FACTORS THAT AFFECT RICE PRODUCTION IN AGROECOLOGICAL

ECOSYSTEMS IN UGANDA

CASE STUDY: UGANDA MARTYRS UNIVERSITY

SUBMITTED BY

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2011-M152-20002

UGANDA MARTYRS UNIVERSITY

SEPTEMBER, 2016

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CASE STUDY: UGANDA MARTYRS UNIVERSITY

A POST GRADUATE DISSERTATION
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UGANDA MARTYRS UNIVERSITY

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LIST OF ABBREVIATIONS

AEATRI - Agricultural Engineering and Appropriate Technology Research Institute

FAO - Food and Agricultural Organization of the United Nations

FICA - Farm Input Care

GDP - Gross Domestic Product

GoU - Government of Uganda

JICA - Japan International Cooperation Agency

MAAIF - Ministry of Agriculture, Animal Industry and Fisheries

NAADS - National Agricultural Advisory Services

NAARI - Namulonge Agricultural and Animal Production Research Institute

NARO - National Agricultural Research Organization

NASECO - Nalweyo Seed Company

NERICA - New Rice for Africa

PMA - Plan for Modernization of Agriculture

SAA - Sasakawa Africa Association

SAA-U - Sasakawa Africa Association, Uganda

UBOS - Uganda Bureau of Statistics

WARDA - West African Rice Development Assoc

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ABSTRACT

The research study examines factors that affect rice production in 3 Agro-ecological Ecosystems in Uganda and determinants of its yield, based on data obtained from a field survey; with research design survey method, through structured questionnaire interviews for 50 farmer households per district which were chosen randomly in 3 parishes for every district and focus group discussions at Parish level with each focus group held having a representation of at least 15 members or more per district. The data from focus group survey was used as check list for farmer household structured questionnaire survey conducted in 3 out of the 10 agro-ecological zones of Uganda. Three districts were (Kumi, Hoima and Lira) which fall in the Kyoga Basin/plains (KB); Western Savannah Grasslands (WSG) and the North Eastern Savannah Grasslands (NESG) respectively. These answers research questions: What are the rice characteristics of agro-ecosystems, factors that affect the yields of rice and the rice production constraints among rice producing households of Kumi, Hoima and Lira districts?

The UBOS Agricultural Household Survey of 2008/09 the rice yield per ha of 2.5 t for the entire farmers growing rice in the country but this is the average over 1.6 t for Western, 1.7 t for Northern, 0.8 t for Central and 3.6 t for Eastern regions (UBOS, 2011). Except Eastern region where irrigated rice cultivation dominates, the yield levels of sampled farmers in 2007/08 are comparable to or higher than those in 2008/09 reported by UBOS. The rice cultivation in Sub-Sahara Africa (SSA), agronomists and development practitioners have found that there is room to increase agricultural productivity by improving on cultivation practices (de Graft-Honson et al. 2014). Since this type of technology does not require additional expenses, can easily be accepted by small holder farmer. As shown in table 13 from the regression analysis, there were only four variables that significantly affected rice yield: (i) The level of education attended by the farmer, (ii) the type of rice variety grown, (ii) whether or not a farmer belonged to a farmer group and (iv) Farmer constraints in rice production mainly insect pests, financial, diseases and chemical inputs. The level of education of household heads, contact with extension, training, ease of access to rice seed and membership to farmer groups are the factors that positively influenced the willingness to adopt rice new technologies. In conclusion, the major constraints to rice production were mainly linked to lack of adequate sensitization and training of farmers on proper methods of farming. The starter material (seed) is the most important factor for crop production; farmers still r0elied on local seed, whose quality is questionable. Hence, there is need to strengthen extension services to ensure that improved technologies generated through research achieve rice farmer yield benefits.

CHAPTER ONE
INTRODUCTION

1.1 Background

Uganda is a land locked country that largely depends on subsistence grown foods like bananas, maize, millet, cassava, beans and ground nuts. In the recent past however, there is an increased preference for rice over the traditional staple foods. The consumption of rice is rising fast owing to rice based school feeding, childhood nutrition, urbanization and a growing population (Bigirwa et al., 2006)

Rice is key commercial crop targeted for food security and household income. Its total consumption is estimated at 204,000 metric tons while its per capita consumption is about 8Kg. Total production are estimated at 144,000 metric tons leaving a deficit of 60,000 metric tons. Rice production (acreage) has increased ever since NERICA was introduced in 2002. By end of 2002, about 6,000 ha were put under NERICA 4 and presently area under upland rice is estimated to be 45,000 ha. Rice importation has dropped from 60,000MT in 2005 to 39,356MT in 2007 saving the country an equivalent of about 30 Million USD (Akintayo et al. 2009).

However, Uganda's population is estimated at 40,386,140 (UBOS, 2014), with agriculture as the most important sector of its economy, employing over 80 percent of the work force and contributing 29% of the Gross Domestic Product (GDP) (Amon 2004). Uganda does not yet produce sufficient rice for domestic consumption. The government of Uganda responded to the need by opening pilot rice schemes during 1970s with basically the lowland cultures of production. In 2000 and 2001, the price of maize was high in the region, Uganda's government and farmers thought of an alternative crop that could provide food security and income (Diao et al. 2008; Otsuka and Kijima 2010; Larson et al. 2010) and rice was identified. SG2000 and the National Agricultural Research Organization (NARO), provided NERICA varieties developed by the Africa rice center (Africarice), NERICA 1, 4, and 10, were identified as a suitable replacement for maize ((Haneishi et al. 2012; Kijima et al. 2008). NERICA 4 was released in 2002 and followed by NERICA 1 and 10 (CGIAR 2013)

Gilbert Bukenya, former vice president of Uganda, identified upland rice as a major strategic intervention for food security and poverty reduction. Based on Dr. Bukenya's advocacy, President Yoweri Museveni launched the Upland Rice Project in 2004. This widely acknowledged the growth of Uganda's rice sector. The growth of Uganda's rice production contributed to greater food security and a reduction in rice imports. According to the Ugandan government, rice imports dropped between 2005 and 2008, which helped save the country about US$30 million in foreign exchange earnings. The areas sown for rice nearly doubled from about 80,000 hectares in 2002 to about 150,000 hectares in 2011. Similarly, paddy production increased from about 120,000 tons in 2002 to more than 220,000 tons in 2011 (Tsuboi, 2014).

