

**CROP DIVERSIFICATION AND PROFITABILITY AMONG SMALLHOLDER
RICE FARMERS IN DOHO IRRIGATION RICE SCHEME – BUTALEJA
DISTRICT**

BY

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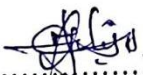
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**A DISSERTATION SUBMITTED TO THE DIRECTORATE OF RESEARCH AND
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THE AWARD OF THE DEGREE OF MASTER OF SCIENCE IN AGRI-
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JANUARY, 2024

DECLARATION

I, AMONGIN LYDIA, declare that the content of this dissertation herewith submitted for the award of Master of Science degree in Agri-Enterprises Development at Gulu University, is my original work and has not been previously submitted for an academic award in any university or higher institution of learning.

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APPROVAL

This dissertation has been submitted for approval with our consent as supervisors.

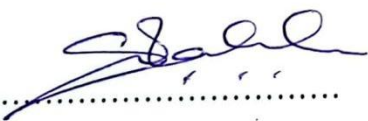
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DEDICATION

Gabrielle Chanel who was famously known as Coco Chanel once said *“a girl should be two things, who and what she wants...”*

I dedicate this dissertation to my dad, Simon Patrick Okanya who despite coming from a society that did not value girlchild education nevertheless created an environment that nurtured learning, believed in our strengths and was patient with our shortcomings. Our little milestones have brought you immense joy over the years, I hope this too makes you proud.

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LIST OF ACRONYMS AND ABBREVIATIONS

CDP	Crop Diversification Program
COVID-19	Corona Virus Disease 2019
DIFACOS	Doho Irrigation Farmers' Cooperative Society
FAO	Food and Agricultural Organisation
HHH	Household Head
IFDC	International Fertiliser Development Center
JICA	Japan International Cooperation Agency
KES	Kenya Shillings
KOPIA	Korea Program on International Agriculture
NaCCRI	National Crops Resources Research Institute
NARO	National Agricultural Research Organization
NERICA	New Rice for Africa
NERICA	New Rice for Africa
NUSAF	Northern Uganda Social Action Fund
PRiDe	Promotion of Rice Development
SACCO	Savings and Credit Cooperative Organizations.

SAID	Sustainable Irrigated Rice Project
SDI	Simpson Diversity Index
SOPs	Standard Operating Procedures
SSA	Sub Saharan Africa
UCA	Uganda Census of Agriculture
UGX	Uganda Shillings
VSLAs	Village Savings and Loans Associations

ABSTRACT

Rice which has gained a lot of prominence both as a food and cash crop globally is a promoted crop in most of Uganda's irrigation schemes. The smallholder rice farmers who are beneficiaries of these schemes have been indoctrinated to monocrop rice on a double annual season. Commercially sustainable farming practices are becoming increasingly important as market forces, consumer tastes, and climate change continue to alter agricultural enterprises. Recognising the critical role smallholder rice farmers play in growing the economy while ensuring global food security, this study therefore sought to examine the effects of crop diversification on the profitability of rice enterprises of these farmers. A structured questionnaire was used to collect data from a multi stage sampled respondent size of 385 smallholder rice farmers. Descriptives such as frequency counts, means, and percentages were used to characterize the scheme's smallholder rice farmers, the Tobit regression model analysed the factors that influenced crop diversification while the two stage least squares helped ascertain the influence crop diversification had on profitability of rice enterprises. Proportion of scheme land to total land, level of education and gender of household head, access to extension services, access to market information through radios, integrating rice with roots or perennials and cost of irrigation were found to impact intensity of crop diversification. While crop diversification was found to be positively associated with rice profitability, other instrumental variables like farmer experience at the scheme, access to credit, extension services from non-government entities, growing 'super' rice variety, selling output to rice processors, growing legumes and roots also had an influence on rice profitability. According to this study, crop diversification can lessen smallholder rice farmers' susceptibility to environmental hazards and market swings, thereby increasing overall profitability of their rice enterprises. Policymakers and development practitioners looking to create policies that support sustainable farming techniques and raise smallholder farmers' standard of living would find great value in the study's insightful contributions.

.Key words; Irrigation schemes, rice, crop diversification, profitability.

CHAPTER ONE

INTRODUCTION

1.1 Background

Market dynamics, changing consumer preferences, and climate variability are all having a significant impact on the agricultural landscape. Smallholder rice farmers become important players in the global food security system amid these shifts, making substantial contributions to local communities and national economies. However, these farmers may be more vulnerable to hazards and uncertain economic conditions due to their historic reliance on monoculture, particularly rice agriculture (Asfaw et al., 2019). Understanding the importance of resilient and sustainable farming methods, this study explores the complex relationship between crop diversification and smallholder rice farmers' profitability. In order to protect these farmers' livelihoods and promote food security more broadly, it is critical to comprehend the financial implications of diversifying crops in addition to rice as the world's population continues to rise and climate change concerns worsen. In order to support strategic interventions and policy frameworks targeted at enhancing the financial well-being of smallholder rice farmers in the midst of a dynamic and changing agricultural landscape, this research aims to untangle the complex mechanisms at work (Hufnagel et al., 2020).

Globally, crop diversification is increasing across the world in favor of more competitive and high-value crops. It has enabled farmers to spread production and income risk; and therefore, reduced livelihood vulnerability to weather and market shocks (FAO, 2018; Mango et al., 2018). Nguyen (2014) defines crop diversification as the strategy of shifting from less profitable crops, changing of variety and cropping system, increasing exports and competitiveness in both domestic and international markets. Feliciano (2019) relates crop

diversification to the replacement of low-value commodities by high-value commodities, usually fruits and vegetables for the export market. Asfaw et al., (2019) reported that due to the overwhelming dependence of Sub Saharan African agriculture in natural conditions, small holder farmers inevitably become more vulnerable to climate variabilities, he thus pointed out that adopted of crop diversification by farmers in the area of his study (Niger, Malawi and Zambia) was due to push factors that left them no alternative to cope with weather changes, price fluctuations and crop disease incidences.

In Bangladesh crop diversification programme (CDP) was launched in the country during the early 1990's. A systematic arrangement of growing a variety of crops in rotation with rice was undertaken, based on farmers' own choice and performances with respect to soil and climatic conditions, thereby ensuring a variety of diverse dietary standards and nutritional status of the rural households. Due attention was given to the protection of nutrient balances in the soil and of all major basic resource endowments in crop production. Improved crop sequences involving rotation of soil exhausting crops followed by restorative ones, shallow rooted crops followed by deep-rooted ones, legumes in rotation with non-legumes among others are envisaged to enrich and maintain soil fertility as well as crop productivity. In this way it becomes possible to ensure some degree of constancy in crop production, by destabilizing many of the limiting biotic and abiotic stresses (De Pinto et al., 2020).

Sub Saharan Africa (SSA) still stands as one of the world's richest genetic resource centres in terms of crop diversity, because of its diverse farming practices, socioeconomics, cultures, and agro-ecologies (Emana et al., 2015). Smallholder farmers grow a wide range of crops in various sections across the continent. However, crop diversification strategies at the farm level are largely influenced by both environmental and social factors. Asfaw et al. (2019) reported that due to the overwhelming dependence of Sub Saharan African (SSA) agriculture

in natural conditions, smallholder farmers inevitably become more vulnerable to climate variabilities, he thus pointed out that adoption of crop diversification by farmers in the area of his study (Niger, Malawi and Zambia) was as a result of push factors that left them no alternative to cope with weather changes, price fluctuations and crop disease incidences.

In Uganda, crop diversification is one strategy that smallholder farmers may adopt to scale down their vulnerability in the current state of global environmental change and unstable market economies. Diversification not only expands the number of potential crop types for the market but also improves agroecosystem functioning by building redundancy into the agricultural system and allowing for innovation in areas exhibiting impacts of climate variability. While the driving forces behind and impacts of crop diversification have been extensively investigated, there are particular issues for the prospects of crop diversification to reduce household vulnerability to price fluctuations and economic shocks, pest infestation as well as aggravated food insecurity (Hussain et al., 2020).

Doho irrigation rice scheme located in reknown Bukedi region in Eastern Uganda is an area of intensive irrigated rice cultivation which started its operations in the 1940s but consequently failed to progress until the Chinese government took charge and revamped it between 1976 and 1989 (Alibu et al., 2022). Today Doho Irrigation Rice Scheme is the largest rice irrigation scheme in the country followed by Kibimba rice scheme in Bugiri district and Olweny rice scheme in Lira district (Akongo et al., 2017). It covers 2500 Hectares with a farmer beneficiary number of up to 10,000 smallholders rice farmers (Barungi & Odokonyero, 2016). Majority of the farmer beneficiaries of Doho irrigation rice scheme live in the nearby villages where they grow several crops in their upland fields in addition to rice monocrop in the low land leased plots at the scheme (Nakano & Otsuka, 2011). Rice growing is the dominant economic activity in the Butaleja District, which

provides the farmer beneficiaries with household income and food security as well as community livelihood. Irrigation is one of the strategic options that has been adopted in mitigating the water scarcity and heavy reliance on rainfall for rice production. (FAO, 2018). Irrigation has thus been taken as a remedy against erratic rainfall situations, enhanced employment opportunities, secured incomes and promotion of cropping intensification.

Profitability of rice farming in general is largely dependent on input costs, level of output/yield, and prevailing market prices (Kumar et al., 2022). However, in open market economies like the case of Uganda, where there is free entry and exit into the market, smallholder rice farmers have continued to face challenges of fluctuating prices of rice that consequently affect their livelihoods. Heavy reliance on a single crop or few crops therefore becomes a danger in itself (FAO, 2018)

Key to note though is that if there is integration of rice production with other crop enterprises, it is possible to realize better yields and consequently improve farmer incomes. Even with several discussions around crop diversification per say, there is need to understand the factors that would influence smallholder rice farmers in a monocropping rice cultivation setting to choose diversification of rice farming with other crop enterprises

1.2 Statement of the Problem

Smallholder farmers under the rice irrigation scheme umbrellas have generally continued to practice monocropping of rice with only a few farmers who tend to integrate rice production with other food crops. The implication of lack of crop diversification is that these farmers are at a risk of crop failure and possibly inability to diversify diets. Continuous practice of monocropping by these rice farmers may also worsen pest infestation, aggravate food insecurity, vulnerability to price fluctuations and other related economic shocks. There are

several studies that have been conducted on crop diversification for instance Bellon et al. (2020) studied the relationship between crop diversity, self-consumption and incomes by small holder farmers in northern Ghana, Kumar et al. (2022) studied the determinants of crop diversification in North East Zone of India and Munialo et al. (2019) analysed how to manage climate risks in Kenya through crop diversification. Though Tesfaye & Tirivayi (2020) studied crop diversification in the Ugandan context, focus was on the rural dryland parts of the country with no specifics on the irrigation schemes per say. The existing gap in understanding how diversifying crops may influence the profitability of smallholder rice farmers underscores the urgency of this study. By scrutinizing the intricate relationship between crop diversification and profitability of the primary enterprise, this study aims to address the pivotal question of whether diversifying crops can enhance the overall economic sustainability of rice farming which may likely be contrary to the wide spread belief that intensive cropping systems are more productive than diversified systems (Munialo et al., 2019). In order to support strategic interventions that not only reduce financial vulnerabilities but also open up previously unexplored opportunities for increased profitability, closing this knowledge gap will be crucial to protecting smallholder rice farmers' livelihoods in the face of an unpredictable and demanding agricultural environment.

1.3 Objectives of the study

1.3.1 General objective

The general objective of this study is to assess farmer characteristics, crop diversification and profitability of smallholder rice farmers in Doho Rice Scheme.”

1.3.2 Specific objectives

1. To characterize the smallholder rice farmers of Doho irrigation rice scheme.
2. To determine factors influencing crop diversification among irrigation rice farmers
3. To determine the influence of crop diversification on profitability of rice farming among irrigation rice farmers

1.4 Research Questions

- i. What are the distinctive socio-economic characteristics of smallholder rice farmers in Doho irrigation rice scheme?
- ii. What are the factors influencing crop diversification among irrigation rice farmers?
- iii. What is the influence of crop diversification on profitability among irrigation rice farmers?

1.5 Scope of the Study

The study focused on the effect of crop diversification on profitability among smallholder rice farmers in Doho irrigation rice scheme, Butaleja District. The time scope of this study being the year 2023(year study was carried out) covering the bi annual farming seasons of 2022. The geographical location was limited to Doho irrigation rice scheme. involving a sampled smallholder farmer population of 385 participants. This study took into consideration analysis of trends associated with crop diversification and its potential effects on the overall profitability of the rice farming enterprises.

1.6 Significance of the study

The research findings will help highlight the positive outcomes of crop diversification and these can be adopted by rice farming populations in promoted crop settings especially Kibimba and Olweny in Uganda to help overcome adverse effects of mono-cropping. To the smallholder rice farmers in Doho irrigation rice scheme, the research findings will help the policy makers craft long lasting and tailormade solutions that may enhance productivity, farm incomes as well as food security in the scheme in the subsequent years. This research may also help the academic fraternity especially students interested in closely related study areas by acting as a reference document.

1.7 Conceptual framework

Figure 1; Shows the relationship between the independent variable (crop diversification), dependent variable (Doho irrigation rice scheme) and intervening variable. Their relationship is indicated among the parameters outlined within the diagram. The framework further indicates direction of the study's research objectives.

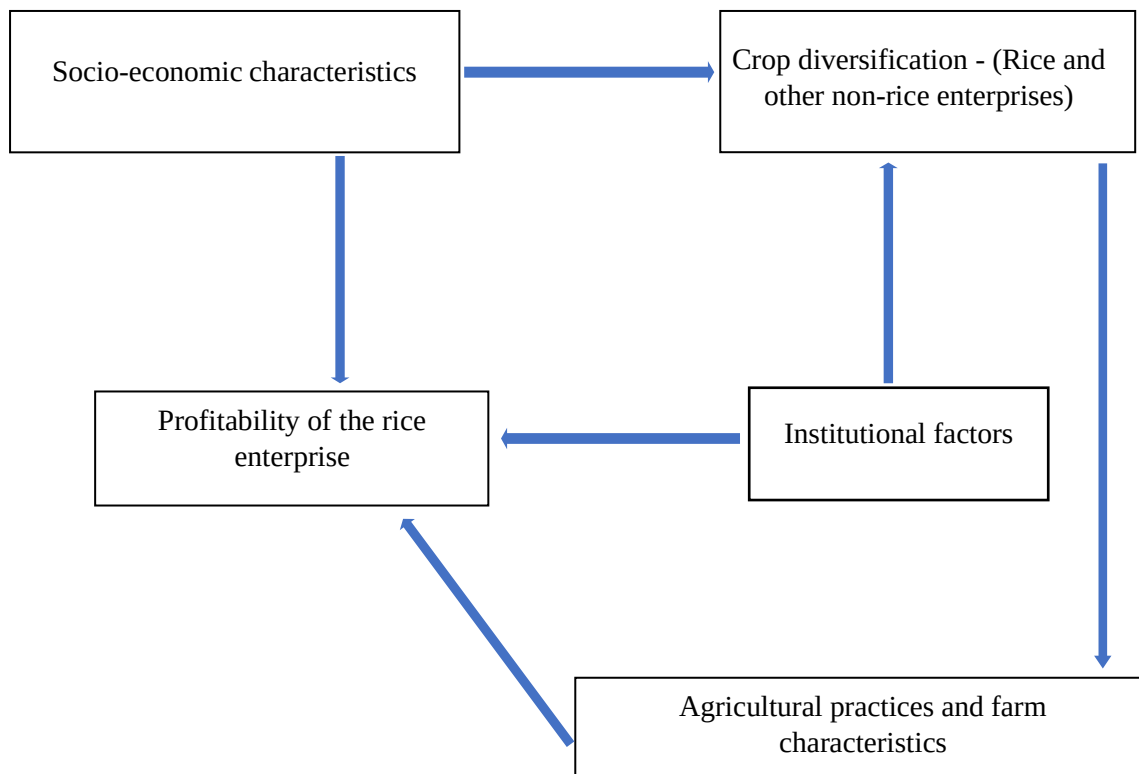


Figure 1: Conceptual Framework of the Study

Source: Developed from literature review of journal articles by previous researchers like Alibu et al. (2022), Alam et al. (2022), Barman et al. (2022) and Kemboi et al. (2020).

Crop diversification in the diagram, also the independent variable is the extent to which smallholder farmers engage in cultivating a variety of other crops alongside the traditional rice.

Profitability of rice farming enterprises implying the financial gains or losses incurred by the smallholder farmers in their rice enterprises. Indicators of this being net incomes, return on investment or overall economic viability of the enterprises.

Moderating, mediating or intervening factors;

- i) Agricultural practices and farm characteristics - The farming methodologies employed as well as the inherent attributes of smallholder rice farmers that influence the relationship between crop diversification and profitability of the rice enterprise. These include among others farm sizes, adoption of technologies (irrigation, pesticides, fertilizers, spacing)
- ii) Socio-economic characteristics – external elements that may affect both crop diversification and the profitability of the traditional rice enterprise. These could be demographics like age, gender, educational attainment, farmer experience or off farm incomes.
- iii) Institutional factors – also same as ii above. Indicators could be market dynamics, government policies, infrastructure among others.

CHAPTER TWO

LITERATURE REVIEW

2.1 Rice Production, Consumption and Sale in Uganda

2.1.1 Characterising smallholder rice farmers.

Heavy reliance on rice cultivation – In rice schemes, smallholder farmers frequently have a strong reliance on rice farming (Akongo et al., 2017). Although this exclusive emphasis on a crop ensures food security, it can also expose these farmers to environmental hazards and changes in the market. Crop diversification appears to be a viable approach to reducing these risks (Okello et al., 2019).

Smallholder rice producers are believed to come from a variety of socioeconomic experiences. Rugema et al. (2018) conducted research that highlights the diversity of smallholders by taking into account variables including income, education, and land size. This research emphasized on how crucial it is to take these variations into account when developing focused interventions and policies.

