ANALYSIS OF THE FACTORS THAT INFLUENCE THE ADOPTION OF IMPROVED TECHNOLOGIES IN RICE PRODUCTION BY SMALL HOLDER FARMERS IN NAGONGERA SUB-COUNTY IN TORORO DISTRICT, EASTERN UGANDA.

BY

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BU/UP/2021/3429

A REPORT SUBMITTED TO THE FACULTY OF SCIENCE AND EDUCATION, BUSITEMA UNIVERSITY IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE A WARD OF A BACHELOR'S DEGREE IN SCIENCE EDUCATION, AGRICULTURE DOUBLE MAIN.

SEPTEMBER, 2024

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SEPTEMBER, 2024

DECLARATION

I, hereby declare that this dissertation is my own original work and has never been submitted any other university or institute for the same purpose

OCHIENG GERALD

Signature.....

APPROVAL

This is to certify that this research report entitled "factors influencing adoption of improved technologies in rice production in Nagongera sub county Tororo district" submitted in partial fulfilment of the requirement for the award of the degree of Bachelor of Science Education of Busitema University is a true record of work carried out by OCHIENG GERALD (BU/UP/2021/3429). I want to assert that this report has never been submitted to any other institution or university for any related purpose.

Signature: ..... Date 07/10/2024

Mr. Dramadri Gerald Afayo.

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DEDICATION

I dedicate this report to my father who tirelessly contributed to all the financial support required during the research study

ABSTRACT:

Rice is a staple food crop in Uganda, with small-scale farmers playing a vital role in its production. However, rice production in Nagongera, a rural community in eastern Uganda, faces numerous challenges, including low productivity, limited adoption of improved technologies, and inadequate knowledge of best practices. This study aimed to investigate the factors influencing technology adoption among small-scale rice farmers in Nagongera, with a focus on understanding the importance of rice production, identifying constraints to rice production, and examining current rice farming practices. Using a mixed-methods approach, combining both qualitative and quantitative data collection and analysis methods, this study explored the socio-economic, institutional, technological, and environmental factors that affect technology adoption among small-scale rice farmers in Nagongera. The study employed a survey questionnaire to collect data from 25 small-scale rice farmers, supplemented by in-depth focus group discussions with 10 farmers and 5 key informants, including agricultural extension agents, local leaders, and technology suppliers. The specific objectives of the study were to:1. Examine the importance of rice production among small-scale farmers in Nagongera, including its contribution to food security, income, and livelihoods.2. Identify the constraints faced by small-scale rice farmers in Nagongera, including biophysical, socio-economic, and institutional challenges.3. Analyze how farmers currently grow rice in Nagongera, including their knowledge, attitudes, and practices regarding rice production, processing, and marketing. The findings revealed that majority of the respondents (100%) benefited from rice production as source of income, 92% noted that rice production is crucial for food security,and 44% converted rice products into livestock feeds and 48% acknowledged that rice production is a good source of employment that enhanced the livelihood among small-scale farmers in Nagongera. However, farmers face numerous constraints, 68% of the respondents noted that limited access to inputs such as improved seeds, fertilizers, and irrigation equipements, 96% acknowledged impact of climate change as a huge constraint, at least every respondent noted the issue of pest and diseases as the main constraint, about 68% of the respondents said inadequate knowledge of best practices, and at least 60% noted that lack of credits and market information are also constraints. The study also found that farmers' current rice farming practices are characterized by limited use of technology, reliance on traditional methods, and inadequate post-harvest handling and processing. Several factors were found to influence farmers adoption to improved technology in rice production such as possession of technical skills, previous experiences with technoloqy, availability and awareness of the technology, level of education, age, among others. Basing on the reseach findings Government through extension agents should carryout mass sensitisation through a variety of media to equip farmers with rice growing skills and new technologies in rice production.

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CHAPTER ONE:

1 INSTRUCTION

1.1 Background

The cultivation of rice (Oryza sativa L. and Oryza glaberrima), holds a significant position in the production of staple food as rice acts as a staple food for over three billion individuals globally (Azizi and Lau, 2022). Rice is grown across all continents with Asia alone producing approximately 90% of the total worldwide rice production. China is the largest producer of rice, contributing around 28% of global rice production (Food and Agriculture Organization [FAO], 2022). This is followed by India accounting for about 22% of global rice production. The Major rice varieties cultivated in India include Basmati and short-grain rice (Ministry of Agriculture & Farmers Welfare, India, 2021). Since the green revolution, the amount of rice produced worldwide has increased threefold. To fulfill the demands of an ever-growing worldwide population and the effects of climate change and global warming, however, more rice must be produced without expanding the area under rice cultivation. Adopting modern improved technologies and sustainable rice production methods is the best way to address these issues.

In Africa Rice has been grown for more than 3000 years. Rice is currently cultivated in rainfed uplands and aquatic ecologies in more than 30 countries in Africa on nearly 10 million hectors of land. The major rice-producing nations in Africa include Nigeria, Egypt, Madagascar, and Senegal. Nigeria has emerged as the largest producer, contributing significantly to regional rice supplies. In 2021, Nigeria produced approximately 4.9 million metric tons of rice, followed by Egypt with around 4 million metric tons (FAOSTAT, 2022). Egypt is particularly noted for its high yields due to advanced irrigation systems and hybrid varieties.

In East and Southern Africa, Madagascar and Tanzania are the major rice producing countries while Rwanda is the smallest producer (FAO, 2010; Kanyeka et al., 1996; Rodenburg and Demont, 2009). In terms of area under rice, the rain-fed lowlands are the dominant ecosystems in these regions comprising 55% of the total area. Irrigated rice ecology (both highland and lowland) comprises 27% while rain-fed uplands comprise 18% of the area under rice. Though there are disparities across countries in the region, the biophysical conditions in East and Southern Africa (topography, water reservoirs, rainfall distributions and soils), suggests that there is untapped potential for improving rice production.

Rice is also the most traded food commodity across borders in the East African Community region, while traditional staples such as bananas are among the least traded. Rice is second to maize as the food commodity most imported into, as well as most exported from the East African Community (Oonyu, 2011). Over the last decade, the consumption of rice in the East Africa has increased by 360% owing to the change in eating habits with urbanization (Nanfumba et al., 2013). As a result, supply of rice in Uganda and other East African Community Partner States cannot keep-up with the rapidly expanding regional market demand.

According to the Eastern African Grain Council (EAGC), East African Community countries import a substantial amount of rice (over 500,000 tonnes annually), valued at approximately USD 500 million a year, from countries in Asia (Kilimo Trust, 2014). Tanzania is the largest producer and consumer of rice in East Africa, the annual consumption for Tanzania is 2,048,000 metric tonns followed by Kenya (370,000 metric tonns) and Uganda (350,000 metric tonns) (Kilimo Trust, 2017). On the other hand, production levels are 1,848,000 metric tonns in Tanzania, 122,465 metric tonns in Kenya, and 300,000 metric tonns in Uganda. This means Uganda, Kenya, and Tanzania require about 500,000 metric tonns to bridge the gap between consumption and production, yet this demand keeps growing on an annual basis across the East and Central African region.

Uganda, like many other African countries (Faye et al., 2020; Lee and Choi, 2020), rice is one of the most important cereal crops. (Bua and Ojirot, 2014). It is mostly grown by smallholders for income, although some of the household production is retained for consumption (Akongo et al., 2017). Uganda produces up to 350,000 metric tonns of rice annually which is equivalent to import substitution of about 104 million USD per year. However, Uganda is still a net importer of rice, since domestic demand exceeds its supply/ production (Barungi and Odokonyero, 2016). The rice supply gap in Uganda is majorly caused by low volumes harvested.

Uganda in East Africa, contributes a significant amount of rice that makes up the total Rice production in East Africa. Rice cultivation in Uganda dates back to the pre-colonial era, where it was grown primarily for subsistence. According to the Uganda National Rice Development Strategy (NRDS) 2018-2028, rice cultivation was mainly concentrated in the eastern region of Uganda, especially in the districts of Iganga, Bugiri, Tororo, and Busia. However, production was low due to the use of traditional farming methods, limited access to inputs and markets, and poor infrastructure. In Uganda, both upland and lowland rice varieties are cultivated. Upland rice is typically grown in areas with well-distributed rainfall, while lowland rice is cultivated in irrigated or swampy areas (Kikafunda et al., 2019). Some of the common rice varieties grown in Uganda include NERICA (New Rice for Africa), Basmati, and Jasmine rice

In the 1960s, the government of Uganda introduced irrigation schemes to support rice production. This led to an increase in production, particularly in the districts of Kamuli, Iganga, and Bugiri. However, the political instability in the country in the 1970s led to a decline in agriculture, including rice cultivation.

After years of neglect, the government of Uganda revived efforts to promote rice production in the country in the 1990s. This included the establishment of the Rice Research Programme at the National Agricultural Research Organization (NARO) in 1991 and the promotion of private sector participation in rice production through the Agriculture Sector Investment Plan (ASIP) in 2001 (Nawendegyeya et al., 2018).

Today, rice cultivation in Uganda has expanded beyond the eastern region to other parts of the country, including the northern districts of Amuru, Nwoya, and Gulu. According to the Uganda Bureau of Statistics (UBOS), rice production has increased steadily in recent years, reaching 237,000 metric tonnes in 2020, up from 151,000 metric tonnes in 2016.

The availability of food and better livelihood for the citizens are major concerns for the government in most developing countries in the world. Improving the technologies in production of Agricultural commodities as well in other non-agricultural sectors can to a greater extend help to improve the food supply and as such improve the standard of living of the people. These improved technologies include among others Agricultural mechanisation, use of improved seeds and use of synthetic agrochemicals to improve production.

Rice has recently become an important crop for tackling food insecurity and poverty in Uganda. Over three-quarters of the country's local rice production occurs in irrigation and rain fed lowlands in eastern and northern Uganda. Despite of the increasing demand for rice in the country, the production has remained low probably because of the poor traditional methods used in its production and other environmental factors. There is great need for more extension services to the smallholder farmers so as to improve their awareness of new technologies that can improve rice production.

Rice cultivation in Tororo District, located in southeastern Uganda, has evolved significantly over the years.Historically, agricultural practices in Tororo District were dominated by subsistence farming, primarily focused on traditional crops like millet and cassava. However, as population pressures increased, farmers began experimenting with cash crops, including rice, especially in areas with suitable wetlands. In the 1970s and 1980s, the Ugandan government launched several initiatives aimed at increasing rice production to improve food security and stimulate economic growth. Programs were established to educate farmers about modern farming techniques, irrigation practices, and pest management. In response to the government initiatives, rice production increased steadily in the district and currently Tororo District is recognized as one of the main areas

of rice production in eastern Uganda. The cultivation is driven by favorable climatic conditions, community initiatives, and agricultural policies aimed at increasing food security. Tororo District benefits from a tropical climate characterized by two main rainy seasons, typically from March to May and September to November. These seasons provide adequate water for rice cultivation (Uganda Bureau of Statistics [UBOS], 2020). The soils in the region are predominantly loamy and clay, which retain moisture effectively, crucial for rice farming (Kibangabi, 2019).