Rice in Uganda is grown mainly in western and eastern Uganda because of the presence of low lands with high moisture content throughout the growing season. NERICA rice was introduced by Uganda Government in 2003 as a high yielding upland variety, with the strategies to eradicate poverty and increase food security.

Except Eastern region where irrigated rice cultivation dominates, the yield levels of sampled farmers in 2007/08 are comparable to or higher than those in 2008/09 reported by UBOS. In the case of rice cultivation in Sub-Sahara Africa (SSA), agronomists and development practitioners have found that there is room to increase agricultural productivity by improving on cultivation practices (de Graft-Honson et al. 2014). These type of technology does not require additional expenses, can easily be accepted by mall holder farmers.

Rice schemes are still small considering the fact that Uganda has about 500,000 hectares of land suitable for seasonal lowland rice production. According to the National Rice Development Strategy, Uganda is expected to produce up to 335,000 tons of rice in 2013 and

500,000 tons in 2018. New lowland rice varieties are expected to be released soon by NARO (Isaac Khisa, 2014).

1.2 Problem Statement

Since 1990, rice production has increased at a lower rate than the population (Datvan, 2000).Yields from farmers have remained low, rarely exceeding 800 kg/acre as compared to yields in excess of 2000 kg/acre obtained in experimental trials (MAAIF,2008). The UBOS Agricultural Household Survey of 2008/09 the rice yield per ha was 2.5 t for the entire farmers growing rice in the country, including both rain fed and irrigated cultivation, but this is the average over 1.6 t for Western, 1.7 t for Northern, 0.8 t for Central and 3.6 t for Eastern regions (UBOS, 2011). Yields of rice production are still low in both improved and local varieties of rice in 3 Agro-ecological systems of Kumi, Hoima and Lira. Therefore the research study was to find out the causes of low yields in rice production in Agro-ecological systems of Kumi, Hoima and Lira while looking at their farming pattern, method of planting, level of income, varieties grown, pests and diseases and all other field operations while characterizing the rice agro-ecosystems in the 3 districts of Kumi, Hoima and Lira in Uganda.

1.3 Objectives of the study

1.3.1 General objective

The general objective of the study was to investigate the factors of low yields in rice production in Agro-ecological systems of Kumi, Hoima and Lira upon characterizing rice agro-ecosystems in Kumi, Hoima and Lira districts

1.3.2 Specific objectives

a) To characterize the rice agro-ecosystems in Kumi, Hoima and Lira districts
b) To determine factors that affect the yield of rice in Kumi, Hoima and Lira districts
c) Identifying rice production constraints among rice producing households in Kumi, Hoima and Lira districts

1.4 The research questions

d) What are the rice characteristics of agro-ecosystems in Kumi, Hoima and Lira districts?
e) What factors affect the yields of rice in Kumi, Hoima and Lira districts?
f) What are the rice production constraints among rice producing households of in Kumi, Hoima and Lira districts?

1.5 The scope of the study

This section highlights the scope of the study in three aspects; geographical, content and the time scopes as seen below;

1.5.1 Geographical scope

This study was undertaken in three districts of Uganda; Kumi, Lira and Hoima. Kumi district lies 250 kilometres, (160 mi) by road, northeast of Kampala. The coordinates of the town are 1°29'36.0"N, 33°56'15.0"E (Latitude: 1.493334; Longitude: 33.937500). (Distance Between Kampala and Kumi with Map". *Globefeed.com*. Retrieved 1 June 2014.) Lira District found in the north, borders with Pader District to the north, Otuke District to the northeast, Alebtong District to the east, Dokolo District to the southeast, Apac District to the southwest and Kole District to the west. The main municipal, administrative, and commercial center in the district, Lira, is located 110 kilometres (68 mi), by road, southeast of Gulu, the largest city in Northern Uganda. The coordinates of the district are: 02 20N, 33 06E (Latitude: 02.3333; Longitude: 33.1000).

Hoima District is bordered by Buliisa District to the north, Masindi District to the northeast, Kyankwanzi District in the east, Kibaale District to the south, Ntoroko District to the southwest and the Democratic Republic of the Congo across Lake Albert to the west. Hoima, the location of the district headquarters, is located approximately 230 kilometres (140 mi), by road, northwest of Kampala, the capital of Uganda and the largest city in that country. The coordinates of the district are: 01 24N, 31 18E. (*"Approximate Road Distance between Kampala and Hoima with Map". Globefeed.com. Retrieved 8 May 2014).*

The sampled districts were spread across 3 out of the 10 agro-ecological zones of Uganda. Three districts (Kumi, Hoima and Lira) fell in the Kyoga Basin/plains (KB); Western Savannah Grasslands (WSG) and the North Eastern Savannah Grasslands (NESG) respectively.

1.5.2 Content scope

This study was limited to three study areas namely; the characteristics of rice agro-ecosystems, Factors' that affect the yield of rice and as well identified rice production constraints among rice producing households of Kumi, Hoima and Lira districts. At the end of the study, the factors that affect the rice production were identified

1.5.3 Time scope

This study considered the period from 2010-2015 to track the most recent trends in rice production and as well consider the factors that affect the rice production despite an increase of population in Uganda. The study started in July 2014 through July March 2015

1.6 The significance of the study

This study is anticipated to assist the rice growers to gain understanding of the constraints of rice growing and coping mechanisms that can assist in designing readily acceptable integrated agronomic practices and management, maximizing the use of local resources and knowledge and integrating useful new practices. Reaching rice farming adopters in communities and focusing on technologies and practices that farmers can manage, establish and diversify their farming systems; and farmer to farmer sharing through groups. Research scientists will implement technologies identified in the study through on farm experiments to demonstrate the new technologies to farmers to improve on their soil management, seeds, water management and farming systems. Opportunities identified in this study can help in accelerating the production and promotion of rice in Uganda which can be source of income to farmers, food security and overcome poverty among farmers' households.