Smallholder rice farmers continue to use traditional agricultural methods that have been influenced by historical and cultural considerations. Rizwan et al. (2017) highlights the significance of comprehending and honoring ancient customs while implementing contemporary, eco-friendly methods to improve output and adaptability to climate change.

Most smallholder rice farmers work with modest amounts of land. (Rugema et al., 2018) draw attention to the fact that most farms are small, generally covering less than two hectares, making it difficult to achieve economies of scale. This limitation affects choices on crop rotation strategies, acceptance of new technologies, general farm management and on a broader aspect crop diversification (Bellon et al., 2020).

A significant factor in smallholder rice growing is gender. The substantial contributions made by women to the rice farming industry are highlighted by studies like (Akite et al., 2022) and (Kikuchi, Haneishi, Maruyama, et al., 2016). These studies also highlight the need for gender-sensitive policies that address differences in access to resources, credit, and extension services.

Numerous obstacles face smallholder rice farmers. According to Kijima (2019a), these difficulties include restricted access to markets and credit, which can impede investment in cutting-edge inputs and technology. As noted by Akongo et al. (2017), climate variability and environmental deterioration also represent serious risks to their way of life.

Improving market accessibility is essential to helping smallholder rice farmers achieve better financial results. In order to improve the market connections for smallholders, studies by The Anh et al. (2020) and Kikuchi et al., (2016); Barungi & Odokonyero (2016) highlight the significance of creating effective value chains, lowering post-harvest losses Ssebaggala et al. (2016), and guaranteeing fair prices.

Smallholder rice growers are frequently a part of tight-knit communities. According to research by Abdul-Rahaman & Abdulai, (2018), farming methods in communities are collaborative, and community-based projects have the ability to improve resilience and address shared concerns. This study emphasised the benefits associated with farmer groups especially in regards to collective marketing and access to credit.

2.1.2 Rice production

Rice though customarily known as an Asian crop, is currently not only a staple food but the second most important as well as third largest grain grown after maize and sorghum in Uganda (Kijima, 2019a). Eastern Uganda (Butaleja, Pallisa, Budaka, Tororo, Bugiri) is considered the largest rice growing region with about 67% of the total rice produced and the

approximate 23% coming from majorly Northern Uganda that is Gulu, Lira, Amuru, Nwoya and Kitgum (Momolu et al., 2016).

Majority of Uganda's rice farmers are smallholder farmers who produce it on less than 2 hectares using rudimentary technologies, yet their total production is estimated to be 90% of the country's total rice output (Alibu et al., 2022). These grow rice twice annually with the first season ranging from January/February to June/July and the second from July/August to December. It's important to note though that the biggest harvests of rice are achieved in the first season with a few farmers cultivating in the second season. Most of the rice produced in Uganda is rainfed and is grown along swampy areas or lake shores. These rainfed rice production systems depend on natural conditions, conventional breeding as well as traditional cultivation methods similar to Ma et al. (2015) who while advocating for the need for an industrialized rice production system submitted that rice production had not changed much even with the diverse technologies that had been incorporated in line with rice breeding and cultivation. According to him, rice production was still heavily dependent on natural conditions like temperature, geographical position and climate.

It is prudent to note that there are only three rice-based irrigation schemes in the country which cover an estimated 5,000 hectares (Haneishi et al., 2013) and these include Doho irrigation rice scheme in Butaleja which is the largest in the country followed by Kibimba and Olweny rice schemes in Bugiri and Lira districts respectively

The main rice varieties grown are local varieties such as Kaiso, Super and WITA9 (Barungi & Odokonyero, 2016). Except for WITA9 which is multiplied by contracted seed multipliers, 81% of the farmers use recycled seed (Alibu et al., 2022). There is however a distinction in terms of rice variety choices among farmers according to their gender. The female farmers tend to consider other attributes besides yield potential like taste or aroma, while many male

farmers prioritize yield and marketability in choosing a variety. Women on the other hand may be unlikely able to afford hybrid rice seed varieties due to their resource constrained nature which concurs with Addison et al. (2018) who studied how gender influenced adoption of innovations in the rice sector in Ghana especially on rice varieties. The women who had limited access to land, were mandated to engage in the domestic activities like caring for children, which conditions affected their adoption of improved rice varieties as well as fertilizer use.

In terms of gender labour disaggregation in rice cultivation, the males dominate the process with an overall estimate of 66.4% involved in the entire rice production activities especially hiring of land, land preparation, purchase of inputs, irrigation, harvesting, bagging and transportation, milling, marketing and sales. The women on the other hand who take up the 33.6% are majorly involved in transplanting, drying and cleaning of the harvested rice (Lusiba et al., 2017)). The youth also participate although the magnitude of their input is not clearly known. The activities they largely involve in include nursery bed preparation, ploughing, transplanting of the seedlings, pesticide and fertilizer application, bird scaring, harvesting and threshing. Barungi & Odokonyero (2016), explain that the limited participation of women and youth on rice production is associated with their lack of equitable access to and use of land as a resource.

Despite several government initiatives through Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) to grow Uganda's rice sector like the Agriculture Improved Rice Project; New Rice for Africa (NERICA) dissemination and Sustainable irrigated rice project (SIAD); and Promotion of Rice Development (PRiDe) project, rice yields across the country remain relatively low with only 2.5 metric tons per hectare. Okello et al. (2019) attributes these poor

rice yields to a number of factors like poor input use, low soil fertility as well as low allocative inefficiencies on the farm by majority of smallholder farmers.

2.1.3 Rice consumption and sale

Rice is a key cereal crop ahead of maize, millet and sorghum (Hyuha, 2017). It is asserted that rice is the staple food for more than half of the world's population and provides approximately 20% of human dietary energy (Segal & Minh 2019; Tonini & Cabrera 2011). Although per capita consumption of rice in Uganda is related to rice attributes such as aroma, wholeness and size of the grain, colour (preference for white other than brown), foreign matter content (stones, debris) and price, its increase in consumption is linked to rise in incomes and urbanization (Mottaleb et al., 2021).

With a rising consumption estimated at 5% per annum, the country's per capita rice consumption remains the lowest in the region compared to Tanzania, Kenya and Rwanda (Akongo et al., 2017). Given the low yields, Uganda meets its annual production or supply deficit of about 110,000 metric tons through imports, mainly from Vietnam, Pakistan, and Tanzania (Hyuha, 2017). The demand of rice grows day by day in Uganda due to the increasing population growth that is estimated at 3.2% annually, the increased urbanization, expansion of the middle class and the wide perception that rice is a superior food. Although some studies have a contrary view on the superiority of rice like one done in Bangladesh by Mottaleb & Mishra (2016) which asserts that with economic progress and growth of household disposable incomes, populations may shift to more nutrient rich foods like vegetables, meat and poultry since rice is considered a poor source of vitamins and minerals with the milling process further depleting it of any additional micronutrients (Muthayya et al., 2014). This may however not be conclusive as economies like China, India, Vietnam, Bangladesh, and Indonesia that have gained a lot of progress in terms of per capita incomes

in the recent past have also equally remained the major rice consuming countries in the entire globe.

Although rice has gained prominence in Uganda over time, it has substitutes that have continued to outcompete it especially in Teso and Lango subregions. It only comes after cassava in parts of Amuria and Serere both as a food and an income crop while in Lango subregion, groundnuts, sorghum, beans and cassava outshine it (Akongo et al., 2016).

Men are reported to be dominantly involved in the marketing and sale of rice, although a study done by Gallina & Farnworth (2016) asserted that women may also sale rice but at the farm gate level. This also conquers with findings in Aryemo et al. (2019) who studied drivers of commercialization of indigenous chicken in northern Uganda where the results found out that the male gender were more market oriented than their female counterparts with better marketing abilities thus attracting relatively higher gross margins.

Time was also reported to be a key aspect in production and final yields of rice thus impacting on proceeds earned from rice farming. For example, timely planting of rice would make farmers benefit from the high market prices since at the inception of the harvesting seasons, there are low quantities of rice supplied to the market that consequently attracts higher pricing. Same was noted for the harvesting, post-harvest losses were said to be higher due to increased attack by the birds as well as shattering and spillage due to over drying in the field (Karubanga et al., 2017). This also study conquers with Lusiba et al. (2017) who found out that shattering and spillage accounted for the highest post-harvest grain losses among rice farmers in Eastern Uganda.

Most of the rice produced is for sale with little portions kept for domestic consumption or for recycling as seed. Rice is therefore moved to the milling points as paddy with consideration

on parameters like logistics services and proximity to these milling sites. Later some portions are returned home for consumption while others are moved to rural and urban markets through several market intermediaries and channels. The urban centres like Kampala are the biggest markets for the milled rice due to its huge working-class population who are relatively income secure, presence of traders, supermarkets, warehouses and transport facilities. Due to the small- scale and scattered nature of production, where schemes and collective marketing are just catching up, middlemen, assemblers, brokers, agents still dominate the rice trade.

Government subsidies to the rice importation which relatively reduces importation costs heavily affects the demand and market of domestically produced rice (Diakite et al., 2012). - This is because imported rice competes with locally produced one in terms of price (low volumes which limits competitive pricing, unsteady supply), quality (Impurities, mixed grades, poor processing and packaging) and therefore market.

2.2 Socioeconomic characteristics associated with crop diversifying and non-crop diversifying farmers.

Different studies used different parameters to define crop diversifying and non-crop diversifying farmers. According to a study on crop diversification analysis amongst smallholder farmers in Kenya, crop diversifying farmers were those that grew three or more crops, and non-crop diversifying ones grew less than two crops (Kemboi et al., 2020). While Shahbaz et al. (2017) looked at the total number of crops a farmer cultivated in relation to the land that was allocated to a particular crop. If a farmer allocated more than 50% of their land to a single crop, then they were considered low or non-crop diversifying and a crop diversifying farmer was one who farmed at least up to three crops on almost equal proportions of their land.

For the case in Zambia, Mzyece & Ng'ombe (2020) classified the crop diversifying farmers to be those that adopted a combination of four crop categories that is a dominate staple (maize), an alternative staple (like cassava, millet, sorghum, rice, sweet and Irish potato), a legume (like groundnuts, soya beans, mixed beans, cowpeas), and then a cash-crop (like cotton, tobacco, sunflower, coffee, paprika, sugarcane, sesame) akin to what Ntakyio & Van den Berg (2019) reported.

Significant to note too is that crop diversifying farmers were found to have attained an education or relatively more years of schooling than their non-crop diversifying counterparts. Kemboi et al. (2020) asserted that their likelihood to participate in crop diversification increased with an increase in their level of education because education was assumed to contribute to the level of awareness of high yielding crop varieties and increases their chances of absorbing new information related to managing a diversified cropping system. This equally agrees with Aheibam et al. (2017) who believes that if a household head attained an education, it would aid them in making what he referred to as “constructive decisions” in terms of adopting new ideas thus the increased willingness to adopt crop diversification. That listed study further elaborated that an increase in formal education by one year was responsible for up to 5% increase in the level of crop diversification of households. These results correlate with previous studies done by Basantaray & Nancharaiah (2017) who also observed that education significantly and positively influenced farmers' participation in diversified farming.

There is vast literature analysing the impact of land size on crop diversification. A review of literature undertaken by Mzyece & Ng'ombe (2020) concluded farmers with relatively bigger farm size were usually associated with crop diversification and farm commercialization than their counterparts with smaller land sizes. Similar positive relationships were also verified by

Dorsey (1999) in Kenya, Chibwana et al. (2012) in Malawi, McCord et al. (2015) in semiarid agricultural systems near Mount Kenya, Hitayezu et al. (2016) in South Africa, and Shahbaz et al. (2017) in Pakistan. Kemboi et al. (2020) estimated that in Kenya, farmers with a larger portion of land were more likely able to allocate an extra land portion to a new crop (sugar beet) by reducing the land area of some of the crops they were actively growing. This however was contrary to Adjimoti & Kwadzo (2018) who found out that farmers with relatively smaller portions of land were more diversified compared to their counter parts. The latter highlighted that approximately 48.3% and 25.6% of the diversified and non-diversified farmers respectively owned less than 5 acres of land. The results further showed that 17.2% and 39.5% of the farmers practicing diversified and non-diversified farming respectively owned not less than nine acres of land.

A highlight was done by Kemboi et al. (2020) who while doing a crop diversification analysis among smallholder farmers in Kenya found out that adoption of a diversified cropping system was more likely to increase with an increase in a farmer's age. According to his study, it was more likely for a farmer to acquire additional skills, knowledge and understanding of the essential benefits of crop diversification as he or she grew older. This however does not conquer with the results from Shahbaz et al. (2017), whose comparative study revealed that the highly diversified farmers were younger than low or non-diversified farmers with an average age of 36 years and 45.6 years respectively. To him, the reason was that younger farmers were assumed to be more innovative, non-risk averse and physically capable to carry out activities related to multiple crop enterprises than their older counterparts. Same was noted with Alibu et al. (2022) who after categorizing his study population into age groups that is young adults (16 - 35years), middle aged adults (36 - 55 years) and older adults (56 and above) found out that the middle age allocated significantly larger land to rice cultivation

than any other crop (maize, beans, cassava) with quite a number of them actually specializing in rice production.

2.3 Factors influencing rice farmers' decisions to crop diversify

Rice is a labour-intensive crop and studies estimate that a rice farming family will spend up to about eight months of very intensive work on the field in a double annual season. Haneishi et al. (2013) even branded it a “pro- smallholder crop” requiring up to an average labour intensity of 332 person-days per hectare cultivated while Akongo et al. (2017) reported an average of 249-man days per hectare. The females and children were reported to spend quite a number of hours of the day in the field scaring birds away and unlike other cereals or crops, rice post- harvest activities were equally labour demanding, tedious and time consuming (Lusiba et al. 2017; Nabuguzi 1993; Kagorora & Kansiime 2021). This accounted for one of the reasons smallholder farmers chose to diversify rice with other crop enterprises that are less labour demanding.

In Queensland - Australia, Makate et al. (2016) used a multinomial logit model to analyze determinants of agricultural diversification. This model revealed that variables like age, education level, number of children, off-farm income, farm size, start-up cost, net income, other crops grown and time factor influenced adoption of agricultural diversification. Similar to that was a study by Tadesse et al. (2018) who also found that age, gender, education, trade experience, extension services and transaction costs influenced farmer participation in crop diversification in Southern Nations, Nationalities, and Peoples' Region (SNNPR) in Ethiopia. A study by Hussain et al. (2020) also revealed several factors that influenced crop diversification. The prominent of them being irrigation and drainage related factors. These however have been dealt with at Doho rice scheme since the rehabilitation which saw infrastructure related challenges being revamped.

In Zambia, Mzyece & Ng'ombe, (2020) while analysing the determinants of crop diversification reported that the size of landholding, fertilizer quantity, distance to market, and tillage using a plough significantly influence farmers' probabilities to practice crop diversification. It asserted that there was a positive and significant association between crop diversification and farm size. One of the major barriers to diversifying farmers' crops was the small amount of land they cultivated. Many small landowners had limited capacity to alter their crop farming because of their small farm size. This implied that as the agricultural area grew larger, farmers could plant different crops on each piece of land, contributing to farm-level crop diversification. Keeping all other variables constant, the farm-level crop diversity index increased by 17% for every additional hectare of farmed land. This study supports Feliciano (2019), who found that increasing land size was a key element in boosting crop diversities. Farmers with extensive landholdings would plant a variety of crops to suit their nutritional needs and sell surplus harvests to boost their income. This same study also found out that crop diversity was inversely linked with market distance. Farmers that lived further distant from the market grew fewer crop species. It reduced crop species richness by 25% for every one-kilometre distance between the areas and the market, holding other factors constant. Similar to the findings of the above study, Emanu et al. (2015) found that poor transportation infrastructure and market access impeded smallholders' adoption of high-value crops in Ethiopian rural areas. This is also akin to Feliciano (2019) whose study found that among the factor key six factors that influenced the implementation of crop diversification were access to roads and markets with the additional five factors being access to water for irrigation, total land size, land and water rights, chronic poverty, and policy interventions.

Poverty or income levels were also found to influence household decisions to diversify. Wealth was found to be positively related to crop diversification. Families with more wealth or relatively bigger income volumes were found to be positively correlated with the decision

to diversify their crop production, this is because they were able to afford inputs related to venturing into an alternative crop enterprise (Bellon et al., 2020).

Smallholder farmers in developing countries have been associated with limited access to financial loans and credits. They therefore depend on savings from their low incomes, which limits opportunities for increased production because they cannot afford to invest more in their farms. For example, a survey of a sample of 344 rural households in Tanzania between May and August 2001 showed that half of total rural household income came from farming, 47.6 per cent from nonfarm employment (wages and self-employment) and less than 4 percent from remittances. This can be associated with the lack of collateral and/or credit history which makes most farmers unable to access funds not only by commercial and national development banks, but also by formal micro-credit institutions. Therefore, it is clear that there is inadequate funding for agricultural operations in Africa generally which negatively affects the farming operations in smallholder farmer settings (Mango et al. 2018). It therefore becomes rather unreasonable to expect farmers who are economically incapacitated to be able to run more than one crop enterprise concurrently.

The increasing prominence of market-oriented approaches especially being championed by humanitarian organizations like Bill and Melinda Gates Foundation in the United States which encouraged market access and integration of small-scale farmers into commodity crop markets (Schurman, 2018). Development institutions also working in the Sub Saharan African such as the World Bank also promote and implement a wide range of market-oriented approaches that seek to integrate smallholders into formal market channels for major commodity crops which helps them penetrate the market.

This was also observed in Uganda with government programs like Northern Uganda Social Action Fund (NUSAF) which boosted production of fruits like mangoes and oranges in

Butaleja district which was largely known for monocropping of rice (Hussain et al., 2020). Same was done by Swiss contact in Uganda in collaboration with Mayuge district local government and Ikulwe Satellite Research Station where interventions to mitigate food insecurity among cocoa farmers have been done since 2019. The cocoa growing households are encouraged to grow orange flesh sweet potatoes which unlike cocoa is more resilient to adverse weather conditions and disease, has a shorter gestation period yet highly nutritious. The smallholder farmers here are offered inputs in terms of improved sweet potato varieties, have access to free extension and advisory support as well as integrated soil management and are trained on land use planning skills.