Information about rice growing and factors that influence technology adoption among small scale rice farmers in Nagongera sub county is not available since no study about it has yet been conducted and as such, this study is aimed at assessing and providing information about the factors that influence the adoption of rice in this sub county.

1.2 Statement of the problem.

Despite several government and non-government efforts through the relevant officers and other responsible bodies in the agricultural sector to improve Agricultural production through dissemination of relevant technologies to small holder farmers, there has still been a significant decline in Agricultural production in most parts of Uganda. Nagongera sub county in Tororo district falls a victim of this constant and in some cases declining yield in rice production due to low technological advancement and adoption by farmers. Most small holder farmers still prefer using the traditional methods of rice production which leaves them with very minimal harvest.

This study aimed to establish the factors that influence the adoption of improved rice production technologies in Nagongera

1.3 Study justification:

Rice is a staple food for millions of people worldwide, and small-scale farmers play a crucial role in meeting this demand. However, these farmers face numerous challenges, including low productivity, limited access to resources, and vulnerability to climate change. Technology adoption has the potential to address these challenges, but its adoption rate among small-scale rice farmers remains low.

This study aimed to investigate the factors influencing technology adoption by small-scale rice farmers. Understanding these factors will help identify the constraints and opportunities for technology adoption, enabling policymakers and development organizations to design targeted interventions that will contribute to improved productivity and efficiency among small-scale rice farmers and a more effective technology dissemination and adoption strategies

By exploring the complex interactions between these factors, this study will provide valuable insights for stakeholders working to promote sustainable agricultural development and reduce poverty among small-scale rice farmers.

1.4 Research questions:

What are the importance of rice production in Nagongera?

What are the limitations affecting rice production in Nagongera?

What are the ways in which farmers are growing rice in Nagongera?

What are the factors that influence the adoption of improved technologies in rice production in Nagongera?

In which ways can the adoption of improved technologies be improved?

1.5 Main objective

To analyze the factors that influence the adoption of improved rice production technologies by small scale farmers of Nagongera in Tororo district.

1.6 Specific objectives

To evaluate the importance of rice production in Nagongera.

To identify the constraints hindering rice production in Nagongera.

To identify the ways in which farmers are currently growing rice in Nagongera.

To study the factors influencing adoption of improved technologies in rice production in Nagongera.

To assess and recommend the ways of improving the adoption of improved technologies in rice production in Nagongera.

1.7 Scope of the study

The research study was carried out on the small holder farmers of Nagongera sub county engaging in small scale rice production. This area was choosen because of the high rice demands by the local consumers despite the low production potentially due to poor rice growing methods.

1.8 Significance of the study

The results of this study will be relevant to the respective stakeholders like the farmers, policy makers, extension officers and research as it will provide an in-depth insight to the factors influencing adoption of improved technologies in rice production by small holder farmers.

1.9 Conceptual framework

The main dependent variable of this study were the factors influencing adoption of improved technologies in rice production by small scale farmers whereas the independent variables were; size of the farm, sex, age and education levels of the respondents.

CHAPTER TWO:

2 LITERATURE REVIEW

2.1 The importance of rice production;

The importance of rice as a commodity has significantly increased over the past decades in Sub-Saharan Africa (SSA) (Seck et al., 2010). Rice plays a pivotal role in African rural household food security and national economies. Since the 1990s urbanization and increased income associated with rural–urban migration (Kennedy and Reardon, 1994) has led to an increase in per capita rice consumption. In SSA rice grain yield per unit area and the total area under production have stagnated (Otsuka and Kalirajan, 2005). The rice value chain creates numerous jobs, from farming to processing and marketing, helping to alleviate poverty in the rice growing regions (Kituuka, 2021). In Uganda today,rice largely contributes to food security, with many households relying on it as a primary food source (Uganda National Planning Authority, 2020). Previously, Hyuha et al., (2005) reported that rice has some favourable impact on the welfare of the farm families involved in its production because it ensures food security and can be sold for money to cater for other household needs.

Income Generation is one the major importance of rice production. The Ugandan government wrote that Increased rice production has led to higher incomes for farmers, fostering economic growth within the community (GOU, 2019). There are however still possibilities to expand area under rice and improve productivity given the positive land balance (FAO, 2010) and the relatively low level of adoption of modern technologies (Balasubramanian et al., 2007). Clearly, there is a need to study important yield reducing factors closely in order to determine strategies to help increase and maintain rice productivity on farmers' fields and, through that, overall regional rice production.

Rice cultivation has played a crucial role in diversifying Uganda's agricultural sector. By promoting the cultivation of rice alongside traditional crops like maize and cassava, the country reduces its reliance on a single crop and enhances agricultural resilience to climate change and market fluctuations (IFPRI, 2019).

2.2 Constraints of rice production

Rice production in Uganda has seen significant growth over recent years, but several challenges continue to hinder its full potential. Both abiotic and biotic constraints limit rice production. Abiotic constraints include climate changes like variability in rainfall pattern, temperature fluctuations, extreme weather events for instance, recent studies indicate that climate variability has affected agricultural productivity by disrupting the growing seasons, leading to reduced harvests (Mugenda et al., 2021). Poor soil conditions such as soil infertility, soil salinity and acidity are also a big challenge. Biotic constraints include weed infestation, pests and diseases. Among biotic factors, weeds are the most serious, followed by diseases. Weeds are generally more competitive than rice in infertile soils. Striga is a parasitic weed of dryland cereals, including rice. Estimated yield losses due to weeds range from 30 to 100%. Weed infestation and loss of Nitrogen reduce yields by 25% on intensive dryland rice farms of West Africa (Becker and Johnson, 2001). Stem borers and rice bugs are the major insect pests. Nematodes are serious problems in continuously monocropped dryland rice fields (Coyne et al., 2004; Plowright and Hunt,1994) and can reduce yields by up to 30%. Termites are problems in some areas. Rodents and birds damage rice crops in all ecosystems.

On the other hand, socio-economic and institutional constraints also play a significant role in lowering rice production. Socio-economic constraints include limited access to; markets, quality inputs, credits, technologies and extension services, inadequate labour supply and inadequate capital. Even when production improves, many farmers experience difficulties accessing lucrative markets, which can lead to price volatility. Without a stable market, farmers may face challenges in selling their harvests at prices that reflect their investment (Wamuyu, 2021). Many smallholder farmers lack access to extension services and training that can help them adopt modern agricultural practices. This knowledge gap can inhibit their ability to increase productivity and implement sustainable farming practices (Mugisha et al., 2020). Farmers often face challenges in accessing high-quality seeds, fertilizers, and agrochemicals. The availability of affordable and quality agricultural inputs can significantly enhance productivity, yet many farmers rely on suboptimal products due to cost and distribution barriers (FAO, 2019). Institutional constraints include poor infrastructure, lack of policies and frame works, limited research and development centers. Insufficient infrastructural development, such as poor transport networks and lack of storage facilities, limits farmers' access to markets. This not only affects their ability to sell their produce but also leads to post-harvest losses due to inadequate storage (World Bank, 2022).

2.3 Ways how farmers are currently growing rice;

Rice is commonly grown by transplanting seedlings into the puddled soil (wet tillage) in lowlands of Asia (e.g., India, Indonesia, Bangladesh, Myanmar) and Africa (e.g., Madagascar, Mali). Transplanting of rice is done manually or by machine. The manual transplanting method involves growing of seedlings in a nursery and replanting of 20–30-day-old rice seedlings into puddled soils. The rice seedling nursery may be raised on wet bed or dry bed or dapog or mat or modified mat methods depending on the locality, soil type, rice ecosystem, and the resource availability. In several Asian countries, the labor-intensive transplanted rice production systems are being practiced until now, where even the labor supply is abundant due to the population growth. For machine transplanting the rice seedlings are grown in trays or in mat-type nursery in which a thin layer of soil mixed with farm yard manure or compost is placed on a polythene sheet and rice seedlings are raised. Mats of rice seedlings from the trays or mat-type nursery are used for machine transplanting.
Direct seeding of rice is another method used to grow rice. It is done by (1) dry seeding, and (2) wet seeding (Kumar and Ladha 2011). At present 23 % of rice area is direct-seeded globally (Rao et al. 2007; Kumar and Ladha 2011). Dry-Direct seeding method consists of sowing dry seeds on dry soils. Seeds can either be broadcasted, drilled, or dibbled. This method is practiced traditionally in most of the Asian countries in rainfed upland ecosystems and is also used in irrigated areas with precise water control as aerobic rice. Wet-Direct seeding method involves sowing of pre-germinated rice seeds in wet puddled soils. Wet- Direct seeding is done by broadcasting the seeds on puddled soil or by using a drum seeder. This method is practiced in favorable rainfed lowlands and irrigated area with good facility of drainage as in Malaysia, Thailand, Vietnam, the Philippines, and Sri Lanka (Pandey and Velasco 2005; Weerakoon et al. 2011). In Asia, rice farmers are shifting to direct seeding method to reduce labor input, drudgery, and cultivation cost (Rao et al. 2007; Kumar and Ladha, 2011).

Uganda is one of the countries in Africa where rice production has gained prominence over the years. The country's diverse agro-ecological zones provide suitable conditions for rice cultivation, leading to an increase in both small-scale and commercial rice farming. According to a study by Mugisha et al. (2020), rice is predominantly grown in Eastern Uganda, particularly in districts like Bugiri, Busia, and Tororo.

Traditionally, Ugandan farmers prefer their indigenous methods and practices in rice production. These traditional practices tend to vary from society to society and/or region to region. A review by Nalubwama et al. (2021) showed that many small-scale farmers in Uganda practice rainfed upland cultivation, where rice is grown on elevated terraces or flat land without irrigation. Farmers rely solely on rainfall for water supply, often employing manual labor for transplanting and weeding. In lowland areas with reliable access to water, traditional farmers adopt the system of paddy farming. They create bunds and ditches to facilitate controlled flooding, which allows

rice plants to grow in standing water (Ahimbisibwe et al., 2020). A study in 2015 revealed a relatively newer traditional method of rice growing which has gained some popularity in some parts of the country. System of Rice Intensification involves transplanting very young seedlings and maintaining wider spacing between plants, allowing for greater root and canopy development (Jagwe et al., 2015). System of Rice Intensification has been practiced by some farmers in Uganda, particularly in the Kyoga and Bunyoro regions.