Likewise, the study is expected to benefit Agricultural planners and extension service providers, since it will be a point of reference to feed into their developmental plans to address the gaps in rice production in Agro ecological systems in Uganda

The study finding will add value to the existing body of literature on factors that affect rice production in 3 Agro ecological ecosystems in Uganda with particular emphasis on the varieties of rice grown and the cropping patters. This will help future researchers in related fields to have a platform for future research and point of reference.

1.7 Justification of the study

Yields of rice production are still low in both improved and local varieties of rice in 3 Agro-ecological systems of Kumi, Hoima and Lira which could be addressed through house hold survey and focus group discussion on pattern of farming, method of planting, varieties grown, earnings of income, pests, diseases and other field operations. Since 1990, rice production has increased at a lower rate than the population (Datvan, 2000). Yields from farmers have remained low, rarely exceeding 800 kg/acre as compared to yields in excess of 2000 kg/acre obtained in experimental trials (MAAIF, 2008). The UBOS Agricultural Household Survey of 2008/09 the rice yield per ha was 2.5 t for the entire farmers growing rice in the country, including both rain fed and irrigated cultivation, but this is the average over 1.6 t for Western, 1.7 t for Northern, 0.8 t for Central and 3.6 t for Eastern regions (UBOS, 2011). Therefore the research study was to find out the causes of low yields in rice production in Agro-ecological systems of Kumi, Hoima and Lira while looking at their farming pattern, method of planting, level of income, varieties grown, pests and diseases and all other field operations while characterizing the rice agro-ecosystems in the 3 districts of Kumi, Hoima and Lira in Uganda. The fact that rice growing is a means of survival for the famers, it was imperative that a study is conducted to establish what hinders its production in the three ecological districts. Failure to conduct this study would mean that farmers would remain unaware of what hampers rice production and as well make the government continue to loose funds in an undertaking that may not be yielding results to the farmer

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

This chapter presented a review of related literature on the variables of the study in reverence to similar studies conducted by other researchers revealing their contribution and existing research gaps.

Rice is produced from all continent except Antarctica and grows from an area ranging in latitude from 53° to 40°. Rice is dry -land crop just like maize or wheat, as a rain-fed crop it operates alternately under flooded and dry conditions, and is crop that can be flooded continuously. It is grown on alluvial plains, flooded valleys, and terraced hillsides. Rice has less drought tolerance compared to other cereal crops, it grows well in arid areas under irrigation such as Egypt and Pakistan. Likewise, it is sensitive to low temperature, high yields are in northern China and Japan and at elevations of more than 3,000 meters in the tropics and subtropics (Proceedings of Symposium on paddy sol by brake). Africa is 300 million ha of arable land for rain fed crops (Hugo Ahlenius, UNEP/GRID-Arendal, 2006) and the total area under reserve is 68%. Africa has a potential to expand its Agricultural production especially in rice. Rice production extensively is under rain-fed (upland) ecosystems which account for 60 percent of the total rice area. Rice competes with other important staple crops for example: maize, sorghum, groundnuts, millet, cassava, yam, coco-yam, plantain and banana, as well as such cash crops as coffee, cocoa, citrus and cola. However, as these crops increase in economic importance, the rice area diminishes because rice is the lowest-yielding crop in that ecology. The wetlands and irrigated ecologies become increasingly important as these ecologies are more suitable for rice production than for other upland crops.

Rice production has been expanding at a rate of 6% per annum, with 70% of the production increase due mainly to land expansion (Africa Rice Center, 2007). In 2006, Africa produced over 20 Mt, up from an average of 16.67 Mt of paddy rice per year in 1987-1997, on 9 million ha (M ha) - the equivalent of 3.4 and 6.0 percent of the world’s total rice production and rice area respectively. The trend is expected to increase at an average rate of 7% per annum (WARDA, 2008). West Africa and East Africa are the main rice producing sub-regions in SSA, accounting for 95% of the total rice produced. However, the southern Africa sub region has had the highest rates of production expansion since 1990s. Despite the positive developments in rice production and consumption, the average yields (1.51 t/ha) in SSA are still lower than the world's average of 3.4 t/ha. The low yields suggest a strong and mostly partial potential used for boosting rice productivity. Policy on appropriate technologies and adoption will increase the current yield levels could be doubled to realize the dream of self-sufficiency.

2.1 Rice cultivation agro-ecologies in Uganda

Rice is produced in 3 main ecosystems in Uganda; rain fed lowlands, uplands and irrigated lowlands. Many constraints are observed in the various ecosystems, some of which are specific, while others cut across ecosystems and regions. The specific constraints are discussed under each ecosystem while the non-specific ones are described generally.