Adekunle et al (2015) pointed out that the underperformance of these small-holder farmers in irrigation scheme settings has been influenced by several factors including absence of farmers' participation in the schemes' activities or belonging to farmer groups. In India, Aheibam et al. (2017) fronted several reasons why active participation was very hard to achieve including farmer's lack of knowledge, confidence, capital and skills. The low levels of farmers' participation were observed to be caused by inadequate returns and insufficient capacity of farmers' organizations. Yet Ingutia & Sumelius (2022) in their study of the situation of rural women in Kenya's agriculture observed that farmer groups leveraged collective action to access of certain services, including the exchange of information, providing representation and voice to members, buying of inputs and marketing of produce to include jointly meeting of transaction costs. This study will therefore like to believe that the farmer groups could have the potential to encourage its members to not only scale up overall performance but also have the capacity to adopt multiple crop enterprises given the benefits that accrue to it.

Most of the studies reviewed found a positive relation between farm size and crop diversification, except for Adjimoti & Kwadzo (2018) who had a report contrary to the earlier listed. McCord et al. (2015) linked the positive association between farm size and crop diversification with increased farmers' ability to tolerate risk as it considers that farmers with larger landholdings have more cultivable space to experiment with new crops. But although this may be the case for crop diversification with several crop mixes and adoption of agricultural technologies such as modern varieties, the increase in farm size may also lead to specialization with fewer and more specialized high-value crops or cash crop production (Adugna, 2012). Birthal et al. (2020) warns about the increased risk small farmers might bear by allocating land to a commercial crop instead of crops that ensure their food security.

2.4 Crop diversification and profitability

Several studies defined crop diversification in different ways but the most appropriate of them as regards this study is the definition by Makate et al. (2016) that relates crop diversification to the introduction or development of additional crops to the existing farming system, further referred to as horizontal diversification.

Profitability in the context of this study is when the income from farming operations surpasses the related costs and expenses. It is therefore a gauge of a farming operation's capacity to earn a profit and maintain its financial viability (Mzyece & Ng'ombe, 2020). A farmer's income, expenses, and overall economic efficiency are all included in the concept of agricultural profitability (Akite et al., 2022).

Nguyen (2014) defines crop diversification as the strategy of shifting from less profitable crops, changing of variety and cropping system, increasing exports and competitiveness in both domestic and international markets. Feliciano (2019) relate crop diversification to the

replacement of low-value commodities by high-value commodities, usually fruits and vegetables for the export market. In Asia for instance, crop diversification programme (CDP) was launched during the early 1990's. A systematic arrangement of growing a variety of crops in rotation with rice was undertaken, based on farmers' own choice and performances with respect to soil and climatic conditions, thereby ensuring a variety of diverse dietary standards and nutritional status of the rural households. Due attention was given to the protection of nutrient balances in the soil and of all major basic resource endowments in crop production.

Improved crop sequences involving rotation of soil exhausting crops followed by restorative ones, shallow rooted crops followed by deep-rooted ones, legumes in rotation with non-legumes among others are envisaged to enrich and maintain soil fertility as well as crop productivity. In this way it becomes possible to ensure some degree of constancy in crop production, by destabilizing many of the limiting biotic and abiotic stresses.

Crop diversification was also linked to household nutrition or food security in the study done by Bellon et al. (2016). On-farm diversity and market participation were positively associated with dietary diversity of rural mothers in Southern Benin, West Africa. This is due to the fact that in smallholder farmer settings, production of crops is not only for sale but, often more importantly, also for home consumption which concludes that a more diversified production implies better access to higher food diversity (Gergel et al., 2020). Dietary diversity is associated with good health and a healthy household is less money consuming in terms of incomes spent on medicate thus posing an ability to retain more incomes within the household.

A study done by Alam et al. (2021) which was evaluating productivity, profitability and sustainability of the multiple crop based cropping systems in Bangladesh advocated for the

replacement of Transplanted Boro rice (which was the intensive irrigated-based winter rice) with the transplanted Aus Rice (the one planted in the normal rainy season known as the monsoon season), Cucumber and the high yielding potato. The reasons he fronted were that using irrigated water was not only environmentally detrimental but also very costly and the entire irrigation system had high overall establishment costs involved. Findings of the study observe that even when the farmers incurred an extra 28% in the production costs due to replacement of the irrigated rice with the rain-based one as well as the incorporation of the cucumber and potato in the cropping system, the results in a 3-year period of observation (2018- 2020) were a 49% higher overall productivity rate, 74% higher gross margin and doubled net returns. This clearly supports that fact that diversified crop systems are profitable in the long run.

Much as several studies assert that there is a positive relationship between crop diversification and profitability among the diversifying farmers, cases are different for farmers in different localities. This related to a study done by Asfaw et al. (2019) where crop and income diversification was studied in relation to household welfare in 3 different countries namely Malawi, Nigeria and Zambia. The results of the study were distinct for each country with Malawi having 1.8% average increase on household income for each marginal increase of the crop diversification index and the same increase of income diversification resulting into 2.5% average increase in household income. However, this study reported that crop diversification had no effect on farmer welfare in Nigeria while in Zambia, it was found to be “a welfare decreasing strategy”.

According to Di Falco & Chavas (2009), cultivating several crop species can also help smallholder farmers to manage price and production risks. In moisture-stressed, ecologically fragile agriculture systems crop diversification can also be a viable strategy to increase farm-

level crop productivity. All these benefits of diversification contribute to improved yield for the smallholder farmer which will translate to more and a variety of food for consumption and marketable surpluses from production.

The combination of various crops in agro-ecosystems in smallholder farming not only permits more efficient utilization of agro ecological processes, but also provides diversity of human diet and/or improves household income, nutrition, and security. Improving income further improves the purchasing power of the household thereby allowing purchase of other food products. Thus, crop production diversification and consumption habits should include a broader range of crop plant species, in particular those identified currently as underutilized and/or scarce in household food diets *ceteris paribus*. Crop diversification can as a result contribute significantly to livelihoods, improved health and nutrition, household food security, climate resilience, and ecological sustainability (Smithson and Lenné, 2010)

Although crop diversification has several accrued benefits, some studies have gone ahead to assert that there is literally no guarantee of profitability for every diversified cropping system. An example is drawn from Mzyece & Ng'ombe (2020) where impact of a diversified system in Zambia was reported to be dependent on the crop's agronomic or market characteristics and how well it interacts with other crops. Scenarios were cited for different crops under adoption say cassava which had strengths like drought tolerance yet had a history of being poorly commercialized and mostly considered a home consumption crop. Another was the legumes which were scientifically proven to fix atmospheric nitrogen and confer agronomic benefits to the soil, thus bringing benefits to other crops in the systems. The others were the cash crops that had great potential to produce higher returns especially if the farmers accessed competitive output markets with favourable prices yet these prices could as well be very volatile due to fluctuations associated with international markets or uncoordinated national

policies. All the listed circumstances would expose households to considerable risk and potential deterioration of household incomes.

In addition, the study by Makate et al. (2016) showed that non-diversifying farmers growing one or two crops generated lower returns compared to diversifying farmers growing more than three crops on their farms. Findings showed that non-diversifying farmers (grew only beans) generated Kenya Shillings (KES) 40,000 per acre while those who grew two crops (maize and beans) generated between KES. 34,500 and 40,000 per crop per acre respectively, totalling to KES. 74,500 per acre and average gross margin of KES.37,250 per acre. Farmers who grew three crops earned an estimated total of KES. 163,750 for the three crops which is an average of KES 54,600 per acre, a margin higher than their earlier listed counterparts This is a clear indication that crop diversification results to higher returns.

Crop diversity is seen as a major strategy to decrease farmer risk. Additionally, in some conditions it has been shown that farmers who plant more crops, particularly those that are high-value commodities, such as fruits and vegetables, can accrue higher incomes. Lower profit associated with crop diversity may be because each crop is planted at a smaller scale, thereby losing scale-dependent efficiencies. In addition to income, crop diversity may also affect other aspects of poverty such as food security. Hence, the relationship between crop diversity, farmer livelihood and risk need to be studied in a variety of ecological and societal conditions, and particularly in biodiverse areas in which crop diversity may also play a role in natural biodiversity conservation yields.

Smithson and Lenné (2010) reviewed a total of 100 studies of intra-specific crop mixtures in smallholder farming (mostly grains and legumes) and concluded that yields were often slightly higher compared to pure stands of component cultivars who did not diversify. Moreover, increasing crop diversity by intercropping tobacco, maize, sugarcane, potato,

wheat, and broad bean was reported to increase yields for the same season between 33.2 and 84.7% for some combinations.

Crop diversification helps rural households to have more opportunities of full-time employment (Barman et al., 2022). Employment generation is a significant role of agriculture although it is associated with seasonal unemployment which leads to migration of labour among other income related challenges (Ahamad et al., 2011).Crop diversification therefore avails opportunities that can enable farmers be engaged all year round especially with the diversity of crop requirements and the different farming seasons and availability of irrigation facilities being an incentive for production.

CHAPTER THREE

METHODOLOGY

3.1. Study Area

The study was conducted in Butaleja District, where Doho (Uganda's biggest irrigation rice scheme) is located. The district headquarters which is at Butaleja, is located approximately 38 kilometers by road, southwest of Mbale, the nearest largest city

Doho Rice Irrigation Scheme which sits on 2500 Hectares of land and established in 1942 was formerly a seasonal wetland on River Manafwa. It is located in both Mazimasa and Kachonga Sub-Counties of East Bunyole County in Butaleja District of Uganda. These two sub counties are also where the vast majority of the beneficiaries to the rice scheme hail from. The area of the study was chosen because it is ranked the among the highest rice producers in the region. According to Ayella et al. (2022), the scheme bears several unique aspects which include among others a steady supply of regulated water from River Manafwa which flows through the Mt. Elgon's fertile slopes existence of organized sets of farmer groups under the Doho Irrigation Scheme Farmers' Cooperative Society (DIFACOS) that has accrued benefits such as access to capital and inputs, collective action (Ingutia & Sumelius, 2022), as well as the recent rehabilitation of the scheme to include flood management mechanisms, road and transport network (Namyanya, 2014) .

3.2 Study design

A cross sectional survey design was adopted to collect primary data from the households of smallholder rice farmers in the study area. This is because cross sectional data is time saving, easily explores relationship between variables, can be done as a one off, and is very flexible (Connelly, 2016). Data was collected using structured questionnaires pretested on fifty (50)

smallholder rice farmers in Doho irrigation rice scheme and were administered through face to face interviews. The smallholder rice farmers who had cultivated rice at the scheme for two consecutive seasons were considered eligible to participate in the study.

3.3 Study population and sample size

The target population of the study constituted of smallholder rice farmers who are beneficiaries of the scheme. The unit of analysis was the household rice farming heads and their spouses (if married). The inclusion criteria were therefore adults, with child headed households (household heads being below 18years - considered minors as per the laws of Uganda) not eligible for the study. Those who participated in the study only did so after fully consenting by signing participation consent forms. The sample size was got from the population of the smallholder rice farmers in the irrigation scheme and this was determined using Yamane's formula (Adam, 2020) as shown in equation (1);

$$n=N/(1+N(e)^2) \quad (1)$$

Where: n represented the sample size, N the population from which the sample was drawn – (10,000 smallholder rice farmers - Alibu et al. (2022) and e being the level of significance. The universally accepted level of accuracy in social science research is 0.05 that is a confidence level of 95% to mean that there are 95 chances in every 100 that the sample results represent the true condition of the population (Rono, 2018). The respondent size was therefore 385 small holder rice farmers who were all members of Doho rice irrigation scheme.

3.4 Sampling Procedure

The study employed multistage sampling to select a representative sample. First stage involved selecting Butaleja district where Doho irrigation rice scheme is located. Mazimasa, Kachonga and Nabiganda sub counties were also selected in the stage because they are the sub counties where the scheme land is located and is where prominent numbers of the scheme farmers come from. The lists for the rice farming households in each of the selected villages were obtained from Doho Irrigation Rice Scheme Farmers' Cooperative Society (DIFACOS) which directly handles the scheme's rice farmers. Those farmer lists are what formed the sampling frame.

3.5 Data Collection Methods

The researcher administered close ended semi-structured pretested questionnaires on the 385 respondents. The questionnaires constituted of four sections that is; socio-economic characteristics, institutional factors and support services, cost of rice production and lastly market-oriented variables. The questionnaire was pretested on 35 smallholder rice farmers to allow for testing of relevance of the study variables in line with the objectives and thereafter a few modifications were adopted. A team of research assistants well knowledgeable in the local language were chosen from the district and trained on the tool to enable them articulately interview the respondents as well as strictly comply with the ethical considerations of the study. They interviewed respondents in the both the local language (Lunyole) and English according to the respondent's fluency in the listed languages but recorded all responses in English. Area guides familiar with the community were employed to guide the data collection team. These as well helped mobilize the smallholder rice farmers to participate in the study. Standard operating procedures for Covid-19 were maintained throughout the data collection exercise

3.6 Data Analysis

The collected data was coded, entered and analysed using both SPSS (Statistical Package for Social Scientists) version 26 and STATA version 13. Data was then thoroughly cleaned and screened to identify the presence of outliers which could potentially influence the results. Descriptive statistics were used to summarize socio-economic, production costs and revenue variables. The Tobit and the two stage least square econometric models were then used to assess factors for crop diversification as well as the effect crop diversification had on rice profitability respectively.

3.6.1. To characterize the smallholder rice farmers at the scheme as per their socio-economic characteristics.

The analytical tools that were used to characterize the smallholder rice farmers' socioeconomic characteristics like age, sex, level of education, marital status, farming experience, household size, size of land holding, off farm income among others were descriptive such as frequency counts, means, percentages and standard deviation. The results from the selected samples thereby helped the researcher to make generalizations about the farmer population from which the sample was drawn

3.6.2 Assessing factors that influence farmers levels of crop diversification

The study used the Tobit model to analyse this objective. We assume that the farmers follow two chronological decisions; that is, first they choose whether to grow any other crop besides rice or not and secondly, depending on their choice, the level to which they grow those other crops besides rice. The Tobit Regression Model therefore was the most suitable regression model because of its ability to capture variables with lower and upper limit censored values in nature. The crop diversification index (calculated using the Simpson diversity index –

which relates to the proportion of land allocated to each i^{th} crop visa vis the total land holding) was the dependent variable consisting of the lower value zero (0) for those that chose not to diversify and figures greater than zero but with an upper limit of one (1) capturing all those that diversified whatever the intensities.

The model specification is listed in Equation (2)

$$D = 1 - \sum n(pi^2) \quad (2)$$

Where: D is the Simpson Diversity Index, Σ (sigma) denotes a summation (crop enterprises visa vis land), n is the number of crop enterprises, pi is the proportion of land allocated to each crop enterprise and 1 is the upper limit for the highest crop diversification level according to Simpson Diversity Index (1 denotes infinite crop diversity and 0 denotes no crop diversity). Drawing a scenario from our study where we assume a sampled farmer grows three other crops besides rice but allocates 80% of their land to rice growing and the remaining 20% for the three additional crops, we substitute these values in the Simpson's formula as below;

$$D = 1 - ((0.8^2) + (0.0667^2) + (0.0667^2) + (0.0667^2))$$

$$D = 1 - 0.653068$$

$$D = 0.347$$

The Simpson crop diversity index for this farmer would therefore be 0.347, signifying a relatively low level of crop diversification.

The Tobit Regression model therefore proceeds to illustrated this phenomenon in equation (3)

$$\gamma_i^* = \beta_0 + X_i\beta_i + \varepsilon_i \quad (3)$$

Where; γ_i^* is the crop diversification index (Simpson Diversity Index), β_0 is the regression constant, X_i are the row of vectors of explanatory variables that could potentially influence levels of crop diversification in a typical promoted crop setting (those applicable to this study or setting are listed in Table 1), β_i is the coefficient while ε_i is the error / disturbance term reflecting unobserved factors that may have had an impact on the farmers' levels of crop diversification

It is also key to further note that Tobit model is a truncated regression model which encompasses continuous values above the lower limit. Although our lower limit in this regression is zero, all values above that limit are continuous. That is the level of diversification is captured continuously above zero to one. Where a farmer chooses not to diversify rice with any other crop, the crop diversification index value in that case is therefore zero as illustrated in Equation (4) while Equation (5) represents farmers that choose to crop diversify capturing the different levels with the highest assuming value one.

$$\gamma_i = \gamma_i^* \text{ if } \gamma_i^* \leq 0 \quad (4)$$

$$\gamma_i = 0 \text{ if } \gamma_i^* > 0 \quad (5)$$

3.6.3 To assess the effect of crop diversification on profitability of rice farming among smallholder rice farmers.

To analyse the impact crop diversification had on profitability of rice as an enterprise, the Two Stage Least Squares regression was used. In this study, the instrumental variables that were employed included; the proportion of scheme land to total land holding and its squared version, household size, age of household head, gender of household head, farmer experience at the scheme, payment of scheme membership subscription fees, credit source DIFACOS or VSLA, extension services from government, farmer association or private companies, rice

buyer middlemen or processor, rice variety super or K-98, other crop combinations grown besides rice being either perennials, legumes, roots or cereals, level of education of household head, access to extension services (dummy), access to farm credit, distance to input markets, use of improved seed varieties, access to market information through the radio, cost of irrigation and its squared version as well as rearing of livestock (dummy). It is key to note that it was inevitable to include the instrumented variables since they were excluded in the first stage of the regression. The impact of crop diversification was noted to be positively significant to profitability of rice alongside other variables that were used as illustrated in the Equation (6)

First stage;

$$Y_i = \beta_0 + \beta_i X_i + \mu_i \quad (6)$$

Where; Y_i is crop diversification, β_0 is the intercept, β_i is the coefficient of endogenous variables (crop diversification), X_i are the exogenous variables that affect crop diversification, μ_i is the error term

In the first stage, the exogeneous variables that affect crop diversification listed in Table (1) include the proportion of scheme land to total land holding and its squared version, level of education of household head, gender of household head, access to extension services (dummy), access to market information through the radio, other crop combinations grown besides rice being either perennials or roots, cost of irrigation and its squared version. The error term here therefore represents other unobserved variables that affect crop diversification

In the second stage, the profitability of rice farming is the dependent variable which is regressed on the predicted values of crop diversification obtained from the first stage. The error term in the second stage are other factors (unobserved) besides crop diversification and

the instruments used that may affect profitability but are not accounted for in the model.