Bakundukize et al. (2019) says traditional rice farmers in Uganda often rely on organic fertilizers such as farmyard manure or crop residues to enhance soil fertility. This practice aligns with the cultural preference for organic production and the limited access to synthetic inputs.

2.3.1 Technology concept;

Agriculture has been involved in the production of food and a means of subsistence since human civilization. Since then, it has presented numerous chances for some people to start their own business. Agriculture was viewed as an unprofitable endeavor in the past, as the globe was heading towards industrialization. But things remain the same even now. However, agriculture continues to be a vital source of income for a large number of people worldwide. New technologies for the advancement of agriculture are being introduced daily. However, there is a limited rate of acceptance of such new technologies (Simtowe et al., 2016; Yigezu et al., 2018; Ruzzante et al., 2021). Investigating the matter thoroughly reveals that a variety of elements influence the adoption process of these new technologies. (Simtowe et al. 2016; Ruzzante et al. 2021).

2.3.2 Adoption concept;

Adoption has been defined differently by many authors. "The integration of a new technology into existing practice and is usually preceded by a period of 'trying' and some degree of adaptation" is how Loevinsohn et al. (2012) defined adoption. However, according to Feder et al. (1985), adoption is "a mental process an individual pass from first hearing about an innovation to final utilization of it," as stated by Bonabana-Wabbi (2002). Another definition of adoption provided by Feder et al. (1985) was "the integration of an innovation into farmers' normal farming activities over an extended period of time." The real practice and time factor are included in each of these definitions.

Adoption was divided into two categories by Feder et al. (1985): "individual adoption" and "aggregate adoption." In 1985, Feder et al. were describing the individual adoption as an adoption occurring at the level of the farmers. "The degree of use of a new technology in the long-run equilibrium when the farmer has full information about the new technology and its

potentials" is the definition for this individual adoption. Diffusion and the time factor are taken into account in aggregate adoption. Thus, "the spread of a new technology within a region" is the definition of diffusion. Consequently, the utilization of a single novel technology within a community, region, or population is aggregated to study the overall adoption. "Diffusion is the process by which an innovation is communicated through certain channels over time among the members of a social system," according to Rogers (1983), who discusses the spread of technology. Additionally, the time factor is increased in this definition. This concept also covers a unique communication method in which the message is delivered via cutting-edge technology.

2.3.3 Factors influencing technology adoption;

Several factors influence technology adoption in the sub Saharan Africa. These factors were divided into three groups by Melesse (2018) and Teklewold et al. (2013), which were as follows: "(1) Factors pertaining to the features and comparative efficacy of technology, (2) Program and institutional factors, and (3) Producers' and Farmers' characteristics. The "Factors related to the characteristics of producers" were as follows: age, gender, educational attainment, previous experience with the introduced technology, wealth status, farm size and its features (e.g., plot characteristics), labor availability, acquisition of necessary resources (own resources, subsidies, grants, etc.), and tolerability of risks associated with the introduced technology. Certain criteria outlined by Ugochukwu and Phillips (2018) are comparable to some of these. The “Factors related to the characteristics and performance of the technology” include factors such as income generation ability, the attitude towards the performance and other characteristics such as availability of technology as well as of the inputs, complexity of the technology in usage, profitability in comparison to similar technologies, and the payback period. The third category, is the “Institutional factors” which include factors such as access to awareness on the technology, the amount and the quality of the information received about improved technologies, availability and accessibility to raw materials and other inputs as well as markets, availability of credit, the ownership of land, and the availability of required infrastructure and other facilities were also mentioned. Support received through extension services were also identified as one key factor in technology adoption.

2.4 Improving adoption of modern technology among farmers.

In sub-Saharan Africa, small-scale farming is the mainstay of agricultural production. Numerous structural and legislative problems have historically hindered the productivity of small-scale agricultural systems, resulting in sluggish yield growth and even stagnation for particular crops and regions. In many developing nations, inadequate access to, incorrect use of, or lack of technology are among the factors attributed to food insecurity (von Braun et al. 2007; McCalla 1999). It appears to be assumed that in locations with certain physical and societal constraints,

agricultural productivity will consistently rise and food security issues will be resolved with the correct technology in place (better seeds, fertilizers, tools, procedures, and so forth). Such assumptions are based on the expectation that if there is a solution to a problem, then it is rational that people who know of the existence of such a solution, have access to it, and are facing problems for which the solution is appropriate will use it to find a way out of their problem (Beckford 2002). At various sizes, international organizations, national governments, regional authorities, and local concerned groups try to increase the productivity and profitability of agriculture by introducing technology that meet or lessen some of the production restrictions on farms. These limitations include, among other things, overgrazing, poor seed quality, soil erosion, depleted soil nutrients, and the use of antiquated farming equipment and methods. These initiatives have mostly produced little results (Ahmed 2004). various farmers in various countries are still without access to several basic technology, particularly those engaged in small-scale production (Gallup et al. 2000). When new technologies are brought by outside extension agents, acceptance rates are typically low at first, and these low adoption rates have mainly failed to expand naturally outside of the communities into which such introductions are made (Moser et al. 2006). Some of these technologies are available, but their adoption rates have been quite low in certain places, which has limited their expansion and prevented them from providing the desired benefits (Lado 1998). Numerous research on the subject of enhancing farmers' adoption of technology have been carried out by institutions and private citizens. According to Katungi et al. (2009), institutional support for technological adoption is critical from the government and pertinent agricultural agencies. Subsidies, advantageous market circumstances, and supportive regulations might encourage rice farmers to use new technologies. Another study highlights that reliable and efficient supply chains for inputs and the availability of extension services are vital for the successful adoption and implementation of new technologies (Mkhabela et al., 2011). A study by Katungi et al. (2009) gave an insight on the importance of farmers' access to information and how it plays a critical role in technology adoption. The study suggests that farmers need reliable and up-to-date information about improved technologies, their benefits, and how to effectively utilize them. Effective communication channels and extension services are required to disseminate this information to rice growers. Timely access to information through demonstration plots, field days, and training programs fosters understanding and promotes adoption. Sserunkuuma, D., & Muwonge, J. (2016) highlighted that providing farmers with training programs focused on new agricultural technologies helps them understand the benefits and functionalities. Hands-on training sessions can promote practical knowledge and skills. Nakaweesi, D. (2017) mentioned that improving access to credit, micro-financing, and insurance can help farmers afford new technologies. Financial institutions should design products tailored to the agricultural sector to reduce risk.

The adoption of modern technologies in rice farming has been identified as an important factor in enhancing productivity and improving livelihoods among rice farmers in Uganda. Studies such as Nakabuye et al. (2019) have highlighted the importance of adopting technologies such as

improved seed varieties, mechanization, irrigation systems, and pest management practices to increase rice yields and income for farmers.

CHAPTER THREE:

3 MATERIALS AND METHODS.

3.1 Study area description:

Located at Coordinates: 00°45′N 34°05′E, Tororo District is a district in the Eastern Region of Uganda. Its total land area is 1,196.4 km2 (461.9 sq. mi), and its population (as of 2012) is 487,900, meaning that its population density is 407.8/km2 (1,056/sq. mi). The district office is located in the town of Tororo.

The districts of Mbale to the north, Manafwa to the northeast, Kenya to the east, Busia to the south, Bugiri to the southwest, and Butaleja to the north-west encircle Tororo District. The district's major town, Tororo, which also houses the district office, is situated about 230 kilometers (140 miles) east of Kampala, Uganda's capital and largest city.

Nagongera sub-county is bordered by several other sub counties with in the district of Tororo. Towards the North, Paya sub county, Petta and Kisoko sub counties border it towards the North, East and South East respectively. Mulanda borders it to the south, Nabuyoga to the South West and lastly Kirewa borders it to the West.

A longitudinal study was conducted across two purposively selected villages of Atan cell and Mahanga cell all found in Nagongera sub-county in Tororo district Eastern Uganda. The villages were selected basing on their previous records of rice production which was obtained from the area extension officer.

3.2 Research Design

The research was carried out using a descriptive cross-sectional survey. The researcher employed both quantitative and qualitative analysis approaches in order to get the attention of a bigger number of respondents and data to be collected. Quantitative design aided in the collection of information from variables that involve measurements, whereas qualitative design aided in the collection of ideas, perceptions, and explanations.

Target Population

A target population refers to the whole group of people or items which the researcher wishes to study. This study targeted small scale rice farmers, agricultural officers and local leaders in Nagongera sub county, in Tororo district, Eastern Uganda.

Sample Size

A sample is the selection from the population from which information will be obtained. Sample size is the number of the selected sample population that represents the entire target population. The research population was composed of a sample size of 25 respondents, consisting of both men and women. The researcher used this size due to financial constraints.

3.3 Sampling techniques

A purposive sampling and simple random sampling techniques were employed by the researcher. Purposive sampling technique was applied to get data from respondents who have direct experience with agricultural policies and interventions like leaders and extension officers in Nagongera Tororo. According to (Tongco, 2007), purposive sampling is a sampling technique in which the researcher chooses individuals who are knowledgeable about a certain aspect to participate in the study. Simple random sampling was used to get respondents who are easily available for example the farmers.

Sampling tools:

Questionnaire

A questionnaire is a research instrument consisting of a series of questions for the purpose of gathering information from respondents. The researcher designed a questionnaire that consist of both open-ended and closed-ended questions. The open-ended questions required detailed explanations while the closed-ended questions restricted the views of the respondents. The questionnaire was administered through interview method as this method was very fast and provided relatively accurate results.

Interview checklist

A semi structured interview checklist is a tool which does not require the interviewer to strictly follow a formalized list of questions. Interviews were used by the researcher to interact with respondents in the focus group discussions and key informants who would not be in position to effectively layout their responses through questionnaires which may require them to read and write.

3.4 Data collection:

Pre-testing of the data collection tools:

Before the actual data collection day, the questionnaires were pre-tested in one of the villages and administered to five respondents. Pre-testing helped to check the validity and reliability of the questionnaire items. The respondents who were involved in the pre-testing were not given chance to participate in the actual total sample size of farmers for interviewing. The obtained results from the pre-testing was used to revise and re-organize the instrument before it was administered to the research sample. Questions that was not clear and specific to the study objectives or complex to the respondents was adjusted accordingly, before starting the actual data collection exercise.

Actual data collection:

Primary data collection:

Combinations of methods (triangulation) were used to collect primary data. Primary data were collected using structured questionnaires and a checklist.