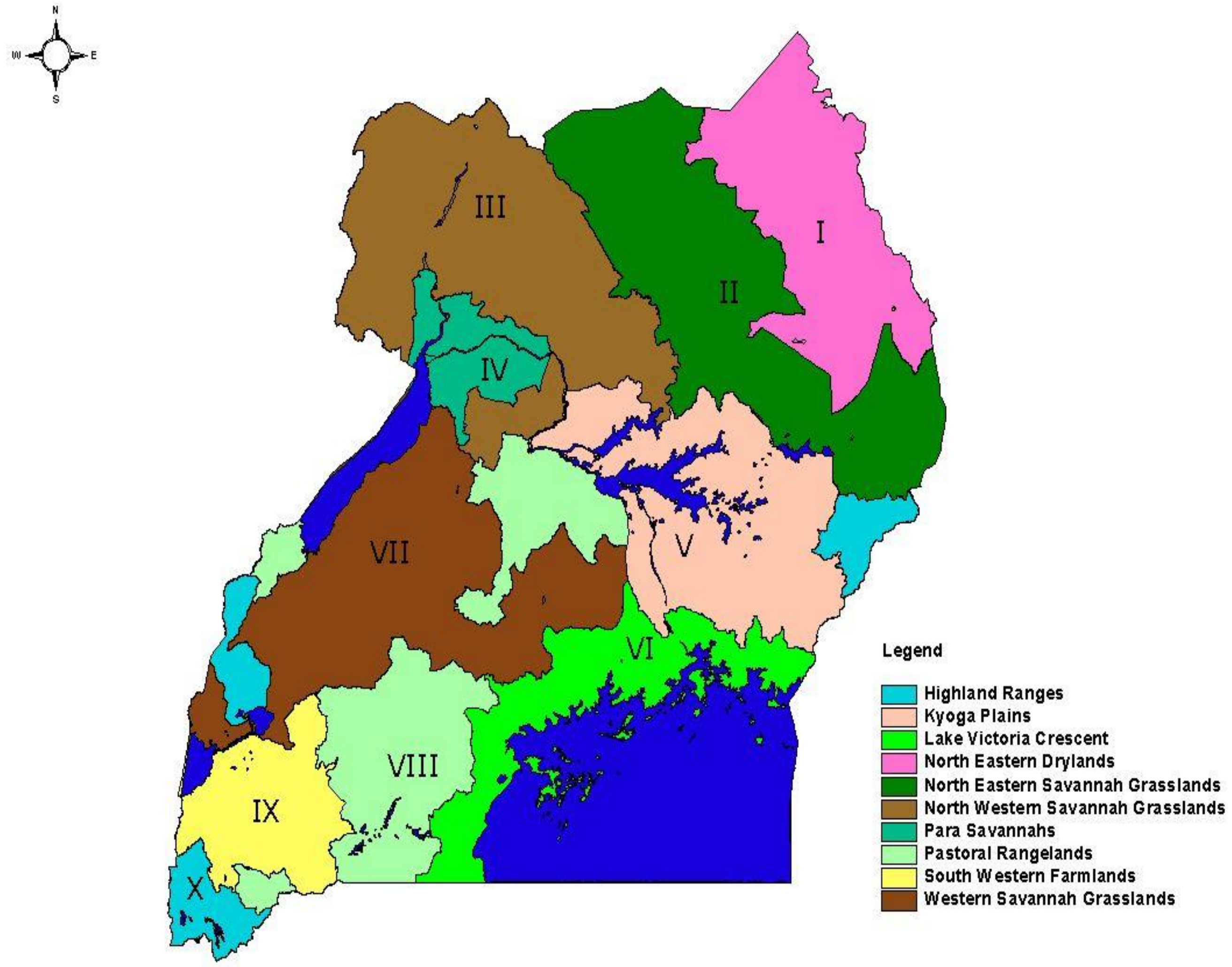

Figure 1: Map of Uganda showing different agro ecological Zones.

Agro ecology is a science or practice that studies the ecological processes that operate in agricultural production (Altieri, M.A. 1992). Ecology is producing, establishing and maintaining new habitats to conserve species diversity in an ecosystem (Altieri, M.A. 1992). An ecosystem includes all living things (plants, animals and organisms) in a given area, interacting with each other, and also with non-living environments (weather, earth, sun, soil, climate, and the atmosphere). In an ecosystem, each organism has its own role to play (Altieri, M.A. 1992). Ecology is the study of ecosystems. Ecosystems are controlled both by external and internal factors. External factors such as climate, the parent material which forms the soil and topography, control the overall structure of an ecosystem and the way things work within it, other external factors include time and potential biota. Ecosystems are dynamic entities invariably, they are subject to periodic disturbances and are in the process of recovering from some past disturbance. To achieve goals in agro-ecological ecosystem farmers employ many practices (practices done at a farm). Improve soils by use of and in some cases replace **chemical fertilizers (**Mc Guinnes, H. 1993) with organic, fertilizers, others, like mulch, are frequently used to control weeds and minimize erosion. **Integration:** diversifying farming by including both crops and animals in the same farm. Animal wastes can fertilize crops while their feed is produced locally, reducing transportation challenges. In some cases, by grazing and directly fertilizing fields, animals reduce energy or time-intensive tasks. **Agroforestry:** Farmers and ranchers can diversify by mixing trees or shrubs into their operations to provide additional income to shade, shelter, and protect plants, animals, or water resources. **Breeds and seeds** (local ones): The crops and animals in many agro-ecological systems include varieties specifically suited for local conditions (soils, weather, and pests). Farmers can produce tasty food that is resilient to existing challenges while also protecting options to manage the challenges of the future (Wojtkowski, Paul A. 2006). **Barriers and strips.** Non-crop plants, like prairie grasses, can be planted as buffers or borders around fields to support pollinators, enhance biodiversity, prevent erosion, and reduce water pollution. When planted in less productive areas, these barriers and strips can rebuild soil health without diminishing profits**.** **Cover crops and green manure**: Cover crops are planted during the off-season to protect soils from erosion, reduce nutrient-loss to waterways, and prevent weeds from expanding into bare areas. **Conservation tillage:** the use of limited to no tillage approaches that seek to balance the fertility to achieve healthy soils (Calegari, A. et al. 2008). **Crop rotation:** Crop rotation involves planting in a sequence the crops planted on same fields from year to year. Rotating crops disrupts pest and weed reproductive cycles**. Diversified fields:** Fields can be diversified by mixing crops, intercropping (arranging multiple crops on a single field). **Designed landscapes** managing landscape to minimize erosion and runoff. For example, terracing on steep areas growing locally adapted seeds and breeds on slopes, farming along natural contours, and constructing check dams to reduce destructive storm water flow in critical areas can prevent soil loss and degradation

2.1.1. Uplands (Dry-land - rain fed) in Uganda

The only source of water is from precipitation, the crop is highly vulnerable to drought resulting from erratic and poor rainfall. Soils in this ecosystem are usually poor in nitrogen, phosphorus, sulphur and iron deficiency may also occur. Rice in upland areas competes with other food crops, both in land availability and labour. The small farmer gives priority to traditional food crops, such as maize, sweet potato, beans, sorghum and cassava. Competition from weeds is also important in rice-growing areas. It is essentially a low-input ecosystem, resulting in poor paddy yields (1 t/ha) for the following reasons: little or no fertilizer application; weed control essentially manual and usually delayed (resulting in serious yield reduction); drought (resulting 6in total crop failure); diseases, such as blast, leaf scald, brown spot and sheath rot; and pests, including birds, termites, mice and other large rodents (WARDA 1993).