Refer to model specification in Equation (7);

$$Y_{ii} = \beta_0 + X_2\beta_2 + \mu_2 \quad (7)$$

Where; Y_{ii} is rice profitability, β_0 is the intercept X_2 is the exogenous variable, β_2 is the coefficient for the endogenous variable (crop diversification) and μ_2 is the disturbance term

The two stage least squares method is therefore used to address the potential endogeneity bias arising from the correlation between crop diversification and unobserved variables that affect profitability. By using the predicted values of crop diversification from the first stage as instrumental variables, the two stage least squares method allows for the estimation of unbiased coefficients for the endogenous variable in the second stage

Table 3.1: Explanatory variables and their apriori signs as used in the Tobit Regression and Two Stage Least Square models

Variable	Category	Units of measurement	Apriori Signs		Literature
			Tobit	2SLS	
Gender – HHH	Dummy	0-Male, 1-Female	+	N/A	(Ghimire et al., 2015)
Crop diversification index	Continuous	Crops grown vis a vis land allocated	N/A	+	(Adjimoti & Kwadzo 2018)
Farmer Exp – scheme	Continuous	Number of years	-/+	-	(Alibu et al., 2022)
Farmer Exp – scheme (squared)	Continuous	Number of years	N/A	+	(Ruzzante et al., 2021)
Edn level – HHH	Continuous	Number of years in formal school	-	N/A	(Kemboi et al., 2020 & Aheibam et al., 2017)
Prop- scheme land total land	Continuous	Acres	-/+	+	(Ruzzante et al., 2021)
Dist. input mkt	Continuous	Kilometers	-/+	N/A	(Feliciano, 2019)
Access ext. services	Dummy	1-Yes, 0-No	-	N/A	(Adeyemi et al., 2023)
Ext. Agent- farmer association	Dummy	1-Yes, 0-No	N/A	+	(Danso-Abbeam et al., 2018)
Ext. agent- private company	Dummy	1-Yes, 0-No	N/A	+	(Danso-Abbeam et al., 2018)
Access - farm credit	Dummy	1-Yes, 0-No	-/+	N/A	(Alibu et al., 2022)
Source of credit- DIFACOS	Dummy	1-Yes, 0-No	N/A	+	(Mojo et al., 2017)
Mkt Info – radio	Dummy	1-Yes, 0-No	+	N/A	(Asfaw et al., 2019)
Use improved seed	Dummy	1-Yes, 0-No	-/+	N/A	(Hong et al., 2021)

Buyer rice processor	Dummy	1-Yes, 0-No	N/A	+	(Donkor et al., 2021)
Grow super variety	Dummy	1-Yes, 0-No	N/A	+	(FAO, 2021)
Other crop category grown – Legumes	Dummy	1-Yes, 0-No	-/+	+	(Sánchez et al., 2022)
Other crop category grown – Cereals	Dummy	1-Yes, 0-No	-/+	N/A	(Sánchez et al., 2022)
Other crop category grown – Roots	Dummy	1-Yes, 0-No	+	+	(Kijima, 2019b)
Other crop category grown - Perennials	Dummy	1-Yes, 0-No	+	N/A	(Wang et al., 2021)
Cost of Irrigation	Continuous	Ugx	-/+	N/A	(Aheibam et al., 2017)
Rear Livestock	Dummy	1-Yes, 0-No	-/+	N/A	(Rugema et al., 2018)

3.7. Ethical consideration.

For ethical purposes, clearance was sought from Gulu University Research Ethics Committee (GUREC) and the study was approved (approval letter attached in the appendix). Permission to access the study area as well as the target population was sought from Butaleja local government administration (also attached in the appendix). To ensure utmost confidentiality for the respondents, the data they provided reflected on the ethics practiced in this study because the research was guided by the principles of respect for people, beneficence, and justice. The four (4) research assistants were trained on ethical practices prior to conducting research. This training covered respect of privacy of the participants, respect of opinion of participants and assurance of confidentiality of participants data. The researcher upheld respondent rights, including the right to be informed about the study (refer to appendix ii and iii for English and Lunyole version consent forms respectively), the right to freely decide whether to participate in the study or not, and the right to withdraw from the study at any time without any penalty whatsoever. The participants were requested to sign an informed consent form (translated into Lunyole language as was required) assuring them that all data collected would be coded to uphold their anonymity.

3.8 Study Limitation

Language barrier as a limitation was solved by recruiting research assistants who were conversant with the language and the purpose of the study adequately communicated to the respondents to ensure sufficient information were obtained.

The poor road networks and remoteness of the study area were countered by having local area guides who were well versed with the geography of the area.

Time constraints from the respondents were countered by offering refreshments and material tokens of appreciation as compensation for time lost as well avoiding asking questions that fall out of the study.

CHAPTER FOUR

PRESENTATION AND INTERPRETATION OF RESULTS

4.1 Characteristics of smallholder rice farmers in Doho Irrigation Rice Scheme

This section presents socio-economic characteristics of sampled smallholder rice farmers in the scheme. Table 4.1 presents a summary of the descriptive statistics of the continuous variables detailing the means and standard deviation.

Table 4.1: Descriptive statistics presenting the rice farmers continuous characteristics

Variable	Unit	Mean	St. Dev
Age – HHH	Years	42.89	11.68
Education level	Years (formal schooling)	6.82	3.88
Household size	Number of members	8.89	5.39
Female household members	Number of members	4.13	2.92
Male household members	Number of members	4.76	3.32
Household members <=17yrs old	Number of members	4.21	3.06
Household members 18-35yrs old	Number of members	3.09	2.42
Household members 36-55yrs old	Number of members	1.36	1.42
Household members >=56yrs old	Number of members	0.28	0.62
Distance to the nearest input mkt	Kilometres	2.10	1.24
Distance to the nearest output mkt	Kilometres	1.98	1.14
Rice farming experience - general	Years	15.44	9.56
Rice farming experience - scheme	Years	15.11	9.25
Total land under production	Acres	1.99	1.44
Land holding – scheme	Acres	1.25	0.97
Number of crop enterprises besides rice	Number of enterprises	1.62	0.98
Cost of irrigation	Uganda Shillings (Ugx)	119,825	92,552

The results reveal that the household heads (HHH) were averagely aged 43 years with the mean number of years of formal schooling being seven years. Average household size was nine members with a composition of four females and five males. Of the above listed, averagely four were children (0-17years), three were young adults (18-35years), a middle-aged adult (36-55years) and no elder person (56years and above). The mean total land under production for the respondents was 2.0 acres while the average land a household owned at the scheme was 1.3 acres. On average, the distance from the households to the input and output

markets was 2.1 kms and 2.0 kms respectively. The respondents also had an average of 15.4 years of experience cultivating rice in general and 15.1 years for experience cultivating rice at the scheme. The rice farmers on average were able to grow two other crops besides rice. The average cost of scheme irrigation water they incurred annually was 119,825 Ugandan shillings (Ugx).

Presentation on the summary of the farmers' categorical variables using frequencies and percentages as in Table 4.2 highlight the following parameters. Majority of the households were male headed (90.4%) and 79.7% of the respondents were married. Of the sampled population, 81.6% were engaged in an off-farm activity while 94.8% owned mobile phones. Almost all the respondents received farmer extension services (99.7%), the difference only being in the number of visits and type of extension agent who visited them. 14% were visited by an agent from the government, 15.3% from the farmer association, 3.1% from private companies and the others from other sources. 61.6% of the total sample also sourced for farm credit. Of these, 61.3% sourced from DIFACOS, 8.6% from VSLAs and the remaining 30.1% from microfinance institutions, commercial banks, friends and family. 95.3% reported to have paid for membership subscription fees at the scheme. 65.7% belonged to a farmer group, only 4.9% used improved seeds and 17.9% accessed market information through the radio. Of the rice varieties grown, those who grew Super were 8.3%, K-98 23.4% while 68.3% grew other varieties like Basmati, Zain, Kaiso and Wita 9. 86.8% of the farmers sold their rice output to middlemen, 5.2% to rice processors and 8% sold either to urban traders, village collectors, other farmers or seed company. 93.8% of the respondents grew other crops besides rice while 90.1% also reared livestock.

Table 4.2: Descriptive statistics detailing rice farmers' categorical characteristics

Variable	Category	Frequency (n=385)	Percentage
Gender of household head	Female	37	9.6
	Male	348	90.4
Marital status of household head (Married)	Yes	307	79.7
	Otherwise	78	20.3
Engaged in non-farm activity	Yes	314	81.6
Own mobile phone	Yes	365	94.8
Received extension services	Yes	384	99.7
Extension agent – government	Yes	54	14.0
Extension agent - farmer association	Yes	59	15.3
Extension agent - private company	Yes	12	3.1
Access to farm credit	Yes	237	61.6
Source of credit – DIFACOS	Yes	236	61.3
Source of credit – VSLA	Yes	33	8.6
Scheme service – membership subscription fees	Yes	367	95.3
Belong to a farmer group	Yes	253	65.7
Used improved seed	Yes	19	4.9
Source of market info is radio	Yes	69	17.9
Sold rice to middlemen	Yes	334	86.8
Sold rice to rice processor	Yes	20	5.2
Variety grown – Super	Yes	32	8.3
Variety grown - K98	Yes	90	23.4
Grew any other crop besides rice	Yes	361	93.8
Other crop category grown – cereals	Yes	237	61.6
Other crop category grown – legumes	Yes	166	43.1
Other crop category grown – roots	Yes	120	31.2
Other crop category grown – perennials	Yes	43	11.2

4.2. Crop diversification and its associated factors

4.2.1 Levels of crop diversification

Tables 4.3 and 4.4 summarize the crop diversification levels of the rice farmers. Table 4.3 explains the intensity of diversification as a crop count variable. First the crops were classified into rice (main crop), other cereals (maize, millet and sorghum), legumes (beans and groundnuts), roots (cassava and sweet potatoes), perennials (bananas and coffee) and vegetables. Farmers who grew only rice is what is referred to as one crop combination. Two crop combination are farmers who grew rice and either other cereals, legumes, roots, perennials or vegetables. Three crop combination are farmers who grew rice and any two

other crop classifications. Four crop combination are farmers who grew rice and any three other crop classifications while five crop combination are farmers who grew rice and four other crop classifications. From the results, these were an estimate of 6.23%, 52.99%, 30.39%, 9.87% and 0.52% respectively.

Table 4.3: Summary of crop combinations (Rice - main crop, Other Cereals, Legumes, Roots, Perennials and Vegetables) as grown by the smallholder rice farmers

Crop combinations	Frequency (n=385)	Percentage (100%)
One crop (Rice only)	24	6.23
Two crop combinations	204	52.99
Three crop combinations	117	30.39
Four crop combinations	38	9.87
Five crop combinations	2	0.52

Table 4.4 on the other hand presents crop diversification from the concept of Simpson crop diversification index that explains diversification from an angle of the land proportion allocated to each crop visa vis the total land under production. The values obtained starts from 0 and tends to 1 as a farmer increases the extent to which they diversify. The farmers are therefore categorized into those that specialized in rice only, those who diversified at a lower, moderate or higher-level basing on their score range as detailed in the table.

Table 4.4: Level of crop diversification by the smallholder rice farmers

Level of diversification	Range (SDI)	Frequency (n=385)	Percentage
Specialization	SDI ≤ 0.0	24	6.23
Lower	SDI 0.01 - 0.5	191	49.61
Moderate	SDI 0.51 - 0.75	142	36.88
Upper	SDI 0.76 – 1	28	7.27

SDI= Simpson diversification index (Mean = 0.48, Standard deviation = 0.21)

4.2.2 Factors influencing crop diversification among irrigation rice farmers

Tobit model results for factors influencing crop diversification are presented in Table 4.5. It shows that the proportion of scheme land to the total land holding has a positive significant

($p < 0.01$) influence on crop diversification. However, the relationship between proportion of land in the scheme and level of crop diversification exhibits an inverted U-shaped trend. This implies that, initially, as the proportion of land in the scheme to the total land holding becomes higher, there is a proportional increase in level of crop-diversification, however once a maximum is reached, having more land in the scheme would be associated with declining level of diversification. This suggests that as more and more land is acquired by a farmer in the scheme (for rice production), their willingness to run multiple crop enterprises consequently lowers as they begun to reap the benefits associated with economies of scale which result into lower costs of production for each additional unit of rice output produced. This therefore becomes an incentive for specialization in fewer crops. Education ($p < 0.05$) significantly and negatively influences crop diversification, suggesting that the more educated a household head is, the more likely a household specializes in a few crops. Gender of the household head positively and significantly ($p < 0.1$) influences crop diversification. This implies that there is a 2.7% likelihood that male headed households will grow more crops than the female headed ones. On the contrary, access to extension services is associated with negative and significant ($p < 0.01$) influence on crop diversification. Farmers who receive extension services are more likely to specialize in a few crops. For access to market information, results show that possession of radios negatively and significantly ($p < 0.01$) influence crop diversification. Farmers who grow other crops besides rice will most likely adopt either a rice-roots crop combination or a rice-perennials crop combination since the listed crop combinations are both positive and significant ($p < 0.01$) to crop diversification.

Table 4.5: Factors influencing crop diversification

Variables	Coeff.	Robust Std. Err.	T	P> t
Scheme land prop to total land	0.307***	0.058	5.27	0.000
Scheme land prop to total land sqd	-0.091***	0.009	-10.40	0.000
Farmer Scheme Experience	0.011	0.008	1.36	0.175
Level of Education	-0.002**	0.001	-2.01	0.045
Gender - HHH	0.027*	0.014	1.94	0.054
Extension Services	-0.043***	0.015	-2.89	0.004
Access - Farm Credit	-0.010	0.009	-1.04	0.299
Dist. Input Market	-0.013	0.010	-1.25	0.213
Seed used is improved	0.029	0.021	1.38	0.168
Radio - Mkt Info Source	-0.056***	0.016	-3.54	0.000
Other crops - Cereals	0.017	0.012	1.44	0.151
Other crops - Legumes	0.009	0.013	0.72	0.470
Other crops - Roots	0.034***	0.012	2.80	0.005
Other crops - Perennials	0.050***	0.016	3.13	0.002
Irrigation Cost	0.474***	0.172	2.75	0.006
Irrigation Cost sqd	-0.019**	0.007	-2.56	0.011
Rear Livestock	0.018	0.014	1.35	0.179
Constant	-2.346**	0.994	-2.36	0.019
No. of Observations	385.000			
Prob > F	0.000			
Pseudo R ²	50.982			
Log pseudolikelihood	397.316			

The cost of scheme irrigation water positively and significantly ($p < 0.01$) influences crop diversification. However, there is an inverted -U- shaped relationship between crop diversification and cost of scheme irrigation water. This infers that, originally, crop diversification increases with each relative increase in the cost of scheme irrigation water to reach a maximum after which the higher the cost of irrigation water the lower the level of crop diversification. It is important to note that in this study, cost of irrigation water is tied to land acreage/size under production. So as a farmer pays more for cost of irrigation water (rather meaning acquires more land for rice production), they begin to incline more to rice specialization to be able to earn benefits of intensified cropping systems. Farmer experience cultivating rice at the scheme, access to farm credit, distance to the input markets, use of improved seed varieties, rearing of livestock, adoption of crop categories cereals and legumes alongside rice did not have an influence on levels of crop diversification by farmers.

4.3 Rice profitability and crop diversification

4.3.1 Rice production costs

Table 4.6 presents a summary of the costs incurred by the rice farmers at the scheme. These costs are presented in 4 subsets to include capital costs, labour costs, cost of materials and cost of equipment. Capital costs that included cost of land lease, irrigation costs and scheme membership fees were 44.3% of the cost of production. Labour costs which were computed to include family labour or hired labour or a combination of both as per the rice farmers' preference constituted 31.3% of the total production costs, cost of materials (seeds, fertilizers, pesticides and herbicides) was 23.4% while cost of equipment (hoes, spraying pumps, knives or sickles, tarpaulins and sacks) was only 1% of the overall production cost

Table 4.6: A summary of production costs incurred by the rice farmers and the profits attained

Variable (Ugx)	Mean(n=385)	St. Dev.	Minimum	Maximum
Hired Labour	295843	519949	0	3070000
Family Labour	835272	746760	0	4797000
Capital Costs	1598968	1210648	185000	6560000
Labour costs (Total hired & family lbr)	1131115	829228	215000	4797000
Cost of materials	844543	783572	84000	4211000
Cost of equipment	37681	23530	0	274000
Total cost of pdn	3612307	2782667	588000	15105000

4.3.2 Rice harvests, revenues and profits

The rice output quantities (harvested, sold and consumed) presented in Table 4.7 are in milled form. The conversion rate from paddy to milled being an average of 70%. However, quantities saved for seed are presented in paddy form. The results show that from the total harvest, 96.13% is sold off, 1.74% consumed and 2.13% saved for seed for the subsequent cropping season. From the rice revenues earned, the results submit that the cost of production

is 46.8% of their total earnings there by amounting to 53.2% profit other factors held constant.