Structured questionnaire was administered to 25 target respondents. A checklist was used for Focus Group Discussion and key informants. The questionnaires and checklist were used to find out the adoption rates of improved rice production technologies and determine the independent and intervening factors that influence the adoption of improved rice production technologies in the selected villages

Focus Group Discussion; A checklist was prepared for three groups comprising of four respondents; two farmers, one non farmer and one rice business dealer. The focus group discussions were used to bring the respondents together as they brain storm on the questions in the checklist. The Focus Group Discussions were important in obtaining information that could not be easily obtained through a questionnaire. A topic guide to aid discussion was prepared to enable exploration of various aspects in the study.

Key informant interviews; A key informant is an individual who is accessible, willing to talk and has a great depth of knowledge about the issue in question. In this study, five key informants who were village extension officers, experienced rice business dealersand local leaders with in Nagongera. These people were interviewed to get their response on the issues researched about using a checklist.

Secondary data collection:

Secondary data was collected from relevant literature, reports, and official documents both in soft and hard copies.

3.5 Data analysis:

Quantitative data was analyzed using statistical software (Microsoft excel), while qualitative data was analyzed thematically. The findings were triangulated to ensure validity and reliability.

3.6 Ethical considerations:

Ethical approval was sought from the relevant authorities, and informed consent was obtained from all participants.

CHAPTER FOUR:

4 PRESENTATION, ANALYSIS AND DISCUSSION OF DATA

4.0 INTRODUCTION

Demographics and socio-economic characteristics of the respondents. These include sex, age, financial status, educational level, occupation.

4.1 Sex of respondents

According to the study results, more males (80% of the respondents) participated in rice cultivation as compared to females (20% of the total respondents). Table 1 below. During the focus groups more males participated than females, still indicating that more percentage of males are engaged in rice cultivation than females. During the oral interviews with the respondents, some of them were heard saying that rice production requires a lot of energy which females don't have and thats why they rarely participate in the rice production. Research by Doss (2014) highlights that women often have less access to agricultural resources, including land, credit, and extension services, compared to their male counterparts. This limited access directly affects women's capacity to engage in rice production.

Table 1: Demographics and socio-economic characteristics of the respondents.(n=25)

Variables	Range	Frequency	Percentage (%)
Sex	Male	20	80
	Female	5	20
Age	18-25	4	16
	26-45	12	48
	46-50	6	24
	51-above	3	12
Marital status	Single	6	24
	Married	14	56
	Widowed	2	8
	Divorced	3	12

Level of education	Informal (Didn't attend school)	3	12
	Primary education	13	52
	Secondary education	7	28
	University/tertiary education	2	8
Main occupation	Farming	22	88
	Employee	1	4
	Business	2	8
Average annual income (UgX.)	50,000 - 200,000	5	20
	300,000 - 400,000	8	32
	400,000 - 500,000	10	40
	700,000 - above	2	8

Source: field results

4.2 Age of respondents

Most of the respondents were in the age range of 26 to 45 years as shown in the table 1 above. 16% were 18-25years,48% were 26-45years, 24% were 46-50years, 12% were 51years and above. The focus groups involved members of between 30 to 50 years of age. The focus groups discussion pinned this to the fact that young people don't have access to land and spend most of their time in trading centers doing gambling activities. This finding relates to a study by De Janvry et al. (2005), that younger farmers typically possess better physical endurance and strength, enabling them to perform labor-intensive tasks essential in agriculture, such as tillage and harvesting. As individuals age, they may experience declines in physical ability, leading to reduced participation in strenuous activities and a reliance on less demanding agricultural tasks or management roles.

4.3 Marital status.

Basing on the data collected, most of the respondents were married followed by the single persons. Table 1 above shows that 24% were single, 56% were married, 8% were widowed and 12% were divorced. During the focus group discussions, it was noted that married people majorly relied on rice to feed and provide for their families. One member said rice cultivation is

the only source of income that she uses to pay fees to her children. Single, widowed and the divorced farmers complained about less family labor that restricts their performance in rice cultivation.

4.4 Level of education

The data collected revealed that most rice farmers in Nagongera sub county are less education with most of them having only the primary leaving education certificate. Table 1 illustrates that 3 respondents (12%) did not go to school to attain formal education, 13 respondents (52%) had primary education, 7 respondents (28%) had secondary education and only 2 respondents (8%) had University/tertiary education.

Respondents said the low economic status of their families did not allow them to go to school during their early days. The female respondents reported that they were not given chance to go to school by their parents.

4.5 Occupation

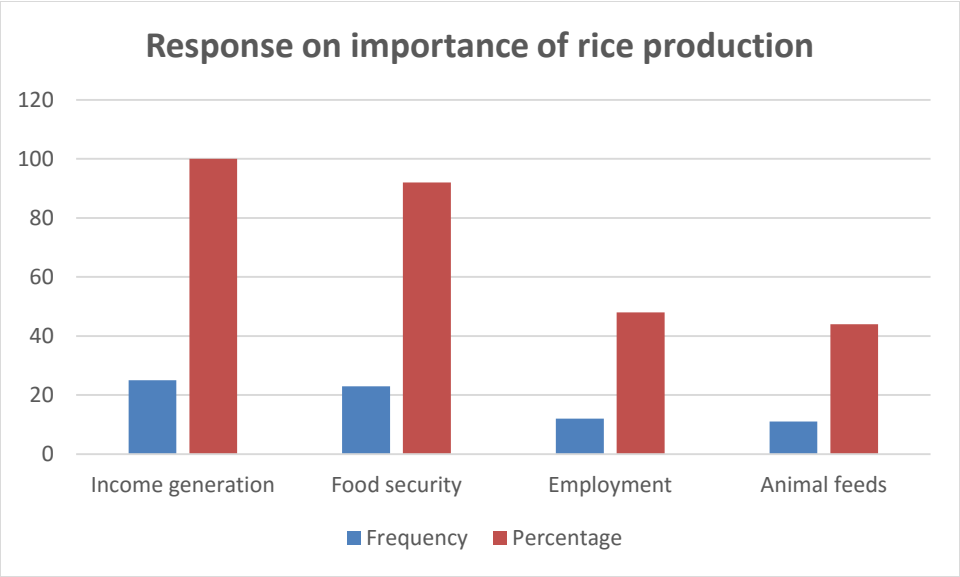
According to the study finding, majority of the respondents (88%) were mainly farmers, and the other 12% of the respondents did not practice farming as a main occupation. Those who practiced farming as a main occupation said they had no other options but to resort to agriculture giving reasons that other occupations require qualifications which they don't have and also that they don't have the capital to start up a business.

4.6 Importance of rice production

Source of food.

Rice is a critical source of calories and micro-nutrients for millions of Ugandans. Its adaptability to various climatic conditions makes it an important crop for food security (National Planning Authority, 2022). According to this study, many (92%) farmers said they derived their family food from rice products. During an open discussion with the respondents, rice was ranked third as a staple food in the area followed by maize and cassava ranked as the main staple food. This implies that rice plays a very important part in food provision

Figure 1: Response on importance of rice production(n=25)



Income generation.

The study revealed that 100% of the farmers in Nagongera sub county grow rice with a purpose of generating income. Some respondents noted that rice is one of the most economically rewarding crop in Nagongera coupled with its shorter gestation period. In Nagongera, cassava is the most grown crop on dry land area and it is also used as the staple food however it experiences a serious prices fluctuation even up to as low as Uganda shillings 300. This fall in price makes farmers to resort to rice growing as a source of income from crops.

Animal feeds.

The findings reveal that few farmers (44%) derived their animal feeds from rice. During a focus group discussion, it was mentioned that because of the small prices offered for rice grains by the buyers, the farmers are forced to sell off even the rice brans to collect extra profit from their rice other than feeding it to their animals. Majority of the farmers explained that rice production is very a tiresome, labour intensive and costly exercise and as such they cannot convert fresh rice plants into animal feeds yet they graze the animals on other grasses. Ochieng et al., (2023) earlier mentioned something related to this finding. In their study they mentioned that by-products of rice production, such as rice bran and broken rice grains, can be effectively used as animal feed. These by-products contain essential nutrients and are cost-effective alternatives to commercial feeds, benefiting livestock farmers.

Employment

The study also found that rice production is a very good source of employment opportunities for the people Nagongera. Although the employment is not direct, a relatively large number (48%) of respondents acknowledged the benefit of rice production in terms of employment. Rice production chain employs a variety of people right from land clearance, planting, weeding, harvesting, post-harvest handling up to the processing stages. The establishment of rice milling facilities by business people within the village trading centers further enhances job creation in rural areas.

4.7 Rice production constraints

Rice production has experienced a lot of constraints that hinder its smooth production. These constraints can be grouped into different categories as abiotic, biotic, socio-economic and institutional constraints.

Abiotic constraints.

The abiotic constraints studied included climatic change and nature of soil.

Climate change.

Drought and heat are identified as major abiotic stresses that reduce crop productivity and weaken global food security (Grover et al., 2011). Given the current and growing impacts of climate change, the occurrence and severity of these stress factors are likely to increase. This leaves communities that solely rely on rainfall for Agriculture with no other options but to adopt climate resilient technologies in Agriculture. According to the results, 96% of respondents confirmed that climate change is a big constraint to rice production. Data collected from the field revealed that climate change significantly affects rice production through various mechanisms, including changes in temperature, altered precipitation patterns, and increased frequency of extreme weather events. Report from the study indicates that increased temperatures lead to reduced yields, as rice is particularly sensitive to heat stress during the flowering stage. This finding relates to kumar's finding that elevated temperatures can also accelerate the maturity of rice plants, which may lead to lower grain quality and reduced nutrition (Kumar et al., 2018).

Just like the earlier study by Lobell et al., (2011) this study also found out that changes in precipitation patterns affected water availability for irrigation, essential in rice cultivation, particularly in regions dependent on monsoonal rainfall. During the focus groups discussion, it was noted that increased rainfall leads to flooding which severely damage both the young and mature rice. The floods are more destructive when the grains are almost ripe. This can lead to rice crop failures.

Climate change also has accelerated the occurrence of rice pests and diseases which are associated with climate change. Some pests and diseases flourish and multiple very fast during

certain weather events and this can further threaten rice production by increasing crop vulnerability.

The nature of the soils;

Owing to continuous erosions sparked by mainly surface runoff after heavy rainfalls, the soil in the rice fields of Nagongera are very infertile. About 84% of the farmers noted that they operated on fairly fertile and infertile soils and yet only 12% of them do apply fertilizer in their gardens.

Biotic constraints

The biotic constraints in this study included weeds, pests and diseases

Weeds.