2.1.2 Lowland rain fed in Uganda

Due to poor drainage, the major physical constraint in this ecosystem is uncontrolled floodwater, which can oppress the crop or produce flash floods capable of carrying away the harvest. Other constraints include: health hazards, with a prevalence of water-borne diseases, including blood sucking leeches; adverse soils in some areas, often producing iron toxicity symptoms; and drought may occur when extreme dry weather is experienced in some areas (Virmani, 1979)

2.1.3 Irrigated ecosystem in Uganda

Under irrigated ecosystem, most of the potential area has not been brought into cultivation. The development is slow due to the following reasons of development; high cost of labour, nutrient deficiency development; and high cost of labour. Other constraints commonly reported include nutrient deficiencies (N, P, S and Zn); weed build-up (build-up of grasses, broadleaves, sedges and wild rice); diseases (rice yellow mottle virus, blast, sheath rot and bacterial leaf blight); insects (gall midge, stem borers and grain bugs; pests (birds, rodents and crabs); germplasm (poor input responsiveness of local varieties and slow release of improved varieties), yi*eld* (Barr, Koecher and Smith,1975).

2.2 Status of rice production and research in Uganda

The National Crops Resources Research Institute (NaCRRI) of National Agricultural Research Organization (NARO) is the research institute for rice research in Uganda. The initial work on rice started as an effort to select upland rice varieties for production. Among the introductions into the country in 1999 for screening, NERICA 4 was introduced for screening and was released officially in 2003. Through financial support from the Rockefeller Foundation, the screening and evaluation was conducted in the country.

Concurrently, the Nalweyo Seed Company (NASECO) participated in the evaluation. The Rockefeller funded activities were implemented by the Cereal program under NARO in collaboration with the farmers, the West African Rice Development Association (WARDA) and Makerere University, Faculty of Agriculture. The objectives were to develop and promote upland rice varieties tolerant to drought stress, efficient in mineral utilization and resistant/tolerant to biotic stresses in the country. It also involved cataloguing the rice varieties grown and the associated constraints to production to be assessed. After preliminary evaluation on station in 2001 seasons, 10 varieties out of 32 original introductions were advanced for on farm evaluation. In the subsequent evaluations, three upland varieties IITA 257, IITA 325 and WAB 450 IBP91HB were selected and released as NARIC 1, NARIC 2 and NARIC 3. The NARIC 3 is a NERICA 4 variety. They are all medium term varieties with growth duration 115, 120 and 120 days, respectively. The mean yields were 4.4, 4.2 and 4.5 t/ha higher than local variety Abilony that yields 1.2 t/ha. Subsequent germplasm introduction and evaluations resulted in the release of more upland rice varieties, NERICA 1 and NERICA 10. Although these varieties do not have higher yields than the standard variety, NARIC 3, they were found to allow the farmers to grow more rice during the year because of their short growth duration. Besides, NERICA 1 is aromatic, which helps in solving the market demand for aromatic rice.

A number of introduced germplasm are currently under Participatory variety evaluation including advanced lines from WARDA, IRRI, CIAT and other countries. Those with desirable attributes will be selected as new varieties. The cereals program has also initiated rice breeding activities, and germplasm characterization is ongoing to select parents for improving the low yielding local cultivars. In the last 10 years, NARO has released 6 upland rice varieties for Uganda. The NERICA varieties yield above 3 t/ha and this is the principle reason that Uganda now has rice production boom after several years of relying mostly on imported rice. Other research activities conducted over the years include; study of the socio-economic environments in which rice production is taking place, including identification of constraints that men and women farmers face in rice production, farmer participatory assessment of rice response to fertility levels and different cropping patterns and alt. (Bergman Lodin, J. Nov 2012).

2.3 Factors that affect rice production

Rice is a major food security crop and a cash crop in several districts in Uganda. Most crops are important for food security, but rice is consumed more in urban areas. Since 2000, the demand for rice in Uganda has grown at an average rate of about 9.5 percent per year. Yields from farmers' fields have remained low, rarely exceeding 800 kg/acre as compared to yields in excess of 2000 kg/acre obtained in experimental trials (MAAIF2008).

The decline within rice growers was recorded in wetlands, who depend on rain fed agriculture. Under rain-fed conditions, the yield is greatly influenced by the amount of available water during the growth phase of rice crops. Because of imperfect markets, household endowment of capital or assets (physical, natural, financial, human and social) and labour availability affect the household's incentives and capacity to adopt new technologies that require out-of-pocket expenditure and high labour input. (Reardon *etal*. 1995) observed that asset endowment has a strong impact on the adoption of new technologies lack of cash and other assets reduces the ability to pay for new technologies. Improper labour markets and the heavier labour requirement in rice production compared to other food crops e.g. maize and beans therefore availability of family labour also affects the adoption of NERICA and other varieties. Agricultural output comes from about 4.5 million small-scale subsistence households, 80% of whom, in average, each owns about 2ha of land and produces a number of different food and cash crops besides herding some livestock (UBOS, 2004)

About 95% of the seeds used by farmers are always from their communities, from neighbors and friends because private companies seriously promote improved seeds in the country. The quality of seed; from the source of seed from farmers are mixtures of several varieties because of lack of technical skills. Improving the adoption of improved seeds in Uganda will be on building the capability of farmers and community-based groups through training for production of good seed (Quality Rice Seed Production Manual. NARO and KABI)

The yield levels of sampled farmers were lower than those of rain-fed upland farmers in central and western Uganda(Kijima et al. 2006, 2008, 2011) and in central Uganda by Miyamoto et al. 2012), but higher than those of rain-fed upland farmers in northern Uganda by (Fujiie et al. (2010). The UBOS Agricultural Household Survey of 2008/09 the rice yield per ha of 2.5 t for the entire farmers growing rice in the country, including both rain-fed and irrigated cultivation, but this is the average over 1.6 t for Western, 1.7 t for Northern, 0.8 t for Central and 3.6 t for Eastern regions (UBOS, 2011). Except Eastern region where irrigated rice cultivation dominates, the yield levels of sampled farmers in 2007/08 are comparable to or higher than those in 2008/09 reported by UBOS

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2.4 Reasons for rice farming increase in Uganda

Release of improved (high yielding, disease tolerant, early maturing) upland rain fed varieties in 2001/02. Promotion of the New Rice for Africa (NERICA), whose production is very rapidly spreading in Uganda under support by multiple stakeholders including Sesakawa Global 2000 -UGANDA, JICA and Community based organizations (Africa Rice Center 2008). Rigorous government policy has promoted upland rice production in an effort to reduce hunger and poverty among the poor sector of the population.