Table 4.7: A summary of the rice harvests, revenues and profits earned

Variable	Mean(n=385)	St. Dev.	Minimum	Maximum
Rice quantity harvested (Kgs)	1195	959	204	5540
Rice quantity sold (Kgs)	1149	927	175	5450
Price of rice (Ugx)	3341	418	1550	5800
Rice quantity consumed (Kgs)	21	18	0	155
Rice quantity saved for seed (Kgs)	36	39	0	250
Rice revenue earned (Ugx)	7,717,380	6,306,381	1,001,000	36,575,000
Annual profit (Ugx)	4,105,431	3,699,638	232,800	23,083,000

Results from table 4.7 which summarizes the rice harvests, revenues and profits earned by the smallholder rice farmers show that the average rice yield is 1,195kgs, with approximately 1,149 taken for sale, 21kgs consumed and 36kgs kept for seeds in the subsequent season. Averagely rice is sold at 3,341UGX with average total revenues estimated at 7,717,380UGX fetching approximately 53.2% profits.

4.3.3 Influence of crop diversification on rice profitability

The two stage least square model results for influence of crop diversification on profitability of rice farming are presented in Table 4.8. the results show that crop diversification has a positive and significant influence ($p < 0.01$) on rice profitability which suggests that the more crops a farmer grew alongside rice, the more likely they were to profit from rice production. The proportion of scheme land to a household's total land holding has a positive and significant influence ($p < 0.01$) on profitability of rice. However, farmer experience cultivating rice at the scheme shows a U-shaped association with profitability of rice. It suggests that in the start, as a farmer begins to learn the dynamics of rice production, their inexperience costs their likelihood of earning a profit from their rice enterprise. They operate at a loss and once they reach a maximum, they begin to adopt to the rice production techniques and are

consequently able to earn a 12.4% profit for each relative increase in the years they spend cultivating rice. Access to credit from the scheme SACCO (DIFACOS) is also a positive and significant ($p < 0.01$) influencer of rice profitability.

Table 4.8: Regression results for the influence of crop diversification on rice profitability

Annual Profit	Coef.	Robust Std. Err	Z	P> z
SDI	1.304***	0.495	2.63	0.008
Scheme land prop to total land	0.704***	0.134	5.23	0.000
Household Size	0.056	0.067	0.84	0.398
Age – HHH	0.002	0.005	0.37	0.708
Gender – HHH	-0.032	0.145	-0.22	0.826
Farming Exp – Scheme	-0.457*	0.277	-1.65	0.099
Farming Exp - Scheme Sqd	0.124**	0.062	2.00	0.046
Scheme service Mber Subscription	0.233	0.193	1.20	0.229
Credit – DIFACOS	0.316***	0.080	3.94	0.000
Credit – VSLA	-0.171	0.149	-1.15	0.251
Ext. Agent - Gov't	0.118	0.127	0.93	0.351
Ext. Agent - Farmer Ass.	0.277**	0.128	2.17	0.030
Ext. Agent - Private Co.	0.383*	0.196	1.95	0.051
Buyer – Middlemen	0.123	0.152	0.81	0.418
Buyer - Rice Processor	0.532***	0.187	2.85	0.004
Variety – Super	0.561***	0.135	4.16	0.000
Variety - K98	0.151	0.100	1.51	0.132
Perennials	0.155	0.123	1.26	0.209
Legumes	0.179**	0.077	2.33	0.020
Roots	0.202**	0.094	2.15	0.031
Constant	11.107***	0.819	13.56	0.000
No of Observations	385.000			
Wald Chi2	185.020			
Prob > Chi2	0.000			
R-Squared	0.282			
Root MSE	0.706			

***, ** & * imply significance at $p < 0.01$, $p < 0.05$ and $p < 0.1$ respectively

Sources of farmer extension services like farmer associations and the private companies are equally positively and significantly ($p < 0.05$ and $p < 0.1$ respectively) associated with rice profitability. Channel of sale of rice output shows an association with rice profitability with those selling to rice processors likely able to earn more profits at positive significance $P < 0.01$. Super rice variety, widely believed to be a superior variety by the farmer population at the scheme has a positive and significant ($p < 0.01$) influence on the profitability of rice. Some crop categories grown besides rice have an influence on rice profitability. These

include legumes and roots which both bear positive and significant ($p < 0.05$) influence. However, age and gender of the household head, membership subscription as a scheme service, VSLA as a source of farm credit, extension service from government, buyer of rice being middlemen and variety of rice grown being K-5 do not have an influence on the overall profitability of rice farming.

CHAPTER FIVE

DISCUSSIONS

5.1 Characterizing Doho Rice Scheme smallholder farmers

The results on mean age in this study relates with what Okello et al. (2019) while referring to Uganda Bureau of Statistics, reported to have been within the range that comprised of (15 – 64 years) almost 50% of Uganda's total population. The listed age mean therefore deduces that since rice farming is considered a labour-intensive crop (Lusiba et al., 2017), the persons around the stated age bracket have the physical stamina entailed to run rice as a crop enterprise. This agrees with Adeyemi et al. (2023) who also emphasized that 36-45 years was considered prime age for economic activity. There are equally many studies that reported almost similar age means (refer, for example - Bellon et al. 2020; Namyenya 2014; Lusiba et al. 2017). However, other rice farming studies though not done in the scheme settings per say had slightly higher (Mojo et al., 2017) - 48years or relatively lower mean household head age (Abdul-Rahaman & Abdulai 2018; Okello et al. 2019) of 37.90 and 37.61years respectively.

Average household size reported in the results is higher than the mean size of between four to six members reported in Mojo et al. (2017); Wilson et al. (2017); Akite et al. (2022) and Semazzi & Kakungulu, (2020) although the survey affirmed that Teso and Bukedi regions (where the study area is located) had the larger average household sizes than other regions in Uganda (Larson & Lewis, 2018). The highest prevalence of males than females reported in this study can be attributed to the cultural and traditional norms that place more value on males than females due to their abilities to contribute to household work and generate incomes. Families may therefore prioritize having male children over female children. However, it may be affected by rural urban migration patterns where the male youths go in

search of employment opportunities leaving a bigger margin of females in the rural areas. There are also other studies that reported having higher male household compositions than females (refer, for example Okello et al. 2019; Lusiba et al. 2017).

Formal schooling attained by household heads in this study is a true representation of the state of education in Uganda today despite several Ugandan government initiatives towards provision of equitable access to education through programs like Universal Primary and Secondary Education (UPE and USE). Musiimenta et al. (2021) reported that bigger margins of illiteracy were found among the female gender (41.2%). It is also key to note that given the labour intensiveness of rice farming, coupled with high poverty levels, farmers in these settings usually opt for family labour and cannot afford the basic financial requirements for attainment of a ‘decent’ education. The would be school going young household members are therefore deprived of the time and resources to attain an education. They are sent to the fields from tender ages to perform chores like bird scaring which are very time consuming. These low levels of education were equally reported in other Ugandan rice farming community surveys by Okello et al. 2019; Lusiba et al. (2017); Namyanya (2014). It is even more appalling in other in other African countries for example Wilson et al. (2017) from Mozambique reported 32% of no formal schooling among respondents and 27% primary school completion which is an equivalent to Uganda’s 7 years of formal schooling, Mojo et al. (2017) from Ethiopia reported 3.8 years, while Bellon et al. (2020) and Abdul-Rahaman & Abdulai (2018) from Ghana reported 2.30years and 2.05years respectively of formal schooling respectively. This suggests that Africa as a continent needs literacy related intervention if they are to improve livelihoods in rural communities.

The land holding under production both at the scheme and in general compares with land sizes reported by Namyanya 2014; Lusiba et al. 2017; Wilson et al. 2017 and Abdul-

Rahaman & Abdulai 2018. On the contrary though, Mojo et al. (2017) and Ingutia & Sumelius (2022) reported relatively bigger total land holdings. It is key to note that Uganda has over the years succumbed to land fragmentation because of its growing population and urbanization related effects. The spontaneous increase in population has put a lot of pressure not only on land but on other non-renewable resources too. Fragmented land holdings therefore mean equally smaller production units that translate to low yields and consequently very low incomes. These in away counter the overall financial ability of the farmer to afford the finically demanding rice enterprise.

Distance from the households to the input and output markets is slightly higher than 1.5kms reported by Namyanya (2014) and contrary to the expectation that as urbanization sets in, development follows suite especially in regard to road networks and communication lines. Although there are several initiatives that have been put in place to facilitate infrastructural development in the peri urban areas like the Uganda Support to Municipality Infrastructural Development under funding (USMID) from World Bank, the remote rural areas have not been catered for. The roads there are unpaved, with poor drainage systems and are impassable during rainy seasons. This makes it hard to the farmers to access output markets making them vulnerable to sale of output to middlemen or rather village collectors who inturn offer them relatively low pricing and reduce their overall profitability. Restructuring of government policies in line with service delivery would go a long way to improving infrastructure in these localities.

The respondents' level of experience cultivating rice in general and at the scheme to be specific are within the margins of what previous studies on rice farming reported. Lusiba et al. (2017) reported 16.7 years and Namyanya (2014) 13years, but Wilson et al. (2017) registered slightly higher than that (22.6years). Farmers in scheme settings are mostly

attracted to farm in the scheme for years due to the benefits the scheme settings offer especially irrigation water which counters weather variability effects (Wilson et al., 2017). This makes them less vulnerable to losses associated with climate shocks that farmers dependent on rain fed systems may face.

The average number of additional crop enterprises grown by the farmers besides rice draws back to the traditional aspects in SSA. African communities from the ancient days took pride in growing multiple crops. It is evident in the number of staple foods across different tribes or regions in Uganda (Wichern et al., 2017). Several studies equally reported diversity of crops in promoted crop settings for example studies by Mojo et al. (2017); Bellon et al. (2020); Okello et al (2019) reported 2.19 crops, 3.2 crops and 4.10 crops. Their argument was that production of multiple crops was necessary (more less inevitable) given the food and income requirements of households.

Male dominance reported in this study emanates from the patriarchal systems that characterize African family settings and quite a number of other continents especially Asia for example in Bangladesh (De Pinto et al., 2020). This therefore explains why various studies also had the same findings as regards to who headed the household. Studies depicting similar trends across Africa include other Ugandan studies by Lusiba et al. (2017) whose findings had 90% and Namyanya (2014) with 94% male headed households. In Ghana, findings from Abdul-Rahaman & Abdulai (2018) and Bellon et al. (2020) had 90% and 91% respectively. Mojo et al. (2017) from Ethiopia had 92% except for Wilson et al. (2017) who reported a contrasting 68% for male headed households in a study done in Mozambique. The prominence of the male gender, who are directly in charge of the productive resources especially land therefore suggests why the male headed households were found to have achieved higher levels of profitability than the female headed ones.

The respondents' marital status reports are in line with studies by Okello et al. (2019) and Mojo et al. (2017) who also reported relatively bigger percentages of married survey respondents (86% and 84% respectively). This is because marriage to date is associated with security, pride and higher social standing (Naisiko 2021; Onyango 2015). In Uganda traditionally, the unmarried were associated with bad luck or poor morals. Buganda to date has the “*Sengas*” and “*Kojjas*” that is Aunties and Uncles whose primary role is to prepare the youngsters for marriage. They also counsel the marrieds to ensure the idea of separation or divorce is not an option they could choose (De Haas & Hutter 2019; Miller et al. 2016)

Of the sampled population, more than half reported to have been engaged in an off farm activity and this agrees with a study by Rizwan et al. (2017) whose findings while ascertaining the determinants and choices of off-farm work among rice farmers in a developing country (Punjab, Pakistan) reported 65% of farm engagements after he categorized off farm activities into off farm labour, self-employment, public services and migration. This study submitted that promoting off farm activities was necessary to enhance rice growing households' incomes which would help the farmers finance rice growing activities thus increasing productivity, reduce poverty and improve living standards.

Majority of the respondents owned mobile phones despite constraints associated with mobile phone usage such as high costs, lack of training on usage and ICT service failure (Adeyemi et al., 2023). However, quite a number of benefits are reported to accrue from ownership of mobile phones by farmer communities like increased agricultural profits, decreased the production costs and reduced time investments of farming (Quandt et al. 2020; Tinzaara et al. 2021),

Almost all the respondents received extension service and credit ought to be directed to the coordination of DIFACOS as well as works of partner organizations that have along the years

given support to farmers like KOPIA, JICA, IFDC, Kilimo Trust among others. Danso-Abbeam et al. (2018) termed extension programs as “the main conduit for disseminating information on farm technologies, support rural adult learning and assist farmers in developing their farm technical and managerial skills”. Results from that study reported an improved farm productivity by 11.3%. It is therefore prudent to note that extension services have the capacity to improve yields and consequently incomes. Evidence can also be drawn from Alibu et al. (2022) who reported that when rice farmers from Doho rice scheme were supported with agronomic skills during the introduction of NARORICE-1 by KOPIA in conjunction with NaCRRI and NARO, they were able to raise their yields from an average of 3.1tonnes to 4.1tonnes per hectare.

It is prudent to note that DIFACOS provided credit to more than half of the respondents that reported having sourced for farm credit. The significant percentages of access to credit from DIFACOS point towards the requirements that are usually advanced as prerequisites for attaining financing which among others include collateral and good credit history on very high interest rates. DIFACOS advances this credit to the farmers using their full membership with them. No third parties, collateral or interest charges accompany these loans. This is an incentive to help farmers source for credit for their farm activities. The relatively bigger numbers of farmers sourcing for credit also points towards the poverty levels existent in these farming communities (Kangile et al., 2018). These make it impossible to farmers to save proceeds from their harvest to facilitate subsequent seasons as they are struggling to afford the basic requirements of life

The prominent numbers that reported having paid for membership subscription fees at the scheme or belonged to a farmer group is related to findings by Mojo et al. (2017) who reported an enormous 96% in farmer group membership. The reasons advanced for this

phenomenon by Abdul-Rahaman & Abdulai (2018) and Ingutia & Sumelius (2022) is that participation in farmer groups is positively associated with increased yield and technical efficiency.

The significantly low levels of use of improved seeds lends support to Barungi & Odokonyero (2016) who while carrying out a rice value chain survey in Tororo, Bugiri and Butaleja districts found out that farmers were either using local or recycled seed (74% and 81% respectively). The low use of improved seed can be attributed to the poverty levels of farmers as Akite et al. (2022). reported an improved rice seed variety accounted for nearly half of the total rice production costs. It is true to assert that this poverty trend is a representation of the study area which is located in Eastern Uganda and was ranked second among the “most chronically poor” after Northern Uganda (Chepchirchir et al., 2017). Hong et al. (2021); Akongo et al. (2017); and Kangile et al. (2018) reported limited awareness about improved seeds consequently leading to very low levels use of the same and fronted it as one of the major challenges that affected productivity. They therefore recommended both public and private institutions to extensively promote use of improved seed varieties to enhance its use.

The low levels of ownership and use of radios can be explained by Otene et al. (2015) who presented the major barriers to use of radios being poor signals from the radio stations, low quality of the programs and inappropriate time of the broadcasts. In Uganda today, though radios are still functional, they are dominated by other entertainment geared programs like sports, music and commercial adverts which are more inclined to the needs of the relatively younger household members. The concept of farm talks and related content has also been replaced by exhibitions, websites, written communications in terms of leaflets, banners, periodic issues or training by partner agencies. It is also key to note that as households grow

bigger, it becomes more difficult to meet the listenership needs of household members who by virtue of the differences in age and social groups feel inclined to different content. However, this contrasts findings by Badiru et al. (2018) who reported radios being the major source of agricultural information to the farmers.

The eminence of Super, Kaiso and Wita-9 over other rice varieties is also documented in studies like Barungi & Odokonyero (2016) and Hong et al. (2021). Akongo et al. (2016) while studying the effects of climate and conflict on technical efficiency of rice production in northern Uganda also found out that farmers who had grown Super, Kaiso and NERICA varieties had higher mean technical efficiency estimates as per the order of listing above. The earlier listed varieties are associated with either aroma, higher pricing, resilience to poor conditions or early maturity period.

The use of middlemen as a marketing/sales channel is a trend that has been associated with smallholder farmers from way back. Studies like Barungi & Odokonyero (2016) reported 66% sale of rice output to middlemen followed by rice urban traders and small margins to other rice buyer categories. They also highlighted that marketing of rice produce individually made the rice farmers more vulnerable to being cheated by middlemen. Kikuchi et al. (2016) in their study referred to these middlemen as town brokers and further explained that they bought both paddy rice (at farmgate from farmers or village collectors) and milled rice (from milling points), stored in bulk and sold off to urban traders or local vendors in public markets.

The prominence of livestock rearing reported here contrasts findings by Owusu (2021) who reported that only 28.9% of the irrigating community reared livestock. However, it portrays that general trend in the rural communities in Uganda where livestock is an equally prominent source of livelihood (Wichern et al., 2017). Findings by Rugema et al., (2018) also listed poultry, goats, cattle and pigs as the most common types of livestock while further

explaining that rearing livestock in smallholder farmer communities is vital as it not only provides food and income but is also a source of social status.

5.2 Factors influencing rice farmers' levels of crop diversification.

In this study nearly all the rice farmers (94%) grew other crops besides the traditional rice. This observation can be attributed to the widespread verdicts that crop diversification curbs risks associated with weather and market shocks (Okello et al. 2019; Tesfaye & Tirivayi 2020; Barman et al. 2022; Hufnagel et al. 2020). De Roest et al. (2018) also asserted that diversified (economies of scope) systems had the ability to reduce market risks as well as improve efficiency of farm organizations and overall resource use.

The positive association between proportion of scheme land to the total land holding conquers with Tesfaye & Tirivayi (2020) who in his study explained that land in general is an important enabler of crop diversification. This implies that if a farmer is able to grow a larger proportion of rice (even though it required more labour and inputs), the farmer most likely earns relatively higher incomes other factors held constant. This income consequently makes the farmers have the capacity to afford extra resource requirements needed to run multiple crop enterprises. This conquers with Asfaw et al. (2019) who found out that wealthier households were more likely able to crop diversify than their poorer counterparts.