Weeds are plants out of place. Majority (88%) of the respondents said weeds are the major problems they face in the production of rice (table 3). Weeds are more prevalent in broadcast rice fields as compared to transplanted rice fields. This probably could be as a result of the competitive nature of the transplanted rice and also in the transplanted rice fields the little water in the puddled field suffocates the germinating weed seeds. Focus groups discussions noted that the most common and troublesome weeds include; Cyperus rotundus (Purple nutsedge), Cyperus esculentus (Yellow nutsedge) and Echinochloa colona (Jungle rice). Striga and pigweed are common weeds in the upland rice fields. Weeds usually lower the yield upto a significant percentage if not managed on time. Farmers said weeds are more problematic in the dry season when water is very little or not avcompletely. Absence of water makes it so difficult to weed the rice fields moreover during the rainy season everyone is busy with family tasks and the available labour becomes so expensive. This leaves the farmers with only family labour which is not enough to promptly manage the weeds. Majority of the farmers confirmed that they manually controlled the weeds using rudimentary tool like hand hoes of various shapes and sizes and knives.

These weeds compete with rice for water, nutrients, light, and space, leading to reduced yields and decreased crop quality.

Pests and diseases

All the sampled rice farmers (100%) confirmed that pest and diseases are significant constraints in rice production

Rice has several pests which are categorized as insect, birds and rodents.

The study revealed that the most dangerous pests which interferes with the quantity and quality of rice produced are the birds. Under poor Management, it is estimated that birds alone can eat up to three-quarters of the total rice yield in a season. During the focus groups discussion, it was

mentioned that African weaver birds and the Red- billed quelea were the most troublesome birds. These birds usually move in groups of more than a hundred birds and their reproductive cycle is very short which makes their population to always be high in normal environmental conditions. They mostly feed during the morning and evening hours of the day. Farmers noted that they control birds through various ways which include; physical chasing, shouting and scaring them off, beating sonorous bodies like tins and jericans to scare off birds, poisoning and trapping among others. This implies that farmers have to hire some people or avail themselves to keep chasing away the birds whenever they land on the rice plantation which is costly and time consuming.

Respondents noted that most of the insect pests that attack their rice include; Rice stem borers, Leaf folders (Cnaphalocrocis medinalis), Rice bug (Leptocorisa oratoria), Hoppers (Nilaparvata lugens, Nephotettix virescens) and Aphids (Rhopalosiphum rufiabdominale). With limited access to agricultural inputs, farmers said they cannot effectively manage and control the effects of this pest. Some farmers said they only rely on traditional methods of controlling some of them like use of wood ash and animal dung which gives very little effect in the control of the pests. Some of these pest not only destroy the rice plants and grains but also spread rice diseases which overall increases the cost of production.

Rodents were also reported as serious constraints especially during the dry season. African rice rat and bush rat usually eat up the fresh stems of younger rice plants. They may burrow into the soil or build nests in tall grass around the rice fields. If not well managed can have a significant impact on the rice yield. Farmers said that they usually manage them by poisoning using rat chemical which they mix with some baits and also by increasing water levels in puddled rice fields especially during the rainy season.

Every respondent acknowledged the impact caused by snails and slugs (e.g., Achatina achatina). They said snails are very destructive specifically when rice is young or when it has just been transplanted. The focus group discussions noted that a severe effect is felt when rice has just been transplanted and a significant amount of water reaching the leaf level of the newly transplanted seedlings is let into the puddled rice fields. This implies that to get rid of this impact, farmers should not allow much water in the rice fields for a period of three to four weeks to allow the seedlings stems become stronger and more resistant to the snails. Some farmers said they always handpicked them and collected in one dry area so that they can starve to death.

These pests can cause significant damage to rice crops, leading to reduced yields and decreased crop quality. Effective pest management is crucial to ensure optimal rice production in Tororo District.

DISEASES

Other than pests, rice diseases are also a problem especially during the wet seasons as revealed by the study. Rice diseases spread very fast during the rain season probably due to the increased field flooding and erosion which carry the disease pathogen from one place to another. According to the study rice yellow mottle virus, rice tungro virus, brown spot and sheath rot are commonest rice diseases in the area. From the findings, many farmers have limited knowledge about disease control and therefore there 8s need for immediate sensitisation

Table 2: Response to the issues of constraints in rice production(n=25)

Constraints	Frequency of respondents	Percentage of respondents
Climate change	24	96
Soil infertility	21	84
Pests and diseases	25	100
Weeds	22	88
Inadequate capital	23	92
Insecurity	18	72
Limited access to credits	15	60
Limited access to inputs	17	68
Limited access to technologies	14	56
Inadequate labour supply	21	84
Institutional constraints	17	68
Inadequate market and unfair prices offered.	23	92

Source: field results

Socio-economic constraints

Inadequate capital; Many Ugandan rice farmers face financial constraints that restrict their ability to invest in inputs like fertilizer, improved seeds, and technologies that could enhance productivity. This report indicates that 92% (table.3) of farmers in the study area go through

financial constraints. This they said was as a result of inadequate credit and low prices of agricultural items in the area.

Insecurity. According to the study findings, about 72% of the farmers noted that insecurity is a big threat to rice production. Farmers said thieves take advantage of the long distances from the rice fields to homestead and steal rice while still in the garden. The farmers noted that this problem has halted several people's desire to invest in rice production. Majority of the farmers noted that the security status of the area was very poor sighting incidences when thieves steal rice while still in the garden. Many of them have land which is not fenced and such thieves take advantage of this.

Limited access to credit. Many farmers complained about inadequacy of credits which leaves them vulnerable and cannot invest in improved technologies. About 60% of the respondents said they have never accessed loans. There reason we're that sometimes loan repayment becomes a challenge especially when the produce is low or when rice prices are very low. During the focus groups discussion, it was highlighted that the money lenders always wanted very many requirements to access the loans and in addition they even charge exorbitant interest rates.

Limited access to technologies. Although most of the new improved technologies are now popular, most farmers in Nagongera are still not aware of them. Rooting from the inadequate extension service in the sub county, 56% of the farmers said they were not aware of these new improved technologies in rice production. The focus groups discussion found out that a significant amount of farmers did not know what improved technologies meant in rice production and this becomes a constraint to rice production.

Limited access to quality seeds and other inputs. Majority of the farmers in Nagongera admitted that they plant seeds from the previous season which they said were easily available and affordable. The focus groups discussion noted that the good quality seeds were only sold in major towns and not in local trading centers which makes is difficult to obtain once required by one.

Limited access to extension services. Farmers said they cannot afford extension services because they don't have enough money to pay for private extension officers. The study also found that the farmers have never been visited by any extension officers to talk to them about rice production technologies.

Shortage of labour. Labour shortage is a very serious problem especially during the the planting season when everyone is in need of workers. High labour demands at this time leads to increased costs of hiring labour which become a challenge. At least 84% of the respondents noted that human resources supply is a big constraint in rice production. Some farmers especially those who rely solely on family labour said they face labour shortage especially when their children go back to school during school times.

Inadequate market and unfair prices. According to the study results,92% of respondents confirmed that shortage of market and unfair prices offered for rice is a big constraint in rice production. During the focus group discussions, respondents asserted that rice markets are inadequate in the area and this prompts the rice business dealers to buy rice from farmers at very low prices. This finding relates to that of Wamuyu, (2021) which noted that even when production improves, many farmers experience difficulties accessing lucrative markets, which can lead to price volatility. Without a stable market, farmers may face challenges in selling their harvests at prices that reflect their investment.

Institutional constraints.

The results indicate that at least 68% of the respondents faced challenges resulting from institutional management and policies. Several institutional challenge were highlighted during the focus group discussion which among them included;

Inadequate infrastructure. Farmers particularly complained about the poor roads that hinders their movement with their rice products to the markets so as to fetch higher profits from their harvest. The poor roads also affect transportation of other inputs to some areas which leads to a challenge in rice production.

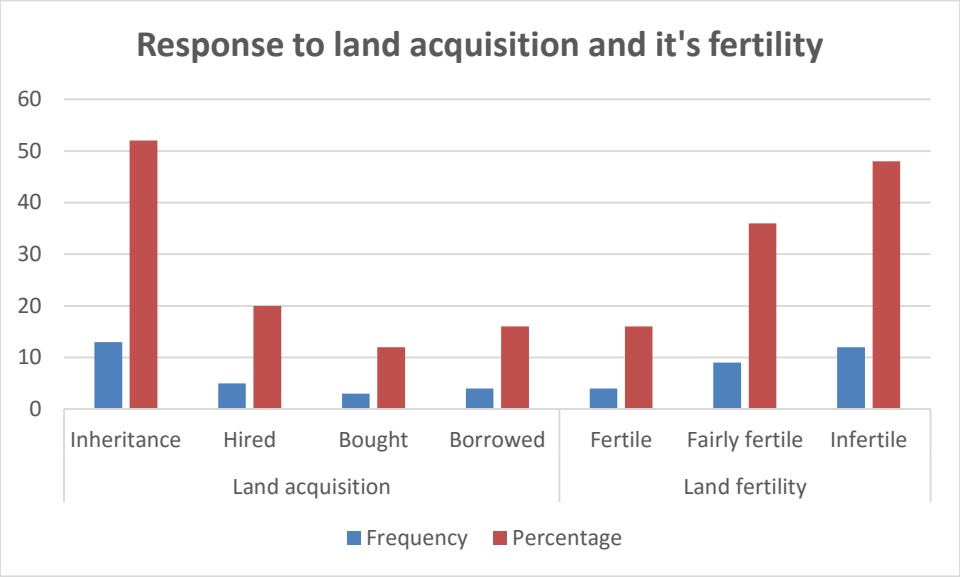
Inadequate laws and policy framework regarding rice production and it's trade by the government. This makes farmers to be cheated by middle men who buy their rice products at a relatively low prices. The farmers in an open discussion said that the government should set a specific price for all agricultural produce so as there is price uniformity in all regions.

Limited research and research centers. Improving the production of rice just like other crops requires improved technologies which can be achieved through continuous research. The inadequate research conducted on rice hinders rice production since farmers keep using the old traditional ways.

Land acquisition and soil fertility in nagongera

Land acquisition and land fertility greatly affects the quantity and quality of a given crop produce. Where land is available and cheap to afford, production is high compared to areas where land is limited and expensive. Similarly, when land is infertility, it's productivity declines.

Figure 2: Response to land acquisition and it's fertility(n=25)



Source: Field results

Land acquisition;

In most societies, it is a common thing to inherit land from parents and this habit is not very different from the one in the study area. According to the study results, the largest percentage (52%) of the farmers acquired land through inheritance, 20% had hired land, 16% had borrowed and only 12 had bought the land which they were using to cultivate rice. The small number of those who bought can be attributed to inadequate capital by the farmers. In contrast, majority of the farmers had inherited land from their parents because of the customary way of sharing parents' property among his/her children. These forms of land acquisition other than buying and inheritance minimizes farmers' interests to invest in improved rice production technologies.