Rapid increase in demand and consumption of rice: as a staple especially by the urban and semi-urban populations and institutions. The country’s annual per capita consumption of rice currently stands at over 10 kg per capita. Also, rice provides a quick - to-cook as saves women’s time. .Rice in Uganda is completely under the private sector. Rice trading in Uganda is completely under the private sector. Most of the trading is done mostly by middle men who buy threshed rice from the farmers at the farm. The price of rice varies from one place to another between UShs.1 500=/kg to UShs.2 500/kg of locally produced rice (MAAIF, 2007). This rice is usually packed in 50 and 100 kg bags. Some medium and large scale processors however process, package and sell a higher market prices between UShs.5 000 to UShs.7 500/kg in 2007.Decline in the production of what used to be important cash-crops such as cotton in eastern Uganda, and coffee and bananas in the central region to have contributed to the rapid increase of rice production, since rice has the potential of taking over as a sustainable cash crop in most parts of Uganda.

Most of the food crops grown are to satisfy household consumption and food security requirements, rice is consumed more in urban areas, rice is more consumed and is one of the major foodstuffs at homes, schools, hospitals and prisons (Ahmed, 2012). Rice is grown almost throughout the country but mainly in the Eastern and Western Uganda due to availability of lowlands with high moisture contents throughout the growing season. However, these (Eastern and Western) regions' lack of market access is the most significant explanation to their food insecurity (McKinne, 2009).

In the same regard, Odogola (2006) observed that 70% of the rice farmers in Kamwenge district (Western Uganda) and 48% of their counterparts in Iganga district (Eastern Uganda) have poor marketing systems. The main constraints were of poor market access: lack of market information, poor road network, small paddy quantities, low quality paddy and inadequate postharvest handling skills (Odogola, 2006).

Constraints to rice production in Bugiri district: farmers that affect rice production reported a number of production constraints. The farmers are well conversant with the major constraints to rice production. These constraints were similar across the two different rice production villages. They were Mentioned and ranked as major constraints in order of importance were; water management, soil nutrient depletion, weeds, labor, pests and diseases, poverty for wetland rice (Bupala) while weeds , change in rainfall patterns , soil nutrient depletion , labor, pests and diseases were mentioned for the upland rice system (Nkaiza)The constraints are in agreement with some of those that were earlier reported by NAADS (2002)and USAID (2003) during on farm trials of upland NERICA varieties that attributed low rice yields to the interaction of changing weather conditions, low farm input use, weeds, pests and disease. These findings were also in line with work of Conway (2000).

Constraints of rice production

Pandey et al., (2006) notes that climate related natural disasters (drought, flood, and typhoon) are the principal sources of risk and uncertainties in agriculture. Wide fluctuations in agricultural output that have occurred throughout the human history attest to the fact that Agriculture is an economic activity dependent on the vagaries of weather. While attempts have been made to reduce the adverse effects of weather on agriculture through scientific research and technology development, the performance of agriculture, especially in developing countries, still depends largely on the weather.

CABI Crop Protection Compendium (2014) indicates that farmers lose about 37% of their rice crop to pests and diseases yearly. There are over 100 species of insects that cause significant economic damage on rice. These insects such as the leaf folder, whorl maggot, and armyworms cause serious damages on rice crop. Other insects include black bug, rice skiiper, rice thrips, green semilooper, greenhorned caterpillar, *Pomacea canaliculata* and *Pomacea maculata*, commonly known as Golden Apple Snails, are highly invasive and cause damage to rice crops. They eat young and emerging rice plants. They cut the rice stem at the base, destroying the whole plant.

Rice Knowledge Bank (2015) shows that Yellow Stem Borer caterpillars bore into the rice stem and hollow out the stem completely. Attacked young plant shows dead heart and older plants show white heads. Often plants break where the stem is hollowed out causing lodging. It was thus worthwhile to undertake a study in Ugandan setting and establish whether insects have similar effects in the districts of Kumi, Hoima and Lira.

Shivakumar and Kerbart, (2004) show that the effect of drought on human societies can be multidimensional. The effect of drought in terms of production losses and consequent human misery is well-publicized during years of crop failure. However, losses to drought of milder intensity, although not so visible, can also be substantial. Production loss, which is often used as a measure of the cost of drought, is only a part (often a small part) of the overall economic cost. Severe droughts can result in starvation and even death of the affected population. However, different types of economic costs arise before such severe consequences occur. Due to market failures, farmers attempt to make costly adjustments in their production practices and adopting conservative practices to reduce the negative impact during drought years.

CHAPTER THREE
METHODOLOGY

3.0 Introduction

This study covered a total of 3 districts in Uganda, strategically selected to represent the entire country. There are three main designated regions in Uganda; Eastern, Western and Northern. In this Kumi study, the Eastern, western and northern regions of the country are respectively represented by, Hoima and Lira districts (NaCRRI, NARO). The purpose of the survey was to understand how rice farmers produce rice and problems affecting their production, and their coping mechanisms. Mainly understanding of farmers' constraints and coping mechanisms that can assist in designing readily acceptable integrated agronomic practices and management. Moreover, opportunities identified in such surveys can also help in accelerating the production and promotion of rice.