On the contrary though, the more land a farmer acquires for rice production, the lesser their motivation to grow other crops besides rice. Land is the major resource that facilitates production and farmers with larger proportions of land tend to be risk averse as explained by Hong et al. (2021). They would rather stick to a crop whose dynamics they are familiar with than invest in research, training and marketing of entirely new crops. It is important to note that the main reason advanced for crop diversification are curbing risks associated with crop

failure and market variability (Okello et al., 2019; Tesfaye & Tirivayi, 2020; Adjimoti & Kwadzo, 2018), yet these risks can be mitigated with introduction of technologies like irrigation and also collective marketing of produce coupled with state regulation on the volatility of market prices (De Roest et al., 2018).

The negative relationship between level of education of household heads and crop diversification is contrary to Tesfaye & Tirivayi, (2020) who reported no association between education and crop diversification or Aheibam et al. (2017) who using the heckman two stage regression model found out that though education of the household head had no impact on their decision to either crop diversify, it instead positively impacted the extent to which they diversified. Asfaw et al. (2019) equally found a positive association between level of education of a household head and crop diversification. Results in this study imply that the more educated a household head was, the more they were likely able to engage and earn from other off farm activities say salaried jobs or better still be able to acquire tailored knowledge, improve their farmer skillset to maximize output and earn economies of scale from a specialized farming system. Asfaw et al. (2019) further termed more educated households as “less risk adverse”, more willing to sacrifice the risks of crop failure for significantly higher returns from specialized cropping systems. De Roest et al. (2018) highlighted that specialization enabled farmers become technically efficient through acquisition of specific production skills and application of the latest production techniques to leverage output although they pointed out that this was only “viable” under stable markets provided by efficient marketing agencies or contract farming.

The positive relationship between gender of the household head and crop diversification is contrary to Tesfaye & Tirivayi, (2020) whose study found out that male headed households had significantly lower levels of crop diversification. This is can be attributed to the

patriarchal systems that characterize the sub Saharan Africa (Lusiba et al., 2017) and parts of Asia (De Pinto et al., 2020), the valuable resources key to production like land, labour and capital are under the control of men (Akite et al., 2022). Women are therefore infringed in terms of making decisions regarding the use of those productive resources (Akite et al., 2023) and it would be practically hard for them to influence how many crop enterprises to undertake at household level.

The poor association of access to extension with crop diversification cannot be disputed because extension services may promote a singular focus on a specific crop other than encourage a diversified system (Danso-Abbeam et al., 2018). Farmers receiving extension services will be equipped with knowledge to handle the crop enterprises they are familiar with and may lose on in terms of will and ability to adopt to new cropping practices which negatively affects crop diversification. Extension services may therefore need to emphasize the importance of diversified systems and also provide incentives for farmers to embrace diverse crop options (Adeyemi et al., 2023).

Radios provide platforms for farmers to access information like weather updates, emergency alerts like disease outbreaks and disasters, crop management techniques (through extension worker broadcasts and farm talks) or market prices which information can help farmers make informed decisions as regards planting timelines, the right kind of farm inputs and equipment, farm credit information, post-harvest handling as well as building strong economic networks in terms of input purchase and output marketing dynamics. This instead increases their likelihoods of benefiting from specialized systems which explains why ownership and use of radio had a negative association with crop diversification.

A study by Alibu et al. (2022) reported that farmers in Doho rice scheme ranked cassava (root) the 4th largest grown crop for sale and consumption after rice, maize and beans in that

order of priority. This is due to the fact that roots are staple foods in Uganda (Kijima, 2019) and that while many farmers hired labour for rice, they didn't do so for crops like cassava. It is enough to conclude that roots besides commanding fewer labour requirements that easily complement the already labour-intensive rice enterprise (Lusiba et al., 2017; Akite et al., 2022), are also equally prone to drought. This therefore explains why the rice roots crop combination was associated with crop diversification.

The relatively higher diversification levels by farmers who grew perennials besides rice aligns with Sánchez et al. (2022) who reported that a combination of cereals and stimulants (citing coffee as an example) which is categorized as a perennial in our study, were more profitable than “simplified” farming systems. Wang et al. (2021) noted that perennials provided complementarity to semi natural habitats. It is important to note that these aid pest control, soil and biodiversity conservation which in turn can help farmers maintain healthy ecosystems and support sustainable agriculture. These habitats may also attract predators and beneficial insects that feed on pest insects, control their population and reduce the need for pesticides. A combination of an almost pest free and low labour requirements of perennials relieves farmers of the additional income that necessitates running multiple crop enterprises, challenges that have been fronted as a disincentive to crop diversification (Feliciano et al., 2019).

The inverted -U-shaped relationship associated with cost of scheme irrigation water and crop diversification is highlighted as below. It should be noted that DIFACOS charges farmers an annual irrigation fee of 100,000 Ugx per acre of rice grown. An increase in irrigation cost therefore means an increase in land under rice production which translates into increased incomes *ceteris paribus*. This lends support to Aheibam et al. (2017) whose study found out that the farmers that had access to an irrigation facility were most likely able to have higher

levels of crop diversification. It is therefore prudent to argue that increase in irrigation costs means an increase in land for rice production thus increased incomes and financial ability to fund costs that come with running multiple crop enterprises. While studies like Namyanya (2014) reported that an increase in land size by one acre influenced a farmer's willingness to pay for irrigation water by 0.25%, it is important to note that in this study, an increase in cost of irrigation is associated with an increase in land parcels for production calls for more resources in terms of inputs, labour and time which may deprive a farmer the ability to run multiple crop enterprises thus the focus on rice growing. An increase in land size also makes it possible for a farmer to increase yields which is consistent with a study by Okello et al. (2019) who reported that for each percentage increase in land allocated for rice production, there was a likelihood of increase of rice yield by 0.67%. This increase in yield translates into increased revenues from the rice enterprise which on the contrary becomes an incentive for rice specialization.

Farmer experience cultivating rice at the scheme, access to farm credit, distance to the input markets, use of improved seed varieties, rearing of livestock, adoption of crop categories cereals and legumes alongside rice did not have an influence on farmers' decisions to crop diversify which contrasts studies like Tesfaye & Tirivayi (2020) who reported positive associations between distance to the input market and farmer experience with crop diversification.

5.3 Influence of crop diversification on profitability of rice farming

The positive influence of crop diversification on rice profitability is explained by Barman et al. (2022) who using an argument of "sharable inputs" highlighted that crop diversification lowered the total cost of producing two or more outputs using the same inputs. This therefore agrees with Okello et al. (2019) who while studying farm level allocative efficiency of rice

production in northern Uganda reported that the number of crop enterprises carried out affected overall yields of rice with those undertaking more crop enterprises registering higher rice yields.

A household's proportion of scheme land to a household's total land holding which equally has a positive influence on crop diversification is supported by Ruzzante et al. (2021) who reported that farmers with larger portions of land were more likely able to adopt farm technologies like improved crop varieties which improves their yields and consequently their incomes other factors held constant.

The U-shaped trend associated with a farmer's experience cultivating rice in regard to crop diversification can be traced back in reports from several studies. An example is drawn from Akite et al. (2022) who reported that farmers that had used hired labour were more profit inefficient than their counterparts who employed family labour. This suggests that inexperienced farmers most likely hire labour to compensate for their inexperience. The reasons advanced here for ineffectiveness of hired labour is that it compromises on the quality of work and also required hours of supervision that raid the farmer of the time to do other planned activities. Farmers with low experience may also not understand the dynamics of crop production and may incur higher costs of production because they are not certain on which inputs and the right quantities to use (Alibu et al., 2022). These irregularities would have an overall negative consequence on their gross margins. Tadesse et al. (2018) in his study about post-harvest losses along the potato value chain also reported that farmer experience was significantly associated with the level of post-harvest losses with less experienced farmers incurring more losses than their experienced counterparts yet Lusiba et al. (2017) explains that these post-harvest losses accounted for loss in farm incomes and advocated for awareness to reduce the occurrence of the same. They may also indulge in

marketing their output single handed (individually) because they haven't built the right networks to explore group marketing. Marketing as individual farmers makes them very vulnerable to being cheated by middlemen (Barungi & Odokonyero, 2016). However, as a farmer continued to invest more time and resources to learn the rice production dynamics at the scheme, they would eventually be able to increase their profits. Farmer experience which is positively associated with technology adoption (Ruzzante et al. 2021; Alibu et al. 2022) therefore has the potential to increase farm yields thereby growing incomes. As the farmer learns the dynamics of rice production, they may also be able to build marketing chains that elevate the possibility of bargaining for better pricing. This is consistent with Akite et al. (2022) who reported a positive significance between farmers engaged in group marketing and profit efficiency of rice farming not to mention the likelihood of buying inputs at relatively lower costs which increased efficiency.

Source of farm credit determined the direction of influence it has on the overall profit of their rice enterprise with those that accessed from DIFACOS registering positive influence. To access credit from DIFACOS, a farmer is mandated to have fully registered with the SACCO administration. The SACCO besides other services extended credit to its members free of interests and without collateral. This therefore explains why the farmers that access credit from DIFACOS are most likely able to earn a higher profit than their peers who get credit from sources like commercial banks, microfinance institutions and friends or family. This is in agreement with earlier studies done by Abdul-Rahaman & Abdulai (2018) and Mojo et al. (2017) which noted that limited access to credit countered farmers' productivity and efficiency levels by negatively impacting on their ability to procure inputs and source (hire) extra labor to meet the production requirements of their farm enterprises.

Farmers who receive extension services from the farmer associations and the private companies are able to earn higher profits from rice farming unlike their counterparts who received from government. It is important to note that if one is to receive extension services from a farmer association, there is a financial implication like membership subscription fees or farmer extension fees as an independent service. Similarly, a private company offering extension service could be an output buyer or seed company who by the nature of their dealings are mandated to monitor the quality of rice right from production stages which affects profitability. These too may levy fees for registration or facilitating a memorandum of association. However, what characterizes a number of rural populations in Sub Saharan Africa today is a mentality that Ding & Kinnucan (2011) in his study on forms of agricultural support in Eastern Cape dubbed as “a culture of dependency and entitlement”, one that is explained by an innate desire to receive services at no cost synonymous to social grants. In as much as extension service from government is free, De Sousa et al. (2017) stated that it was inefficient due to poor salaries and working conditions of extensions workers. In his study on irrigation and crop diversification in 25 de Setembro irrigation scheme in Mozambique, his findings spell only 28% of the farmers had received extension services in a period of two years yet studies have found out that agricultural extension has a positive relationship with productivity and household incomes (Danso-Abbeam et al., 2018; Barungi & Odokonyero, 2016; Adjimoti & Kwadzo, 2018). Namyanya et al. (2022) reported that some of the reasons that affected the quality of agricultural extension services in Uganda were low staffing, budget allocations and level of education attainment by the extension officers citing that those that possessed a master’s degree performed better than their counterparts with inferior qualifications.

Studies highlights below lend support to the positive influence rice processors as a sales channel has on rice profitability. Jia & Bijman, (2013) classified these rice processors into

three groups. The first being companies with a brand, sub brands and an image to protect. These were reported to adhere to buyer specified quality parameters and usually adopt contract farming arrangements to guarantee quality. The second group being firms without specific brands and adopt flexible arrangements in their segments. These in general sold inferior products by mixing different varieties or qualities. The third group being firms that enter exports directly as well as adhered to strict quality parameters. The Anh et al. (2020) also explained that most of the rice processors whom he termed as “polishing firms” were the main actors providing de-husking services to the village collectors or traders, purchased paddy rice for milling, supplied rice to the domestic retail and wholesale market as well as exports. Donkor et al. (2021) found out that though very few farmers sold their output to rice processors which he termed as “direct marketing”, they were given a better pricing than those that sold to middlemen (indirect marketing). Exposure to direct marketing according to Akite et al. (2023) enables farmers to access profitable markets and eliminate middlemen who cheat them with very low pricing.

Super rice variety which indicated a positive association with profitability of rice, also locally known as “Supa”, is prominent for its aroma making it superior from other rice varieties grown in the scheme especially the Kaiso Collection (K-5, K-98, WITA-9 and Zain). The aromatic properties in super rice variety thereby makes it command a relatively higher pricing enabling those that grow it attain a higher profit. These findings are similar to previous studies by Mottaleb & Mishra, (2016); Kikuchi et al. (2016) and Alibu et al. (2022) that listed aroma as one of the properties that influenced rice pricing, buyer and consumption choices. Ssebagala et al. (2016) in their study on farmers’ perceptions towards rice post-harvest handling technologies in Iganga and Namutumba districts also found out that while farmers largely used sickles to harvest rice, “Supa” rice was an ‘exceptional variety’ which was harvested using knives even when they were perceived to be slow in realizing the

harvesting activity. This is because Supa was considered “a high value variety” and the knife made it possible that one could harvest only mature grains which greatly impacted on the overall quality of the rice. Contrary to submissions above, Hong et al. (2021) while studying the opportunities for rice production in Uganda listed negative attributes associated with Supa rice. They termed it as a “late maturing, low yielding and susceptible to diseases” variety. He further submitted that given its relatively higher height, it was difficult to harvest, required deeper waters to thrive and was highly preferred by birds thus necessitating those that grew it to employ extra labour in bird scaring.

The positive influence of legumes or roots crop categories on rice profitability is consistent with findings by Sánchez et al. (2022) who in their study reported that net incomes were higher in diversified systems that combined cereals and pulses (classified as legumes in our study) as well as cereals and roots. To further support the above, De Roest et al. (2018) asserted that diversified systems that provided for conditions where a farmer can use the same inputs to produce more than one output lowered the total costs of producing those outputs separately thus increasing their gross margin. The relatively lowered costs of production thereby translated to higher gross margins of the farm enterprises other factors held constant.

This study therefore affirms that in the context of a promoted crop, crop diversification enhances the profitability of the primary enterprise (rice farming). This is evidenced in this study where smallholder rice farmers who adopted a diverse approach to crop farming experience improved financial outcomes. The evidence gathered in this study points to crop diversification as an important contributor in smallholder rice farmers' higher profitability in addition to being an effective risk management approach. Adopting these kinds of methods could make rice-growing businesses more robust and commercially successful.

CHAPTER SIX

SUMMARY, CONCLUSION AND RECOMMENDATIONS

6.1 Summary

The study assessed crop diversification and profitability of smallholder rice farmers in Doho rice scheme in Butaleja district of Uganda. Interviewed respondents were from Mazimasa Subcounty, Kachonga Subcounty and Nabiganda Town Council. Structured questionnaires were used to collect raw data from the respondents. The respondents were found to have largely male headed households, with little education, growing at least two additional crops from the traditional rice on small parcels of land. Furthermore, the proportion of scheme land to total land holding and its squared version, level of education of household head, gender of household head, access to extension services (dummy), access to market information through the radio, other crop combinations grown besides rice being either perennials or roots, cost of irrigation and its squared version were significant influencers for the decision and or extent of crop diversification. The two stage least squares regressed results showed that crop diversification alongside other instrumental variables like the proportion of scheme land to a household's total land holding, farmer's experience cultivating rice at the scheme and its squared version, access to credit from the scheme SACCO (DIFACOS), receiving extension services from either a farmer association or the private companies, selling rice to rice processor, growing super rice variety and growing legumes or roots alongside rice influenced the levels of profitability among the smallholder rice farmers.

6.2 Conclusions

Since the study aimed at providing a detailed understanding of influential factors for crop diversification and its overall association with the rice enterprises, it can therefore be concluded that based on the findings, the respondents had a varied range of demographic and farming characteristics. Majority being male with little educational attainment, growing rice as a primary crop and a few additional crops on small parcels of land.

Scheme land proportion to total land was found to influence both crop diversification and profitability of the rice farming enterprises. This suggests that farmers who own a sizable amount of scheme land might be more aware of market trends and sustainable agricultural practices. Crop diversification may be viewed as a calculated move to take advantage of varied markets and the need for distinct agricultural goods, which both have the potential to raise overall profitability. Besides, relatively larger portions of land at the scheme may to a broader view translate into more production, yields and consequently more incomes that make it possible for them to afford the financial obligations that come with diversified systems.

The positive influence of crop diversification on profitability of rice farming signifies the complementary of the diverse crops with the primary rice production, which is a key enterprise in Doho rice scheme. This therefore lends support to the several benefits accrued to using a diversified cropping system in a rice scheme, from market potential to risk reduction and overall financial stability.

6.3.0 Recommendations

6.3.1 Policy Recommendations

Respondent characteristics seem to suggest that policies geared towards gender equality between male and female members in agricultural communities for example in Doho irrigation rice scheme ought to be given priority. This is in a bid to create gender balance in terms of access to valuable resources that facilitate production processes. The government of Uganda and partner agencies ought to strengthen monitoring and evaluation of education programmes to ensure equitable and quality education is availed to the target population. In as much as there several programs geared to the same, routine policy assessment in line with the core objective need not be ignored and this is paramount in facilitating deliverables. DIFACOS needs to reform policies related to access and use of land. This is evidenced in the relatively smaller parcels of land reported in this study. Subsidies can be provided to farmers in relation to size of land they hire at the scheme which will act as an incentive for acquiring bigger land sizes that consequently improve the likelihoods of benefitting from economies of scale.

In as much as crop intensification has its accrued benefits especially economies of scale, agricultural programs aimed at scaling up performance in multiple crop enterprises by households ought to be given priority by bodies like MAAIF and lower local government production departments. The government of Uganda therefore ought to;

- i) Introduce Time saving technologies that are eco-friendly, affordable and tailored to suit the needs of the rice farmer population. These will lessen the time spent in the farms and open more avenues for multiple crop ventures.

- ii) Facilitate development of sound market information systems that clearly address demand and supply related parameters. This will guide farmers to make informed decisions in line with farming.
- iii) Administer programmes related to access to credit with fairness and in an equitable manner for example the current Parish Development Model (PDM). This access to credit has the potential to boost farmers abilities to run multiple crop enterprises and consequently move out of poverty.