Land fertility

Fertility usually determines the productivity of a particular soil. The results revealed that most (40%) farmers are using unfertile soil, 36% of the farmers are operating on fairly fertile soils and only 24% are using fertile soils to produce rice. Soil infertility in Nagongera can be linked to the severe soil erosion that occurs during the rain season as a result of heavy rainfalls received causing too much surface runoff.

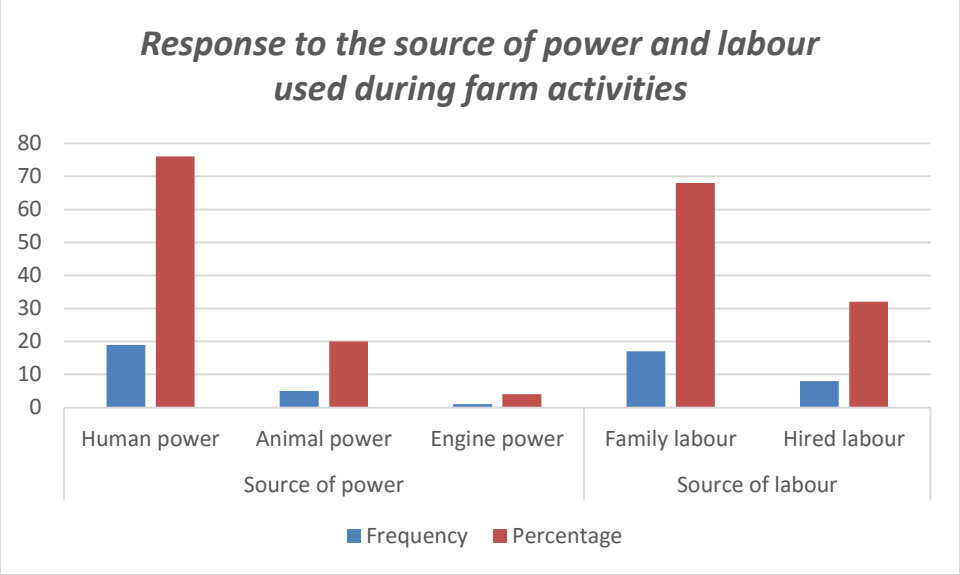
4.8 How farmers are currently growing rice.

Most farmers grow the lowland rice variety compared to the upland variety.

Land clearance; Land clearing is done in January in preparation for the first season and July to August for the second season. The findings reveal that the main source of power used for land clearing was human power with the majority of the farmers using rudimentary farming implements such as axes, slashers and hoes. Land clearing was majorly done by family labour although sometimes labour was hired to offer extra support. According to the results in table 5 below, about 76% of the respondents reported that human power was their main source of power and 68% of the respondents acknowledged that they solely relied on family labour to perform farm tasks like land clearing and cultivation.

Cultivation; Cultivation normally starts immediately after land clearing to avoid weed growth again. It is normally done manually using hand hoes by the family members although some farmers (20%) reported that they used animal traction to plough the garden. First cultivation is done and the garden is left for about a week before they do the second cultivation. At this time the nursery bed is already growing.

Figure 3: Response to the source of power and labour used during farm activities(n=25)



Source: Field results

Sowing; In late March to early April when the rains are more and so there is enough water for rice production, the farmers begin to make final land preparation like level the land in preparation for sowing seeds. Seeds are either sown directly or sowed in nursery bed to all them establish themselves before they are transplanted.

Table 3: Respondents' response on sowing methods(n=25)

Sowing method	Frequency	Percentage
Direct seeding	7	28
Transplanting	18	72

Source: Field results

Transplanting; When seeds are sown in nursery beds, they are left for about four weeks before they are transplanted to the main garden. Farmers always transplanted seedlings during the morning and evening hours as they also rest from the hot sun during the day. According to the results, 72% of the respondents transplanted their rice seedlings while only 28% practiced direct seeding of rice. The respondents said that the transplanting method gives higher yields compared to other methods.

Weeding; The study findings reveal that 48% of the respondents controlled weeds through mechanical means by use of hands and small hoes, 32% of the respondents use cultural methods by flooding their puddled rice fields and 20% use chemical methods by applying selective herbicides to kill some weeds. Flooding is mostly done during the rainy season where farmers channel surface ran off from rain water in swamps into their gardens and maintain a higher water volume in the puddled rice gardens where the weeds are suffocated to death.

Table 4: Respondents' response one weed control methods(n=25)

Weed control methods	Frequency	Percentage
Chemical approach	5	20
Cultural methods	8	32
Mechanical methods	12	48

Source: Field results

Pest and disease control; Most farmers (80%) used indigenous approach to control pests and diseases. They applied wood ash animal urine and dang and other substances other than chemicals to manage pest population. Only 20% of the respondents noted that they used chemical approach by using pesticides to control pests and diseases.

Harvesting; After a period of about three to four months depending on the variety, the rice matures and the farmers only wait to harvest it when it is ripe and turned brown in colour. Harvesting is done manually using sickles. Depending on the garden size, the farmers may

decide to use family labour or to hire some few people to help him or her speed up the work. The rice with the rice straws are heaped together in a huge heap having a tarpaulin underneath. The heap is left to ferment for about two or three days and it is threshed manually by beating a small heap on the rest. This, they said makes the unripe but mature grains to ripen and also to allow the seeds fall of easily.

4.9 Factors that influence technology adoption

Several factors were pinned for influencing technologies adoption among small scale rice farmers.

Table 5: Distribution of respondents according to the adoption of technology(n=25)

Technologies	Frequency	Percentage
Fertilizer	3	12
Pesticides	5	20
Machinery	1	4
Irrigation	2	8
Improved seeds	10	40

Source: Field results

From the table above, it can be noted that different technologies were adoption at different rates by the farmers. It indicates how many respondents had adopted to a particular technology. These differences in the adoption rate among farmers were created by many factors majorly; level of education, age, gender, farm size, previous experience with technology, technical skills and average annual income of the respondents. These are discussed below.

Level of education.

It has been noted by several researchers that education plays a big role in technology adoption among farmers of various crops. Table 1 shows that Most farmers in Nagongera are illiterates with primary leaving education as the highest education attainment. Indicated that 12% of the respondents did not go to school to attain formal education, 52% of the respondents attained primary education, 28% attained up to secondary education and only 8% attained University/ tertiary education. These results show that most (62%) farmers in Nagongera are illiterates and school drop outs with primary leaving education as their highest education attainment.

Since adoption requires a critical and careful analysis of the technology by the farmers, the shallow education of these farmers makes them disadvantaged when it comes to understanding and interpreting the benefits that come along with new technologies. Batz et al. (2012), earlier stated that education enhances farmers' problem-solving skills and encourages innovative thinking, which is crucial for adapting to new agricultural practices.

Average annual income of the farmers;

It has been noted that (table 1) 52% of the respondents in the study had an annual income of Uganda shillings 50000 to 300000 and 40% had annual income of Uganda shillings 400000 to 500000 and only 8% had average annual income of above Uganda shillings 700000. This implies that the reason why very few farmers adopted the new improved technologies was their low financial status. Farmers who had enough income viewed the new improved technologies as a good venture for improving production while those who did not have enough money looked at adoption of new improved technologies as a risk because they fear investing the little money that they have. Farmers also said they do not adopt to these technologies because they don't have money to acquire some of them for example quality inputs.

Age of the farmers.

As illustrated in table.1 above, 16% of the farmers involved in the study were between 18-25 years, 48% were 26-40 years, 24% were 46-50years and 12% were above 50 years. This means that most farmers in Nagongera sub county are above the age of 35 years according to the study findings.

From the table 9 below, it can evident that respondents of the age group 18-25 and those of 51years and above did not adopt to the improved technologies.

Table 6: How different age groups influence technology adoption among farmers(n=25)

Variable		Percentage rate of technology adoption by farmers				
		Fertilizer	Pesticides	Machinery	Irrigation	Improved seeds
Age in years	18-25	0	1	0	0	2
	26-45	1	2	1	1	4
	46-50	2	2	0	1	3
	Above 51	0	0	0	0	1

Source: Field results

This study found out that many young farmers of between 18-25 years did not adopt the new improved technologies probably because they didn't have enough income to invest in the technology and perhaps they feared the risks associated with the technology. On the other hand, older farmers of above 51years above did not adopt probably because they are not physically strong yet some of the technologies require physical strength. This finding relates to a study by Naseem et al. (2018) that found out that older farmers often lack exposure to formal education and training programs, limiting their access to new information and knowledge on modern technologies. They may have limited exposure to extension services, agricultural research institutions, and other sources of technical guidance.

Gender

Gender plays a significant role in shaping the adoption progress among farmers

Table 7: How gender influences technology adoption among farmers(n=25)

Variable		Improved technologies in rice production				
		Fertilizer	Pesticides	Machinery	Irrigation	Improved seeds
Gender	Frequency of Male	3	3	1	2	7
	Frequency of Female	0	2	0	0	3

Source: Field results

The study revealed that, for every improved technology in the study, the number of male farmers who had adopted to it were higher as compared to their female counterparts. This could be due to several reasons such as social norms and perceptions, limited access to resources and physical fitness. In many societies women are only bound to homework and caregiving and also due to cultural norms, women are not allowed to own anything and also not to inherit property. These restrictions altogether lead to low adoption rates in women. This finding is similar to that of Doss, (2014) which also noted that women, who constitute a significant portion of the agricultural labor force, often face barriers in accessing resources such as land, finance, and credit. These barriers result in lower adoption rates of modern technologies among female farmers compared to their male counterparts. In another related study, it was mentioned that women farmers may be discouraged from adopting certain technologies due to societal expectations around gender roles, which often prioritize men as the primary agricultural experts

(Morris et al., 2016). Such perceptions can limit collaboration between genders and reduce the likelihood of women engaging with new agricultural technologies.

Table 8: Distribution of respondents according to previous experience with technology and technical skills.(n=25)

Variables	Technologies	Frequency	Percentage
Previous experience with technology	Machinery	1	4
	Fertilizer	3	12
	Improved seeds	5	20
	Pesticides	7	28
Possession of technical skills	Machinery operation	1	4
	Fertilizer and pesticide application	4	16

Source: Field results

Previous experience with the technology.

Table 2 above indicates that the distribution of respondents with their experience with different technologies. It shows that only 4% had previous experience with machinery, 12% had previous experience with fertilizers, 20% had experience with improved seeds and 28% had experience with pesticides. This implies that majority of the farmers have never had any attempt to use the improved technologies.