3.1 Research Design

Research survey method through structured questionnaire interviews for 50 farmer households per district which are chosen randomly in 3 parishes for every district and focus group discussions at Parish level with each focus group held having a representation of at least 15 members or more per district the data from focus group survey can be used as check list for farmer household structured questionnaire survey.

The questionnaire Survey focused on main crops grown, land holding, varieties, intercropping, crop rotation, production constraints and coping strategies; rice insect pests and coping mechanisms; diseases; farmers income, pattern of cropping system. The farmer households are to be chosen randomly from 3 parishes. More data is to be taken from focus group discussions at Parish level with each focus group held having a representation of at least 15 members or more per district the data from focus group survey can be used as check list for farmer household structured questionnaire survey.

3.2 Description of the study areas

Data was collected from three districts of Kumi, Hoima and Lira. Kumi district is in the Eastern part of Uganda. The largest town in the district is Kumi and it is the head headquarters of the district. It is bordered by Katakwi district in the north, Nakapiripirit district, Bukedea District in the northeast, Pallisa district in the east and Ngora district in the west..The main town in the district is Kumi, which is located approximately 54 kilometres (34 mi)}, by road, southeast of Soroti, the largest town in Teso sub-region.[2] The coordinates of the district are: 01 30N, 33 57E. The annual population growth rate in the district is 4.5%. In 2012, the population of Kumi District was estimated at about 255,500. 84% depend on subsistence farming for their livelihood (1991 Population Census Report). The district covers a total area of 1,771.74 sq.km, out of which 1,440.98 sq.kms is land area while 330.76 (18.7%) is covered by open water bodies and swamps/wetlands. The main water bodies include lakes; Bisina, Opeta, Nyangwo, Meito and Nyasala.

Demand for fuel that is firewood, charcoal and agriculture are adversely affecting the environment contributing to erratic weather conditions marked by untimely onset, irregular distribution of rains, generally affecting food production and management in the district. The main crops are cassava, Finger millet, Sorghum, Sweet potatoes, Groundnuts, Maize, Beans, Cow peas, Sun flower, Rice, Soya beans, Bull rush millet, and Green grams. Cotton is no longer the main cash crop it used to be. Food crops are used as both food and sources of income/cash. Intercropping is common due to land shortage or as a measure of reducing the risk of total harvest failure. The crops are affected by various crop pests and diseases e.g. army worms, meal bugs, stalk borers, aphids, leaf minors and viruses like cassava mosaic

Lira District is located in Northern Uganda and is bordered by the districts of Pader to the North, Abim and Amuria to the East, Dokolo to the South-east, Amolatar to the South; and Apac to the West. The area approximately has a total of 515,666 km2 of which 3,482 km2 is land area and the rest are wetlands. It lies between: Latitudes 1o 21’N, 2o42”N Longitudes 320 51”E, 340 15”E. The district covers approximately a total area of 515,666 km2 of which 3,482 km is land and the rest of the land is wet land. The high crop production is the result of large hectare under crops with relatively low yields per unit area. Crops are grown by smallholder peasant farmers who are under rain fed ecosystem for agriculture and crops grown are pegion peas, sweet- potatoes, cabbages, beans rice, sunflower, G/nut, simsim, Soya beans, maize, pineapples mangoes and oranges.

Hoima district is found in western Uganda. Like most other Ugandan. Hoima District is bordered by Buliisadistrictn the north, Masindi district in the northeast, Kyankwanzi district in the east, Kibaale District in the south, Ntoroko district to the southwest and the Democratic Republic of the Congo across Lake Albert to the west. Hoima, the location of the district headquarters, is located approximately 230 Kilometers (140 mi), by road, northwest of Kampala, the capital of Uganda and the largest city in that country. The coordinates of the district are: 01 24N, 31 18E. In 2012, the mid-year district population was estimated at 548,800. Economic activity: crops are grown mainly for food. Crops grown include: Sorghum, maize, millet, peas, groundnuts, sunflowers, sweet, potatoes, beans, cotton, tea, coffee, tomatoes, cabbage, onions, and tobacco. Fishing employs several hundreds of people on Lake Albert employs. The recent discovery of petroleum in the district is attracting people from the district in the many activities in the industry.

3.3 Data collection

The research survey was conducted using both qualitative and quantitative research method. Qualitative research method was to gain an understanding of underlying reasons and motivations and expected into the setting of a problem, generating ideas and/or hypotheses.

Quantitative research method: To quantify data and generalize results from a sample to the population of interest and measure the incidence of various views and opinions in a chosen sample. Deductive process used to test pre-specified concepts, constructs, and hypotheses that make up a theory. Its objective provides observed effects interpreted by researchers of a program on a problem or condition

Data collected through a structured questionnaire and data was randomly collected from 50 rice farming households per district. A questionnaire targeting a household as a unit respondent and a check list for Focus Group Discussion was developed with the help of a socio-economist.

The questionnaire focused on main crops grown, land holding, varieties, intercropping, crop rotation, production constraints and coping strategies; rice insect pests and coping mechanisms; diseases; farmers income, pattern of cropping system. The households were chosen randomly from 3 parishes. More data was taken from focus group discussions at Parish level with each focus group held having a representation of at least 15 members or more per district.

Both scientists and technicians took data in every house hold by Research survey method through structured questionnaire interviews for 50 farmers per district which were chosen randomly in 3 parishes for every district. Each scientist or technician was interviewing one household at a time up to 50 households were all interviewed in every district. Normally the head of the family is interviewed or any other person on his or her behalf. . A one to one interview between respondents and researchers/enumerators was conducted to obtain information for household. This was supplemented by on-site observations. In each sub-county, the selected respondents for individual interviews and key informants were conducted in their respective homes.

Focus group discussion was carried in one other parish per district where farmers at least 15 or more are collected from one parish and asked the same questions as in house hold then they answer one at a time within the group to confirm what was given through house hold structured questionnaire interviews whether it was the same. A non-formal participatory research technique based on interactive focus group discussions was used for obtaining relevant information during group discussions. The respondents for focus group discussions were gathered at a central meeting place for the discussions.