6.3.2 Recommendations for further study

Since the study concludes that there is a significant association between crop diversification and profitability of rice farming in Doho rice scheme (an area where rice is a promoted crop), it is prudent therefore to carry out more studies to ascertain whether similar scenarios exist in other intensive rice farming communities in Uganda like in Kibimba, Olweny and Mubuku. Future investigations could also delve deeper into the specific crop combinations that yield the highest returns, consider the socio-economic dynamics influencing farmers' decisions, and explore the long-term sustainability of diversified farming practices. The triggers to this phenomenon ought to be carefully studied as they could help in crafting policies that could go a long way in empowering farmers in the face of adversities culminating from volatility of prices and weather extremes.

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APPENDICES

Appendix I: Data collection tools

Gulu University Faculty of Agriculture and Environment Department of Rural Development and Agribusiness Household Survey Questionnaire, Version 2.0.	Date of Interview: Questionnaire ID No. Enumerator Name:
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Hello, my name is, I am a master's student from Faculty of Agriculture and Environment, Gulu University. I am conducting a study on crop diversification and profitability of rice farmers in Doho rice scheme in Butaleja District. This study is purely academic and your household has been selected randomly to participate because of your experience in rice farming. Please note that the information provided by you will be treated confidentially and there will be no way to identify you as the one who gave specific information.

Subcounty: Parish: Village:

SECTION A: SOCIO-ECONOMIC CHARACTERISTICS

1. Gender of household head (A1)	2. Age of household head (number of years)	3. Marital status (A2)	4. Level of education (years in formal school)	5. How many people are in your household (A3)?	6. What age groups are they - numbers (A4)?	7. How many of them work in the farm - numbers (A5)?	8. How many years have you spent cultivating rice?	9. How many of these years have you cultivated in Doho Rice Scheme?	10. Are you engaged in any non-farm income activities? (A6)	11. If yes, which activities are those? (Tick all that apply- A7)	12. Annual estimated earnings from these activities (Ushs – A8)
<u>A1: Gender</u> 1=Male 2=Female		<u>A2: Marital Status</u> 1=Single 2=Married 3=Divorced 4=Widowed		<u>A3: Household size</u> 1=Male 2=Female	<u>A4: Age categories</u> 1=Children (0-17yrs) 2=Young adults (18-35yrs) 3=Middle aged adults (36-55yrs) 4=Elderly (55yrs-above)	<u>A5: Family labour</u> 1=..... 2=..... 3=..... 4=.....			<u>A6: Non-farm activities</u> 1=Yes 2=No	<u>A7: Non-farm activities</u> 1=Salaried Job 2=Petty trade 3=Boda boda 4=Bricklaying 5=Charcoal burning 6=Casual Labour 7=Others (Specify)	<u>A8: Non-farm incomes</u> 1=..... 2=..... 3=..... 4=..... 5=..... 6=..... 7=.....

SECTION B: INSTITUTIONAL FACTORS AND SUPPORT SERVICES

1. Were you visited by an extension agent in the last one year? (B1)	2. If yes, what kind of extension agent? (B2) (Tick all that apply)	3. If yes, averagely how many times per season were you visited by the extension agent?	4. Have you borrowed money for farming in the last one year? (B3)	5.If yes, from which sources? (B4) (Tick all that apply)	6. If yes, what did you use the borrowed money for? (B5) (Tick all that apply)	7. Where do you get market information from? (B6) (Tick all that apply)	8. What is the distance to your nearest input and output market (B7) (kms)?
<u>B1; Recipient of extension services</u> 1=Yes 2=No	<u>B2; Extension service provider</u> 1=Gov't Entity 2=NGO 3=Research/ Academic Institution 4=Farmer Association 5=Private Company 6=Others (Specify)		<u>B3; Access to farm credit</u> 1=Yes 2=No	<u>B4; Source of loans</u> 1=DIFACOS 2=VSLA 3=Commercial Banks 4=SACCO 5=Microfinance 6=Friends and Family 7=Others (Specify)	<u>B5; Reason for borrowing</u> 1=Rent Land 2=Buy Inputs 3=Pay Labour 4=Post-Harvest Activities 5=Others (Specify)	<u>B6;Source of market information</u> 1=Farmer group 2=Extension workers 3=Mobile phone 4=Radio 5=Others (Specify)	<u>B7; Distance to markets</u> 1.Input Mkt 2.Output Mkt
9.Do you own a mobile Phone? (B8)	10.If yes, how does it help you in farming? (B9) (Tick all that apply)	11.Do you belong to any farmer group? (B10)	12.If yes, which of the following farmer groups do you belong to? (B11) (Tick all that apply)	13.If yes, how many members are you in the group? (B12)	14.If yes, what functions does your group perform? (B13) (Tick all that apply)	15.What services do you pay for in the scheme?_(B14)	16.Give details of how much you pay per service per season? (B15)
<u>B8; Ownership of mobile phone</u> 1=Yes 2=No	<u>B9; Use of mobile phone</u> 1=Access Ext. Services 2=Connect with input dealers 3=Connect with output buyers 4=Source farm laborers 5=Others (Specify)	<u>B10; Membership to farmer groups</u> 1=Yes 2=No	<u>B11; Membership to farmer groups</u> 1=DIFACOS 2=OWC 3=SACCO 4=None 5=Others (Specify)	<u>B12; Size of farmer group</u> 1=Total: 2=Male: 3=Female:	<u>B13; Farmer group functions</u> 1=Cash rounds 2=Soft loans 3=Trainings 4=Information sharing 5=Collective bargaining 6=Others (Specify)	<u>B14; Scheme services</u> 1=Irrigation water 2=Membership subscription fees 3=Monitoring fees 4=Others (Specify)	<u>B15; Scheme service fees</u> 1: 2: 3: 4:

SECTION C: COST OF PRODUCTION - RICE

CAPITAL COSTS			COST OF MATERIALS				LABOUR COSTS - SEASON 2 (August – December 2022)						
Item	Cost	Period	Item	SN 1 (Jan-May 2022)		SN 2 (Aug-Dec 2022)		Production stages	Persons	Days	Hours worked per day	Amount paid per person per day	If not paid, how much do others pay?
				Qty	Unit cost	Qty	Unit cost						
Land lease (per acre)			Seeds (Per kg)					Bush/Land Clearing					
Membership fees (DIFACOS)			Herbicides					Ploughing					
Extension services (Per acre)			Pesticides					Nursery Bed Mgt					
Irrigation water (Per acre)			Fertilizers					Transplanting					
								Weed control					
								Herbicide Application					
								Pesticide Application					
								Fertilizer Application					
LABOUR COSTS								Harvesting					
SEASON 1 (January – May 2022)								Threshing					
								Drying					
Production stages	Persons	Days	Hours worked per day	Amount paid per person per day	If not paid, how much do others pay?	OUTPUT							
Bush/Land Clearing							SN 1	SN 2					
Ploughing						Land allocated to rice growing (acres)							
Nursery Bed Mgt						Rice harvested (kgs)							
Transplanting						Quantity sold (kgs)							
Weed control						Price per kg							
Herbicide Application						Quantity consumed (kgs)							
Pesticide Application						Quantity saved for seed (kgs)							
Fertilizer Application													
Harvesting													
Threshing													
Drying													

SECTION D: OTHER PRODUCTION AND MARKET ORIENTED VARIABLES

1. Did you grow rice in both the last two seasons? (D1)	2. If yes, which rice varieties did you grow? (D2) (Tick all that apply)	3. If yes, which seed type did you use? (D3)	4. Main source of seeds (D4)	5. Which of the following equipment did you use in your farm? (D5) (Tick all that apply)	6. Averagely how much do you spend on each per year? (D6)	7. What is your total land holding? (D7) (Acres)	8. What portion of your land did you allocate to rice farming? (D8)	9. How did you dry your rice? (D9)																														
<u>D1; Rice Cultivation</u> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 5%;">S. 1</td> <td style="width: 15%;">1=Yes 2=No</td> </tr> <tr> <td>S. 2</td> <td>1=Yes 2=No</td> </tr> </table>	S. 1	1=Yes 2=No	S. 2	1=Yes 2=No	<u>D2; Rice Varieties</u> 1=Super 2=K- 5 3=K- 98 4=WITA-9 5=Zain 6=Basmati 7=Others (Specify)	<u>D3; Rice seed type</u> 1=Improved 2=Local 3=Both	<u>D4; Source of rice seed</u> 1=Agricultural office 2=Farmer union 3=NGO/CBO 4=Research/Academic Institution 5=Other farmers 6=Agro input dealer 7=Home saved seed 8=Others (Specify)	<u>D5; List of equipment</u> 1=Hand Hoes 2=Spraying Pumps 3=Hand Knives 4=Tarpulins 5=Storage bags 6=Others Specify	<u>D6; Expenditure on equipment</u> 1=..... 2=..... 3=..... 4=..... 5=..... 6=.....	<u>D7; Total land holding</u> 1=Scheme(Acres) 2=Outside(Acres) Scheme	<u>D8; Land allocated to rice</u> 1=Scheme 2=Outside Scheme	<u>D10; Drying mode</u> 1=On bare ground 2=On Tarpaulins 3=Others (Specify)																										
S. 1	1=Yes 2=No																																					
S. 2	1=Yes 2=No																																					
10. Did you sell any rice in the last two seasons? (D10)	11. If yes, how long did you store it after harvest before sale? (Days)	12. If yes, in what form did you sell the rice? (D11)	13. If yes, where did you sell the rice? (D12)	14. If yes, who bought the rice from you? (D13)	15. Did you grow any other crops besides rice in the last two seasons? (D14)	16. If yes, which other crops besides rice did you grow in the last two seasons? (Tick all that apply) (D15)	17. If yes what was the land allocated to each of these crops in season one and two? (Acres) (D16)	18. Did you rear any livestock throughout the year? (D17)	19. If yes, which type of livestock did you rear? (List them down)																													
<u>D10; Rice Sales</u> 1=Yes 2=No		<u>D11; Form of the rice sold</u> 1=Unmilled 2=Milled 3=Both	<u>D12; Rice salespoint</u> 1=At farmgate 2=Cooperative 3=Market 4=Milling Point	<u>D13; Rice buyers</u> 1=Village collectors 2=Middlemen 3=Seed company 4=Rice cooperative 5=Other Farmers 6=Rice Processors 7=Urban Traders 8=Others (Specify)	<u>D14; Other crop enterprises</u> 1=Yes 2=No	<u>D15; Other crops</u> 1=Maize 2=Beans 3=Cassava 4=Sweet Potatoes 5=Groundnuts 6=Millet 7=Sorghum 8=Bananas 9=Coffee 10=Vegetables 11=Others (specify)	<u>D16; Land allocated to other crops(acres)</u> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th>No</th> <th>S1</th> <th>S2</th> </tr> <tr><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td></tr> </table>	No	S1	S2																												<u>D17; Livestock rearing</u> 1=Yes 2=No
No	S1	S2																																				

Appendix II: English Consent Forms

INFORMED CONSENT DOCUMENT

VERSION 2.0, DATED 10th /APRIL/ 2023.

Title of the study: CROP DIVERSIFICATION AND PROFITABILITY AMONG SMALLHOLDER RICE FARMERS IN DOHO IRRIGATION RICE SCHEME, BUTALEJA DISTRICT

Investigator(s): AMONGIN LYDIA

Institution(s): GULU UNIVERSITY

Introduction

Dear Sir/Madam

My name is Amongin Lydia, a student pursuing a Master of Science in Agri-Enterprises Development of Gulu University conducting research on the topic "Crop Diversification and Profitability among smallholder Rice Farmers in Doho Irrigation Rice Scheme - Butaleja District" with approval from the Gulu University Research Ethics Committee, and the Faculty of Agriculture and Environment, Department of Rural Development and Agribusiness.

During the study, you will be asked to fill the questionnaire together with guidance from the researcher. This informed consent explains the details of the study to you. After the study has been explained, any questions you may have will be answered, and if you decide to participate in the study, you will be asked to sign a consent form, which document you will retain a copy of.

A brief description of the sponsors of the research project

This study is sponsored by the MasterCard Foundation and Regional Universities' Forum for Capacity Building in Agriculture (RUFORUM). The partnership between the said institutions is to support learning in many African agricultural universities and facilitate students in carrying out research to enable them craft tailor made solutions to the problems in their communities.

Purpose:

This study is purely academic and its core intention is to help researchers understand the motivation for crop diversification in a promoted crop setting, the distinctions between the crop diversifying and non crop diversifying smallholder rice farmers as well as the relationship between



crop diversification and profitability in Doho Irrigation Rice Scheme. Your household has been selected randomly to participate in this survey and the information provided by you will be treated in a confidential manner. Please note that there will be no indepth details that will be used to identify you as the one who gave specific information in this survey. After understanding the above parameters, the researcher will present the findings to the policy makers and the government institutions responsible for rice cultivation in Doho Irrigation Rice Scheme to enable smallholder rice farmers to make better investment decisions interms of incorporation of other crop enterprises alongside rice.

Procedures:

Your participation in this study will involve providing answers to the questions regarding crop diversification in Doho Irrigation Rice Scheme based on your personal experiences. I would be glad if you could spare some time (approximately 30 minutes) to answer our questions.

Who will participate in the study?

A smallholder rice farmer who is a beneficiary of the Doho Irrigation Rice Scheme and has actively grown rice for the last two seasons will be eligible to participate in this study. The interview will last for approximately 30 minutes and a total of 385 respondents will participate in this study.

Risks/discomforts:

There is a foreseeable risk of harm or discomfort that will arise from your participation in this study. There's a risk of contracting Covid-19 or any other communicable diseases among the participants and the research team. However regulation on contracting the said diseases will be done by strictly adhering to the well laid out standard operating procedures as directed by the ministry of health. There shall be regular washing of hands with clean water and soap, wearing of face masks or face covering, limited body contact (hugging, shaking hands), and maintaing a distance of 2 metres apart during the interactions. This shall be observed by both the reaseacrth team and the respondents/ household survey members. The other foreseeable risk may be the incovinience interms of time that will be spent during the interview.



Benefits:

You will be provided with refreshments (a drink and a snack) at the end of the interview. You shall also get a bar of washing soap after the interview as a token of appreciation for your valuation participation in the study.

During the study, participants will get the privilege of having any queries related to the study answered. Research participants will get feedback on findings and progress of the study, and that any new information that affects the study participants (including incidental findings) will be made available to research participants. Research participants will also benefit if favourable policies are generated from the study recommendations.

Confidentiality:

Your identity will not be revealed to any one as we shall only use codes to identify participants. Information obtained will also only be accessed by the research team. Soft copies of the data will be protected by encrypting passwords and hard copy files will be kept under lock and key. Confidential information will only be accessed by the principal investigator.

Alternatives:

You do not have to participate in this study if you are not interested. You are not indebted to participate without your free will.

Cost:

There will not be any additional cost incurred as a result of participating in this study.

Questions:

If you have any questions related to the study as a research participant, please contact the principal investigator, AMONGIN LYDIA on telephone number 0781372175 or via email address lydiaamongin@gmail.com

Statement of voluntariness:

Participation in the research study is voluntary and you may join on your own free will. You have a right to withdraw from the study at any time without penalty.

If you have any issues pertaining to your rights and participation in the study, please contact the Chairperson, Gulu University Research Ethics Committee, Dr. Gerald Obai Tel: No., 0772305621; email: lekobai@yahoo.com/lekobai@gmail.com; or the Uganda National Council for Science and Technology, on plot 6 Kimera road, Ntinda, Kampala on Tel 0414705500.

Respondent's statement of consent

..... has described to me what is going to be done, the risks, the benefits involved and my rights as a participant in this study. I understand that my decision to participate in this study will not affect me in any way. In the use of this information, my identity will be concealed. I am aware that I may withdraw at any time. I understand that by signing this form, I do not waive off any of my legal rights but merely indicate that I have been informed about the research study in which I am voluntarily agreeing to participate. A copy of this form will be provided to me.

Name.....

Signature/Thumbprint of participant.....

Date.....

Name.....

Signature/Thumbprint of witness.....

Date.....

Name.....

Signature of the interviewer.....

Date.....



Appendix III: Lunyole Consent Forms

EHINGHANDIHO EHISUUNGA OHWEBUUSA MU HWENDULILISA

EHYO MULUUNDI 2.0 NGA 10/NAMOOME/2023.

Omutwe gw'esomo: OHWONGERAHO OBUNGI BWE BIRIME NA MAGOBA MU BALIMI ABATONO AB'OMUCEERE MU DOHO IRRIGATION RICE SCHEME, E BUTALEJA DISITULIKITI.

OMWENDULILISI: AMONGIN LYDIA

ESSOMERO: GULU UNIVERSITY

ENYANJULA

ERI OMWAMI/OMUHYAALA

Ndiise Amongin Lydia omusomi wa maasitas wa sayaansi mu hutandiiha endima ey'ebyefuna mu Ttendehero ery'e Gulu university kola ohwendulilisa hu musomo gw'Ohwongeraho obungi we birimiwa ko na magoba mu luungu ery'omuceere e doho mu butaleja ni hi hahasiwa ohunghwa mu Ttendehero ery'e Gulu university mu hahiiho ahanghira episa mu somero ery'e byo bulimi n'obutonde w'ehyaalo ko n'abanghira ebye'kulahulana mu byaalo ne nima ey'eby'ohufuna epiiya.

Nghagati mu hweega, ojja hugobolamo ebibuuso n'ohulunghamisibwa ohw'omwendulilisi. Ohw'ebuusa huno hunyonyola ebijufu by'omusomo guno. olufanyuma lw'ohunyonyolwa ohweega, ebibuuso by'emwe bijja hugobolew'amo era oteho omuhono hu lupapula luno, osigase ho n'ekopi ya lwo.

ENYONYOLA MU BUUPI ABATAMO EPIIYA

Ohweega huno huteew'amo epiiya na ba "Mastercard foundation nghalala n'aba Regional Universities Forum for capacity building in agriculture (RUFORUM)". Omuhago nghagati w'ebitongole byombi gw'ahunghengerera ohweega mu matendehero g'abalimi. n'ohudulumilila mu hwendulilisa ohusobola ohwola huhugoonjola ebisibu mu bitundu byaawe.