Most farmers feared to adopt to some of these technologies because they had never interacted with them and thus they have inadequate knowledge about the technologies which makes them feel that the technology could be risky to introduce into their farm.

The few farmers who had ever interacted with the technology noted that it is expensive to maintain for example during the focus groups discussion one person said that it was too expensive to keep buying improved seed varieties and fertilizers every season.

Technical skills.

Even if some farmers could afford some of these technologies, they said the complexity of some these technologies forced them to ignore it. From the table 2 above, 4% of the farmers in Nagongera have the skills of operating farm machinery while only 16% possess the skills of fertilizer and pesticide application.One respondent said he can afford an irrigation system but she doesn't have the operating skills required. This therefore implies that possession of technical skills had a positive influence on technology adoption

Farm size.

Farm size is a very important aspect when it comes to factors that influence technology adoption by farmers. Larger farms often benefit from economies of scale, which enable them to invest more in technology (Ricker-Gilbert et al., 2015). These farms typically have greater access to capital and resources, making it easier to adopt innovative practices and tools that improve productivity (López et al., 2018). Conversely, smaller farms may face financial constraints and have limited access to information and support systems, which can hinder their capacity to adopt new technologies (Nakasone et al., 2014).

The study revealed that more than half of the respondents had only three acres of land or less under rice cultivation. Table 3 shows that 28% of the respondents had less than an acre of land, 32% had 1-2 acres of land, 20% had 3-4 acres of land, 12% had 5-6 acres of land and only 4% had above 7 acres of land used for rice production. It was noted that people who had larger farms (five acres and above), according to the study had adopted to some of the new improved technologies in rice production for example use of fertilizer, use of pesticides and use of improved seeds while those who had small pieces (less than an acre) did not adopt. This could be attributed to the high income generation in such farms which allows them to invest in the new improved technologies. Also the farmers said that the large acres of land favors technology advancement for example mechanization and irrigation systems.

Table 9: Distribution of respondents according to their farm size(n=25)

Variable	Size in acres	Frequency	Percentage
	Less than 1	7	28
	1-2	8	32

Land size	3_4	5	20
	5-6	3	12
	> 7	2	8

Source: Field results

4.10 Technologies used by rice farmers.

Most rice farmers in Nagongera solely rely on the indigenous methods of crop production. It was noted that most farmers used the locally available materials in rice production. Farmers used wood ash to control pests and diseases, hand hoes to cultivate and even level rice fields, local rice varieties sourced from the previous harvest or neighbors as planting materials and also use channels to direct rain water into their rice gardens.

4.11. Reason for not adopting to the improved technologies.

Table 10: Farmers' response to reasons for not adopting to the improved technologies(n=25)

Reasons	Frequency	Percentage
Expensiveness of technology	23	92
Unavailability of technology	17	68
Low rice prices	21	84
Limited land	22	88
Unavailable credit	13	52
Ignorance	11	44
Complexity of technology	17	68
Inadequate extension services	19	76

Source: Field results

Farmers always give various reasons for not adopting to a particular technology. This

During the focus group discussions and questionnaire interviews, farmers gave several reasons for not adopting improved rice production technologies. Majority of the respondents said that they did not adopt improved technologies due to ignorance, complexity of the technology, unavailability of technology, expensiveness of technologies, unavailability of credits, limited land, low prices of rice in the market and inadequate extension services. Hence, farmers continued to use traditional technologies in rice production.

Expensiveness of technology: According to the study results, 92% of the respondents noted that the high costs of various technologies limited their access to them and thus did not adopt. In this same study, farmers said that they don't not have enough capital to purchase improved technology in rice production. In a related study, Muwonge et al. (2020) also noted that the high cost of inputs relative to farmers' incomes makes it challenging for them to invest in improved technologies.

Unavailability of the technology: Based on the study results, 68%of the farmers noted that they failed to adopt to improved technologies because of their unavailability

Low rice prices: The low prices of rice results into inadequate capital among farmers which limit accessibility and affordability of improved technologies. This results into failure to adopt. 84% of respondents mentioned that low prices hindered their adoption to improved technologies.

Limited land: Most respondents noted that land is limiting factor in rice production. 88% of the respondents noted that it was less economical for them to invest in improved technologies since they own very small pieces of land and some have just hired.

Unavailability of credits: Technology adoption requires capital to invest, yet most farmers mentioned that their average annual income is very small. The unavailability of credits worsens the farmers' financial status and thus limits their adoption to improved technologies in rice production. The study indicates that 52% of the respondents did not adopt because of the unavailability of credits to invest in the technologies.

Ignorance: Due to inadequate extension service and demonstration sites, farmers have remained ignorant about the existence and the benefits of improved technologies in rice production. About 44% of respondents confirmed that they did not adopt because they were ignorant about the technologies in rice production.

Complexity of the technology: Most farmers do not have the technical skills required to use the technologies in rice production yet some of the technologies require basic skills to operate. The study revealed that 68% of the respondents did not adopt because they lacked the necessary skills to use the technologies.

Inadequate extension services: Owing to the limited number of extension officers in the study area, farmers do not have adequate contact with extension officers thus they remain uneducated

about proper methods of rice production and technologies required to improve production. This study confirmed that 76% of the respondents did not adopt due inadequate extension services. In a related study, Byakagaba et al. (2017), mentioned that accessibility of agricultural extension services and information is often limited, thereby reducing farmers' awareness and understanding of improved rice varieties and production techniques.

4.12. Farmers' opinions about improving technology adoption

In response to ways of improving technology adoption among small scale rice farmers, respondents shared their opinions on how to improve technology adoption. Most farmers mentioned that improving extension services can change very many people's attitude towards adoption the improved technologies. They said inadequate extension services limits their knowledge and awareness about the technologies. Farmers noted that enhancing institutional support such as carrying out market research, employing more extension agents, constructing infrastructures, improving security and providing subsidies to farmers can encourage farmers to adopt to improved technologies in rice production. During the focus group discussions, it was noted that provision of credits and encouraging farmers' groups among small scale rice farmers can enhance technology adoption.

CHAPTER FIVE:

5 CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

Several studies have reported issues related to adoption of technologies and factors that influence adoption of technologies. This study mainly aimed at assessing factors influencing adoption of improved rice production technologies in Nagongera sub county, Tororo District. The finding indicates that majority of the respondents in the study area did not adopt the improved rice technologies and that they continued using the traditional technologies in cultivating rice. There are many reasons that contributed to low adoption of rice improved technologies by farmers, which included the difficult in using it, high costs of technologies, unavailability of technologies and ignorance among farmers. The study also established that dissemination of technologies to farmers is not done properly or not done at all. Factors that influenced farmers' adoption to improved rice production technologies included market availability, availability of inputs, high quality planting materials and access to credit facilities. Extension workers were inefficient due to several reasons such as lack of transport, large coverage areas, most of them are engaged in other non-agricultural related activities. Farmers' opinion about improving technology adoption among small scale rice farmers were development of infrastructure, strengthening institutional support and encouraging farmer groups among others

5.2 Recommendations

A targeted intervention should be developed through designing policies and programs that address the specific needs and constraints of small-scale rice farmers in Nagongera.

The government should improve access to technology by providing subsidies, training, and extension services to enhance farmers' access to and adoption of improved technologies.

Institutional support should be enhanced by strengthening agricultural extension services, farmer organizations, and market information systems to support farmers' decision-making capacity and facilitate market access and linkages for farmers to sell their produce at competitive prices. Additionally, the government should improve infrastructure to facilitate movement of technology and extension officers.

Technology demonstration should be prioritized through the establishment of demonstration plots and showcases to demonstrate the benefits and practicality of improved technologies.

Government through extension worker should improve extension services delivery to farmers through different communication media such as radio, leaflets, brochures, television and newspapers on improved technologies for rice production.
Nagongera town council through agricultural extension officers should organize adequate seminars and workshops for farmers in order to improve technology awareness, provide training and capacity building programs on technology so as to increase rice production as well as adoption of technology

Financial institution; both government and private, should provide softer loans with friendly conditions to allow farmers obtain credits inorder to invest in improved rice technologies.

Table 11: Budget

S.N	ITEMS	Cost(Ug.shs)
1	Printing data collection materials	5000
2	Transport to and from the various fields	40000
3	Printing and binding of the report	50000
4	Respondents' allowance	60000
5	Other emergencies	30000
6	Total	185000

Table 12: Work Plan

S.N	Date/week	Event (s)
1	20th-25th March	Preparation of data collection tools and materials and distribution of the questionnaires
2	26th-31st March	Data collection
3	1st-10th. April	Data analysis
4	11th- 15th April	Data interpretation
5	16th-20th April	Printing and binding of the final report for submission.

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Appendix 1: Map of nagongera

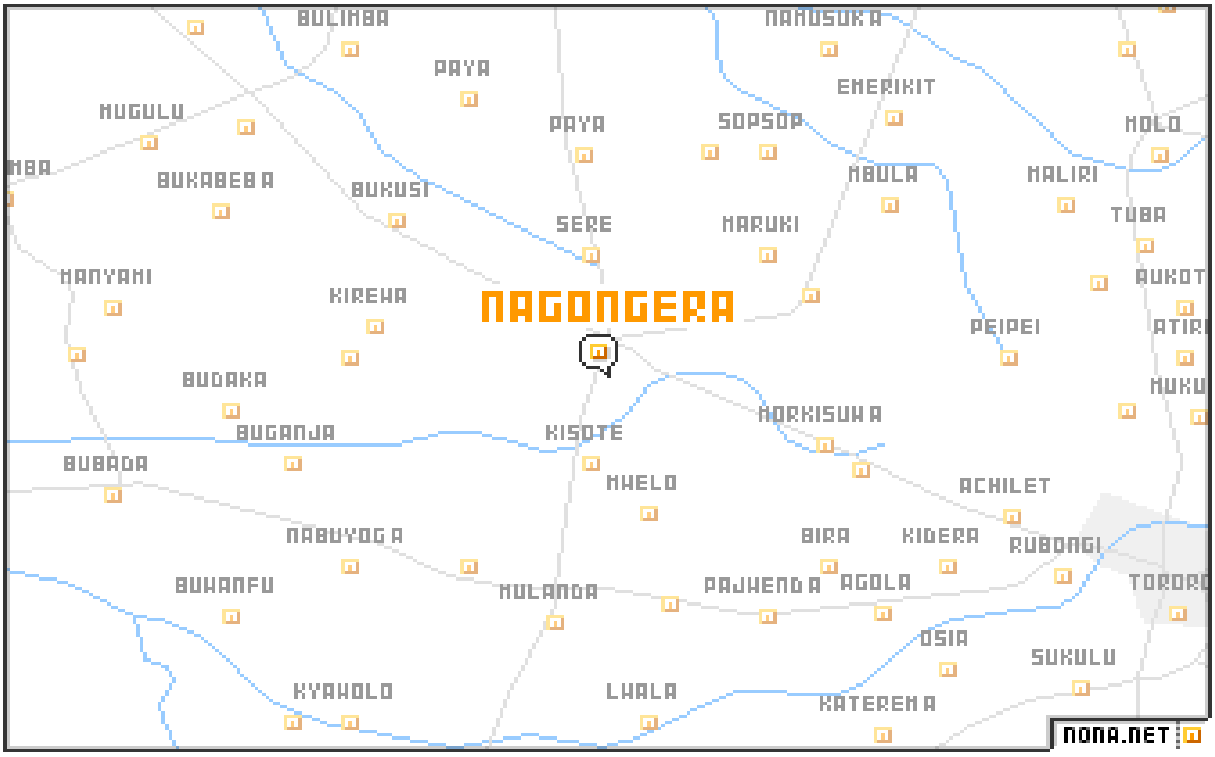

Figure 4: A map showing major routes towards and out of Nagongera sub county indicating her neighboring sub counties

