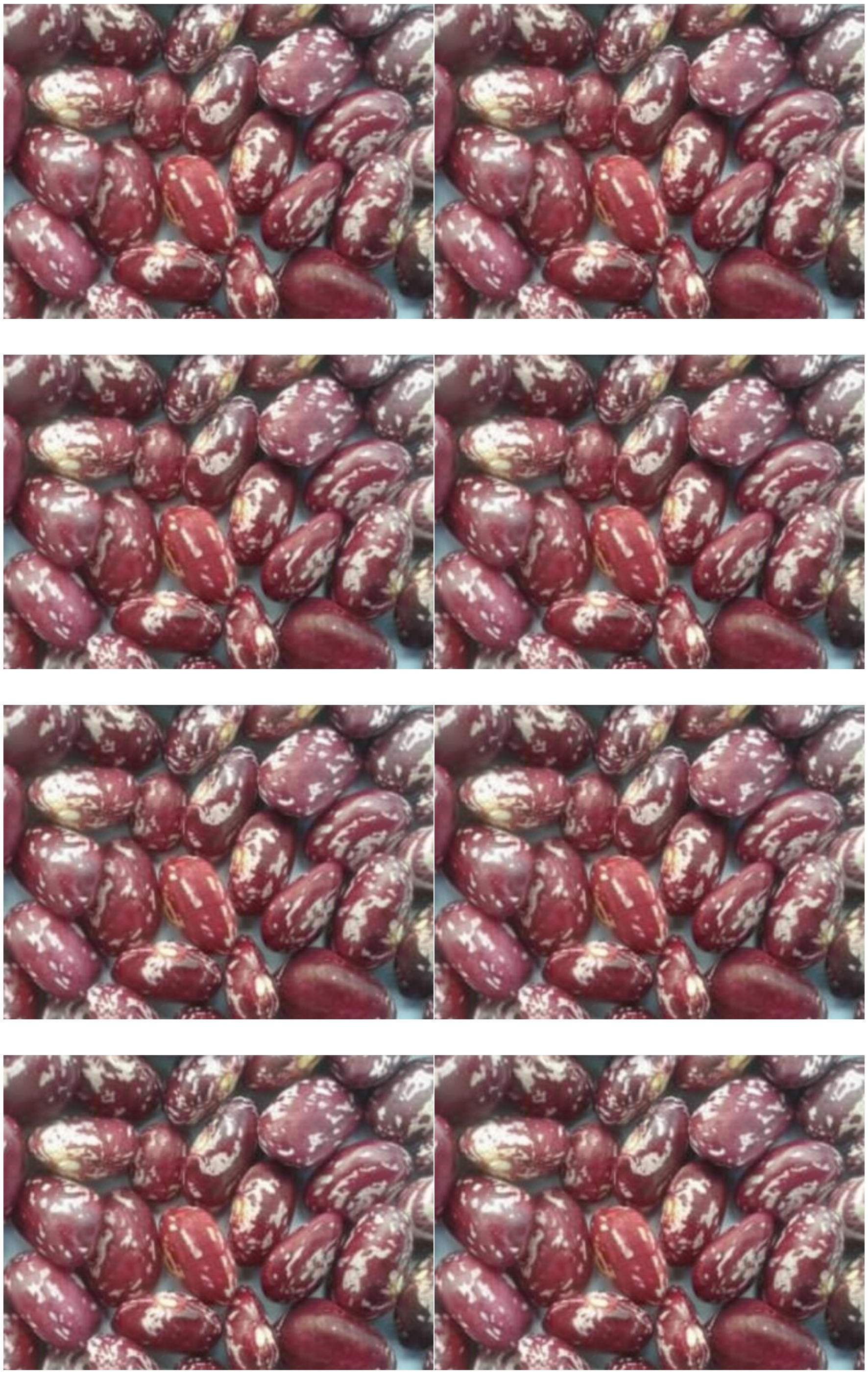
PHOTOS OF BIOFORTIFIED BEAN VARIETIES

APHOTO SHOWING NARO BEAN 1 VARIETY



APHOTO SHOWING NARO BEAN 2

A PHOTO SHOWING NARO BEAN 3



A PHOTO SHOWING NARO BEAN 4C

A PHOTO SHOWING NARO BEAN 5C