EHIGENDELERWA

Ohweega huno hwa by'enjegeresa n'ehigendelerwa ehyo huyaamba ab'endulilisa ohufuna amaani mu hwongera ho ebirime mu ngeri eya nghamugulu, enjawulo mu hwongera ho ebirimiwa oha ohusigata byo birimiwa by'onghene n'epambagana nghagati wo hwongera ho



ebirimiwa na magoba mu Doho rice scheme. Enyumba yiyo ndala hujaangaliwe mo ohuba mu hwendulilisa huno era eby'onatulomere binasigale by'ahyaama ate era enghuma ajja humanya nti ndiwe abitulomeeye. Olufanyuma lw'ohumanya ebyo, omwendulilisi anahaanjule ebinghooye mo eri abahinghambaho n'ebitongole bya gafumete bahole ohusalango ohulangi mu ngeri ey'Ohulima mu butongole ebirime ebindi ohwongera hu muceere.

EMITENDERA

Ohuba huhwo mu hwendulilisa huno huja hu hweetagisa ohugobola mo ebihubusiwa ni binghamba hu hwongera ho ebirimiwa mu Doho rice scheme ni husinzira hu humanya huhwo. Hija huusangaasa ni bunjasihiro ho onyaanga jijo nga edakiika amahumi adatu(30)ohugobola mo ebibuuso.

NJ'ANI AGIHILISIWA MU HWENDULILISA HUNO?

Abalimi b'omuceere ab'edaala lya ngaasi nga balala hu baganyulwa mu Doho rice scheme era nga babaaye bafuba ho ohulima mo omuceere endima ebiri ejibitire bajja huba basanila ohuba mu hwendulilisa huno nga huja hunghira edakika adatu gonghene era n'abatu ebihumi bidatu na kinaana na bataanu(385) nj'abaja hu huba mo.

OHUFILISIWA/EBIREETA OHUNAKUNGHALA

Ndagula ohukosewa ni hunghwa mu hwendulilisa huno nga nj'ohw'otaaye nohufuna COVID19 n'endwaye ejiindi ejigeendera mu Puuji . Ehyo ni hili angho, ebyo byosi bija hw'ewaliwa ni hu tiinila hu techa techa ey'ehitongole hy'ebyo bulamu mu Uganda , Ohusaba mu'ngalo ni sabuuni mu maaji amatuhuli ,Ohwambala masiki, Ohuwiiha oweeni n'ohutelilihana ko n'amabanga age mita ebiri.

Hino hija hu holewa n'abendulilisa ko n'ababayambaho. Ehiindi ehyo bulabe chisuubirwa njo'hutataganya mungeri ye nyanga eji huja huhozesa mu hubuusa n'ohugobolamo ebibuuso.

EMIGANYULO

Ojja hungheewa ehyo hunywa n'emberenge olufanyuma lwo hugobolamo ebibuuso. Bajja huhungha omusaala gwa saabuni nga ahasiimo olw'ohuganya ohubuusiwa ebibuuso.

Mu hweega huno, abaatu banahangheewe omukisa ohubusa n'ohugobolewa mo ebibuuso byosi.



EKUUMA Y'EBYAAMA

Ebihunghambaho bijja huhumiwa nga ehyaama mu ngeri y'enukuta mu hifo hy'amasiiina. Ebin'anghwemo bijja humanyiwa ho ab'endulilisa bonghene era obutaambi hubute ho "Password". Epapula jija huhumiwa ne kuufulu era bimanyiwe ho n'ahulila abendulilisi bonghene.

EBIINDI EBY'OSOBOLA OHUHOLA

Oyinza ohusalango w'ahola bino; Ni huba ni hutali husiima huhwo huhweegayiliye ohutaba mu hwendulilisa huno ate era silija hufuuha Bbanja singa nga siweende hu huba mo.

EHYENDEWA

Enghuma hiindi hija hwendewa hulw'ohwendulilisa huno

EBIBUUSO

N'oba noli n'chibuuso hyosi hyosi, ni hinghamba hu hweega huno huhusuunga ohubire omuhyaala Amongin Lydia hu simu yino 0781372175 Oba hu email yino lydiaamongin@gmail.com

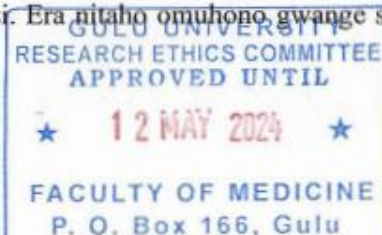
OHWENGHAYO

Ohuba mu hwendulilisa huno hunghwa eri ohusalango huhwo wamwene era oli w'edembe ohunghwa mu hwendulilisa huno enyanga yosi eyi weenda ni nghanghuma hubonelesewa hwosi hwosi.

Onaba noli n'esonga yosi yosi n'enghwa hu dembe lilyo mu hwega huno, huhusunga ohubire ahulila Gulu university Research Ethics committee, DR.Gerald Obai hu simu yino 0772305621, email lekobai@yahoo.com/lekobai@gmail.com oba Ahahiiho he gwanga aha sayaansi n'ebya computer hu plot 6 kimera road, e ntinda hu simu yino 0414705500.

EBIGAMBO BY'AGEEBUSIBIRWEHO

.....G'anyonyooye ehija hu holewa, eby'obulabe, n'emiganyulo ejilimo n'edembe lyange mu hweega huno .Manyile nti ohusalango hwange mu hweega huno si hii kosa mu ngeri yosi. Mu huhozesa ebinaalome, ebiipamba ho banabyesigahise mu hyaama era manyire nti sobola ohubinghwa'mo enyaanga yoosi. Era nitaho omuhono gwange shiitusaho dembe lyange mu matecha naye hitegesa nti



baategehiise ho hu hwendulilisa huno ohuneesimiiye simwene ohub'amo. Lulala hu lupapula
luno lun'apeewe ho ndusigase.

Esiina.....

Omuhono/ehiinkumu.....

Olunaku lwo mweesi.....

Esiina.....

Omuhono/ehiinkumu.....

Olunaku lwo Mweesi.....

Esiina.....

Omuhono/ehiinkumu.....

Olunaku lwo Mweesi.....

Appendix IV: COVID-19 Standard Operating Procedures.

Measures for the prevention and control of risk of spread of COVID-19 during the implementation of research

Study Title: Crop diversification and profitability among smallholder rice farmers in Doho irrigation rice scheme.

Principal Investigator (s): Amongin Lydia

Introduction:

The novel Coronavirus is transmitted from human to human through droplets and direct or close personal contact with an infected individual

Novel Coronavirus signs of infection include respiratory symptoms, fever, cough, shortness of breath and breathing difficulties. In more severe cases, infection can cause pneumonia, severe acute respiratory syndrome, kidney failure and even death

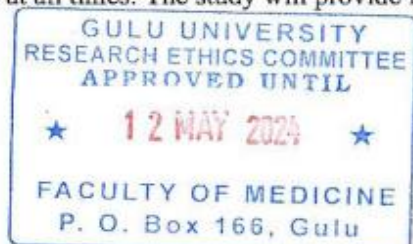
Implementation of the prevention and control measures

In the implementation of this research activity, we the investigators will be committed to ensuring the safety of our research team, research participants and communities where the study will be conducted. The study team undertakes to comply with the Standard Operating Procedures issued by the Ministry of Health, and presidential directives to mitigate against the risk of infection of COVID-19, rapidly detect and effectively respond to any COVID-19 case that may occur in the process of carrying out the study, screening, face covering, physical distancing, and good hand hygiene.

Procedures to be followed during the implementation of the research.

Prior to data collection and Training

1. **Health guidance:** There will be training sessions dedicated for COVID-19 sensitization and awareness, to equip the research team with knowledge of signs and symptoms of the COVID-19, and preventive measures such as hand hygiene before placing and removing the mask, as well as storage of the mask, social distancing. The research team will circulate notices, posters, charts on common signs and symptoms of COVID-19 as provided by the Ministry of Health, and develop and/or use existing plan for the appropriate referral pathway for identified and/or suspected cases.
2. **Personal Screening:** All researchers, research assistants, research participants and any other individuals engaged in research activities will screen temperature daily for fever. Screening for temperature will be carried out during planning meetings, trainings, community outreach. Any individual found with COVID 19 symptoms will be withdrawn and referred to Kachonga and Mazimasa 3 health centres for further assessment and management. The withdrawn individual will be allowed to return only if they present a valid certification of their COVID-19 status showing negative result
3. **Wearing face coverings:** All researchers and research assistants and any other individuals engaged in research activities that require interaction with fellow researchers or research participants or the community member will wear a face mask that fully covers the mouth and nose at all times. The study will provide face masks for individuals who do not have.



4. **Physical Distancing:** There will be social distancing during the training, meetings, community outreach of at minimum of 2 metres. During breaks, the team will not be allowed to congregate in common areas.
5. **Good hygiene:** All team members will be required to wash their hands or use hand sanitizers before and after entering the training room, and other common areas. Hand washing equipment shall be supplied and made available at all times. All surfaces and equipment shall be sanitised frequently.

During data collection

1. **Personal Protective Equipment (PPE):** All research assistants involved in tracing of respondents and in in-person interviews and research participants (respondents) will use PPE including a properly fitted face mask. Enumerators/Researchers and research participants will wash hands with soap and water or use hand sanitizer prior to the interview. Handshakes and hugging are prohibited. Physical distancing of at least 2 metres in all research related activities shall be observed.
2. **Consent Process:** The Researcher /Research assistants will observe social distancing when taking consent (while 2 metres apart) upon arrival to the participant. Enumerators/Researchers and research participants will wash hands with soap and water or use hand sanitizer prior to the interview. Participant(s) will then be sensitized on covid-19 and presented with preventive measures.
3. **Equipment sanitization:** shared devices used to record or capture data shall be sanitized regularly.

During Dissemination/Community engagement

1. **Community Engagement:** The research team shall carry educational materials on prevention of COVID-19 in Lunyole. These materials shall also have visual images to support understanding. Enumerators/Researchers and research participants will wash hands with soap and water or use hand sanitizer prior to the interview. Screening for temperature will be carried out prior to conducting community engagements.
4. **Equipment sanitization:** shared devices used during community engagements to shall be sanitized regularly.

The preventive and control measures will continuously be reviewed based on new information and guidelines communicated by the Ministry of Health



Appendix V: Approval Notice Letter

GULU		UNIVERSITY
P.O. Box 166, Gulu (U) Website: www.gu.ac.ug Email: gurec@gu.ac.ug		Tel: +256 471 432 096 Fax: +256 471 432 913 Mob: +256 772 305 621 +256 776 812 147
RESEARCH ETHICS COMMITTEE		

12/05/2023

To: lydia amongin

Gulu University
+256781372175

Type: Initial Review

Re: GUREC-2022-477: Crop diversification and profitability among smallholder rice farmers in Doho irrigation rice scheme

I am pleased to inform you that at the **96th** convened meeting on **15/02/2023**, the Gulu University REC, committee meeting voted to approve the above referenced application.

Approval of the research is for the period of **12/05/2023** to **12/05/2024**.

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

1. All co-investigators must be kept informed of the status of the research.
2. Changes, amendments, and addenda to the protocol or the consent form must be submitted to the REC for re-review and approval **prior** to the activation of the changes.
3. Reports of unanticipated problems involving risks to participants or any new information which could change the risk benefit: ratio must be submitted to the REC.
4. Only approved consent forms are to be used in the enrollment of participants. All consent forms signed by participants and/or witnesses should be retained on file. The REC may conduct audits of all study records, and consent documentation may be part of such audits.
5. Continuing review application must be submitted to the REC **eight weeks** prior to the expiration date of **12/05/2024** in order to continue the study beyond the approved period. Failure to submit a continuing review application in a timely fashion may result in suspension or termination of the study.
6. The REC application number assigned to the research should be cited in any correspondence with the REC of record.
7. You are required to register the research protocol with the Uganda National Council for Science and Technology (UNCST) for final clearance to undertake the study in Uganda.

The following is the list of all documents approved in this application by Gulu University REC:



A rectangular blue stamp with the text: GULU UNIVERSITY RESEARCH ETHICS COMMITTEE APPROVED UNTIL ★ 12 MAY 2024 ★ FACULTY OF MEDICINE P. O. Box 166, Gulu

No.	Document Title	Language	Version Number	Version Date
1	Research Proposal	English	2.0	2023-05-09
2	Informed Consent	Lunyole	2.0	2023-05-09
3	Covid-19 Risk Management Plan	English	2.0	2023-05-09
4	Informed Consent forms	English	2.0	2023-04-27
5	Data collection tools	English	1.0	2023-01-20

Yours Sincerely




Dr. Gerald OBA
P. O. Box 166, Gulu
For: Gulu University REC

Appendix VI: Study Area Approval Letter

Appendix VII: Results -Tobit Regression Model

Tobit regression

Number of obs = 385

F(17, 368) = 444.64

Prob > F = 0.0000

Log pseudolikelihood = 397.31585

Pseudo R2 = 50.9823

SDI	Coef.	Robust Std. Err.	t	P> t	[95% Conf. Interval]	
log_lanProp	.3066548	.0581753	5.27	0.000	.1922571	.4210526
log_lanProp_sq	-.0910788	.0087546	-10.40	0.000	-.108294	-.0738635
log_exp	.0106147	.0078066	1.36	0.175	-.0047363	.0259658
LevelofEdn	-.0024303	.0012102	-2.01	0.045	-.0048101	-.0000505
Gender_HHH	.0265798	.0137312	1.94	0.054	-.0004215	.0535812
ExtensionAgentVisits	-.0425288	.0147326	-2.89	0.004	-.0714995	-.013558
FarmCredit	-.0096971	.0093281	-1.04	0.299	-.0280401	.0086459
logDis_InputMkt	-.0126669	.0101592	-1.25	0.213	-.0326442	.0073104
Seedtype_Improved	.0290963	.0210476	1.38	0.168	-.0122925	.070485
MarketInfoSource_Radio	-.0559002	.01578	-3.54	0.000	-.0869305	-.0248699
cereals	.01686	.0117288	1.44	0.151	-.0062038	.0399238
legumes	.0092217	.0127413	0.72	0.470	-.0158332	.0342765
roots	.0339835	.0121261	2.80	0.005	.0101383	.0578287
perrenials	.0501718	.0160201	3.13	0.002	.0186694	.0816743
lnTotCost_Irrigation	.4735062	.172295	2.75	0.006	.1346998	.8123125
lnTotCost_Irrigation_Sq	-.0189076	.0073826	-2.56	0.011	-.033425	-.0043902
Rear_Livestock	.0184906	.0137328	1.35	0.179	-.008514	.0454952
_cons	-2.346258	.9939626	-2.36	0.019	-4.300817	-.3916991
/sigma	.0769372	.0058942			.0653466	.0885278

Obs. summary: 24 left-censored observations at SDI<=0

361 uncensored observations

0 right-censored observations

Appendix VIII: Results - Two Stage Least Squares

Instrumental variables (2SLS) regression

Number of obs = 385
Wald chi2(20) = 185.02
Prob > chi2 = 0.0000
R-squared = 0.2814
Root MSE = .70622

lnAnnualProfit	Robust					
	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
SDI	1.304323	.4951916	2.63	0.008	.3337654	2.274881
log_lanProp	.7038473	.1344967	5.23	0.000	.4402387	.967456
logHHsize	.0564794	.0668771	0.84	0.398	-.0745972	.187556
Age_HHH	.0017782	.0047442	0.37	0.708	-.0075203	.0110767
Gender_HHH	-.0319073	.145458	-0.22	0.826	-.3169997	.2531852
logExp_Scheme	-.4574162	.2769472	-1.65	0.099	-1.000223	.0853903
logExp_Scheme_sq	.1236891	.0618599	2.00	0.046	.002446	.2449322
SchemeSvs_MbershipSub	.2325509	.1933357	1.20	0.229	-.14638	.6114818
Sourceofcredit_DIFACOS	.316251	.0802051	3.94	0.000	.159052	.47345
Sourceofcredit_VSLA	-.1708396	.1488149	-1.15	0.251	-.4625113	.1208322
ExtAgent_Govt	.1183997	.1270155	0.93	0.351	-.1305462	.3673455
ExtAgent_FarmerAss	.2769937	.1278897	2.17	0.030	.0263345	.5276528
ExtAgent_PrivateCompany	.3826894	.1960597	1.95	0.051	-.0015805	.7669594
Buyer_Middlemen	.1229384	.1516582	0.81	0.418	-.1743062	.4201829
Buyer_RiceProcessor	.5319544	.1868837	2.85	0.004	.165669	.8982398
Variety_Super	.5605466	.1347008	4.16	0.000	.2965379	.8245554
Variety_K98	.1506594	.1000617	1.51	0.132	-.045458	.3467768
perrenials	.1546336	.1231312	1.26	0.209	-.0866992	.3959664
legumes	.179187	.0769992	2.33	0.020	.0282713	.3301028
roots	.2021997	.0938445	2.15	0.031	.018268	.3861315
_cons	11.10657	.8191481	13.56	0.000	9.501074	12.71208

Instrumented: SDI

Instruments: log_lanProp logHHsize Age_HHH Gender_HHH logExp_Scheme logExp_Scheme_sq
SchemeSvs_MbershipSub Sourceofcredit_DIFACOS Sourceofcredit_VSLA
ExtAgent_Govt ExtAgent_FarmerAss ExtAgent_PrivateCompany Buyer_Middlemen
Buyer_RiceProcessor Variety_Super Variety_K98 perrenials legumes roots
log_lanProp_sq LevelofEdn ExtAgentVisits FarmCredit logDis_InputMkt
Seedtype_Improved MarketInfoSource_Radio cereals lnTotCost_Irrigation
lnTotCost_Irrigation_Sq Rear_Livestock