Appendix 2: Map of Tororo

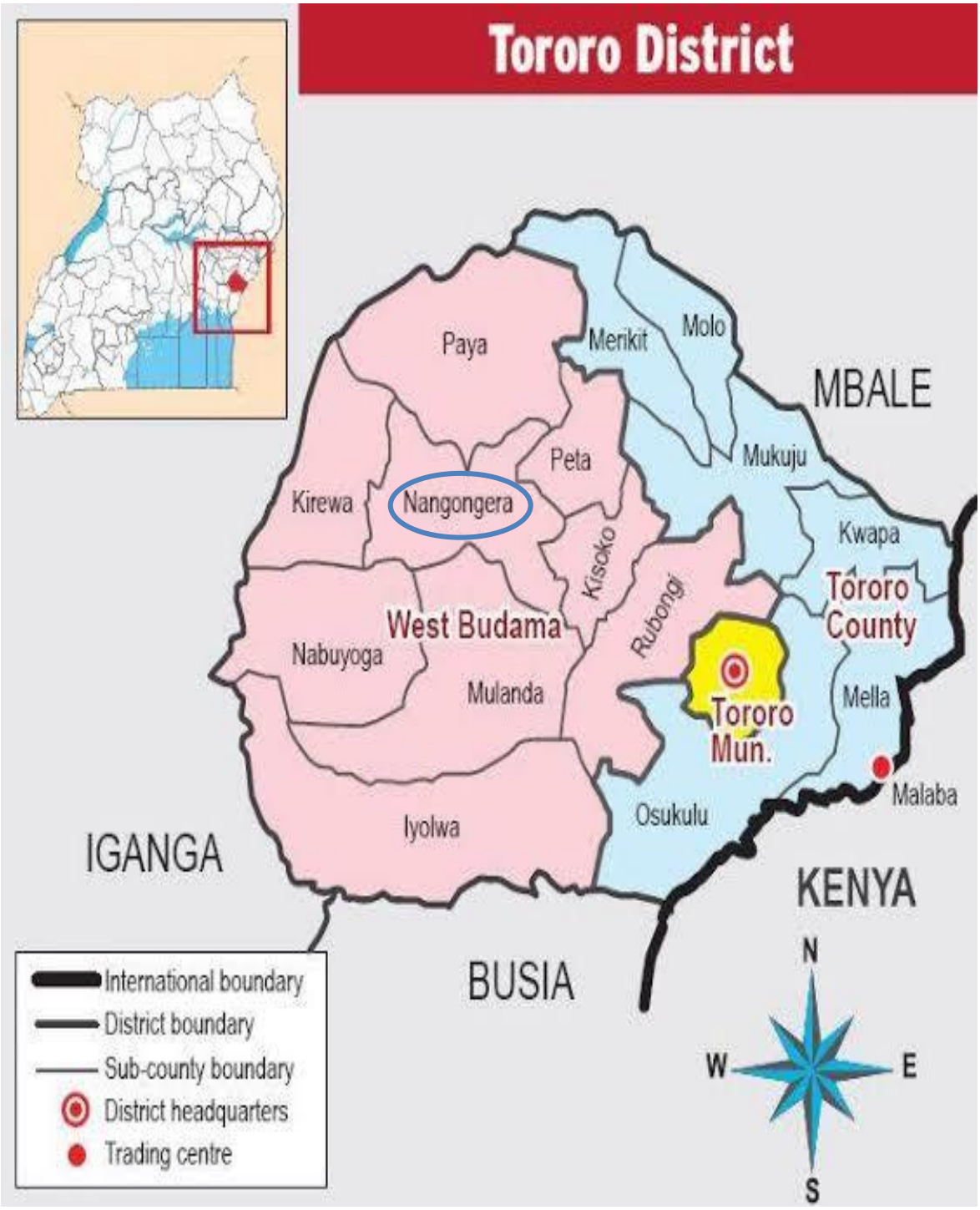

Figure 5: A map extract of Tororo district showings the sub counties and counties where the study will be conducted.

Appendix 3. Study questionnaire

STUDY QUESTIONNAIRE

Dear respondent;

I am conducting this study as part of the requirement for the partial fulfillment of the award of a bachelor's degree at Busitema University, Nagongera campus

I hereby call upon your voluntary participation in this data collection exercise by answering this questionnaire to the best of your knowledge without any bias. Your identity will not be disclosed in any part of the report and your responses will be confidential and for that matter the information provided here will be treated with due respect as required.

This study will help to improve on the production of rice in Nagongera sub county.

INSTRUCTIONS

Answer the questions below by ticking in the box(s) behind the answer(s)/options

In cases where there is more than an option tick all the boxes behind the right options.

Where it is required, write the answer in the space(s) provided.

1. How old are you?

	18-25 years
	26-45 years
	46-50 years
	51 years and above

2. What is your gender?

	Male
	Female

3. What is your marital status?

	Single
	Married
	Widowed
	Divorced

4. What is your highest level of education?

	Informal (didn't attend school)
	Primary education
	Secondary education
	University/tertiary education

5. What is your main occupation.

	Farming
	Employee
	Business

6. What is your main source of income?

	Farming
	Business
	Causal labor
	Profession

7. What is your average annual income status (Ugx)

	50,000 - 150,000
	151,000 - 300,000
	35,000 - 400,000
	500,000 and above

8.Do you have access to credit services

	Yes
	No

9. Do you grow rice?

	Yes
	No

10. If yes, for how long have you grown it.

	1-3 years
	4-6 years
	7-9 years
	10 years and above.

11. Do you grow local or improved variety of rice

	Local variety
	Improved variety

12. From where do you source your rice seeds

	Research stations
	Extension center/officers
	Neighboring rice farmers
	From last season's harvest.

13. How do you sow(plant) your rice?

	By broadcasting seeds/direct seeding.
	By transplanting seedlings

14. Do you grow your rice manually or mechanically

	Mechanically
	Manually

13. How large is the land where you are growing rice?

	Less than an acre
	1-2 acre
	3-4 acre
	5-6 acre

	7 and above

14. How did you acquire the land where you are growing rice

	Bought
	Hired
	Inherited
	Borrowed

15. How easy or hard is is to acquire land in this area

	Very easy
	Easy
	Hard
	Very hard

16. How fertile is your land?

	Very fertile
	Moderately fertile
	Infertile

17. Do you use fertilizer during the rice cultivation.

	Yes
	No

18. If "Yes", Why do you use fertilizer.

	Because it is cheap to buy
	Because it is readily available
	Because the soil is infertile
	To improve on production

20. How often do you use fertilizer.

	Every season
	Rarely

21. What is the source of power you use to cultivate your land

	Human power
	Animal traction
	Tractors

22. How is the labor market

	Labor is readily available
	Labor is not available and it is expensive

Which is the main source of your labour in the farm

	Family labour
	Hired labour

How do you control weeds in your rice gardens?

	Mechanical approach
	Chemical approach
	Cultural approach

23. What is the market condition of rice here.

	Readily available
	Not readily available

24. How is the price of rice in the market

	Very high
	High
	Low
	Very low

25. Do you sell your rice in the local market or you sell in the international markets.

	Local markets
	International markets

26. What is the security condition of this place

	Very tight
	Tight
	Poor
	Very poor

27. Have you ever received any advice or training about rice cultivation or production

	Yes
	No

28. If "Yes", from who/where?

	Research
	Extension centers/officers
	Neighboring rice farmers
	Friend

29. Have you ever had any extension officer talking to/ teaching you about rice cultivation

	Yes
	No

30. If "Yes", What did he/she teach or talk about in the meeting

.....

.....

.....

31. How often do you receive extension services here in Nagongera

	Every season/regularly
	Not every season/ not regularly

32. What are some of the technologies that you were taught by the extension officer

.....

.....

.....

.....

.....

33. Are all the above technologies similar to those that you have been using in your rice production.

	Yes
	No

34. If "No", then why haven't you been using some or all of the above technologies?

.....

.....

.....

.....

.....

.....

35. What is your opinion about improving technology adoption in rice production?

.....

.....

.....

.....

.....

36. How do you benefit from growing rice.

.....

.....

.....

.....

.....

What are the constraints you face in rice production?

.....

.....

.....

.....

THANK YOU FOR YOUR PARTICIPATION

Appendix 2: Checklist for Focus Group Discussion

The benefits of rice cultivation

The current ways how farmers are growing rice
The constraints farmers face during rice production
The solutions for the constraints faced in rice production

The kinds of extension services offered to rice farmers

Availability of rice market in the study area
Factors influencing the adoption of rice production technologies

Farmers opinions about improved rice production technologies.

Appendix 3. Checklist for key informants

Sex……..
Occupation….....
Village.....

1. For how long have you been serving in this position?
2. How have you been helping farmers in rice farming?
3. What do farmers use to cultivate their land for rice production?
4. Do farmers use fertilizers? if yes, which types do they use?
5. How many times do farmers weed their farms per season?
6. How do farmers weed their farms?
7. Do farmers use fungicides/pesticides for preventing pests and diseases?
8. How do farmers grow and sow their rice in Nagongera?
9. Which variety of rice is commonly grown by farmers in Nagongera?
10. What benefits do farmers gain by producing rice?
11. Is there any market for rice in your area?
12. Do you always have contacts with rice farmers?
13. If yes, how often do you have contact with them?
14. What do you think are constrains facing farmers for not adopting new technology?
15. Which are the most serious constraints faced by rice farmers here in Nagongera
16. What are the factors leading to the adoption of rice production technologies?
17. What do you think can be done to improve rice production in the area?

****THANK YOU FOR YOUR COOPERATION****