In Hoima district it was done in Kibugubya, Bulindi and Buraru parishes. In Kumi district it was done in Omurang, Kanyumu and Mukongoro. In Lira it was done in Alebere, Olilo and Ayira parishes.

Focus group discussion was carried in one other parish per district where farmers at least 15 or more are collected from one parish and asked the same questions as in house hold then they answer one at a time within the group to confirm what was given through house hold structured

questionnaire interviews whether it was the same. A non-formal participatory research technique based on interactive focus group discussions was used for obtaining relevant information during group discussions. The respondents for focus group discussions were gathered at a central meeting place for the discussions. Focus group discussion was carried out in Omusio in Kumi district.

Figure 2: Focus group discussion in Lira district

Focus group in Lira district: Focus group holding a non-formal participatory research technique discussion based on interaction for obtaining relevant information during focus group discussions at Parish level with each focus group held having a representation of at least 15 members or more per district the data from focus group survey can be used as check list for farmer household structured questionnaire survey. Confirming what was given through house hold structured questionnaire interviews whether it was the same information.

All data was entered in the computer and analyzed. We then looked at the objective of the study and data analyzed accordingly.

3.4 Data analysis

Data was analyzed using econometric statistical package Statistical Package of Social Science (SPSS) in addition Research ANOVA and Correlation was used for analysis.

3.5. Farmer households

The study involved only farmer households who are rice growers who had experience in rice growing.

CHAPTER FOUR

PRESENTATION ANALYSIS AND DISCUSSION OF FINDINGS

4.0 Introduction

This chapter contains data presentation, analysis, interpretation, and discussion of the findings. Data presentation and discussion was done in line with the study objectives, which were to;

g) Characterize the rice agro-ecosystems in Kumi, Hoima and Lira districts
h) Determine factors that affect the yield of rice in Kumi, Hoima and Lira districts
i) Identifying rice production constraints among rice producing households of in Kumi, Hoima and Lira districts

This chapter presents demographic characteristics of respondents on one hand while on the other, it presents and discusses study findings in accordance with the study objectives

4.1 Socio economic characteristics of respondents

This study captured the demographic characteristic of the respondents. The characteristics included level of education, age of respondents, and experience in framing and particular in rice farming. This was done to give show where this information was generated

Table 1: Socio economic Characteristics of rice producing households in percentages

Time	Kumi	Hoima	Lira
Education Level			
No education	3.4	3.3	0.0
Primary Education	72.4	33.3	44.8
Secondary Education	17.2	53.3	55.2
College/University Education	6.9	10.0	0.0
Age (Years)	43	47	35
Experience in farming (Years)	21.8	15.7	27.4
Years in rice farming	15.9	3.9	11.5
Average Total production area (Acres)	6.9	8.1	5.3

Source: Field data

Table 1 indicates that from the survey, male farmers interviewed were 65.9%. The average age of the respondents was 42 Years. In terms of education, a majority of rice farmers had attained primary level of education and the proportions varied by location as shown in table 1 above. Also, a relatively large number of respondents had attained secondary education.

The education level of farmers in Kumi district was the highest in Primary level with72.4% followed by Lira with 44.8%. At least all farmers in Lira received some education, .and had the highest level of secondary education with 55.2 then followed by Hoima with 53.3%. Very few farmers had College or University education Hoima was the highest with 10% followed by Kumi with 6.9% and Lira had none. Lira farmers were more experienced in farming with 27.4 %as well as Kumi with 21.7%. Years in rice growing Kumi district was the highest with15.9%, then Lira with 11.5% and lastly Hoima with 3.9%.

Generally farmers had low education level which would make adoption and transfer of technology difficult unless communication always done in the local language according to the location village, sub-county or district. Rice is new crop more training needed for more farmers to adopt rice farming. The production area for rice is generally low in the 3 districts.

4.1.2. Major source of income for rice farmers

Table 2: Major source of income in percentages

Major source of income	Hoima	Lira	Kumi
Crop farming	96.5	96.7	83
Livestock rearing	0	3.3	17
Transport	3.5	0	0

In all the three districts, the major income source was crop farming in the 3 districts Lira was the highest with 97.7%, Hoima 96.5% and Kumi% with 83%, followed by livestock rearing as shown in table 2 above. In all the three districts, the major income source was crop farming. It is clearly indicated that 96.7% of farmers in Lira, 96.5% farmers from Hoima 83% of farmers from Kumi derived their income from crop farming. Furthermore, whereas 17% of the farmers from Kumi and Lira 3.3%'s farmers obtained income from livestock rearing, no single farmer from Hoima depended on livestock rearing to finance rice production but rather 3.3% of them obtained income from transport. Therefore, farmers use diversified sources of income to finance rice production. The farmers who participated in the study revealed that in actual sense, agriculture, and transport were the two major sources of finance for rice production in Hoima, Lira and Kumi districts.

Table 3: Percentages of specific income source in the 3 districts of Kumi, Lira and Hoima

Specific income source	Kumi	Hoima	Lira
No specific source	17	0	3.3
Bodaboda (Transport services)	0	3.3	0
Piggery	13.2	0	0
Bananas farming	1.9	0	0
Citrus farming	1.9	0	0
Cassava farming	7.5	0	6.7
Cotton farming	0	0	3.3
Cows	0	0	3.3
Construction	0	3.3	0
Irish potato farming	0	3.3	0
Millet farming	5.7	0	6.7
Beans	0	0	3.3
Rice farming	52.8	60	73.3
Tobacco farming	0	30	0

(MSc. Agro ecology 2014)

Rice farming was the most important source of income for the sampled households as shown in table 3 above its production was done alongside other crops that were also equally important as a source of income. The specific enterprises that raised income are as well shown in the table 3 above. Rice farming was the highest in Lira with 73.33%, then Hoima with 60% and Kumi with 52.8%. In Kumi piggery was the second specific source of income with 13.2%, while tobacco farming was the second in Hoima district and cassava and millet farming in Lira district.

There is need to help farmers to increase production through rice farming since it is the highest source of income among most farmers, through training on Agronomic practices, the use of improved varieties both upland and low land varieties, and the use of farmer groups so that they can learn more easily from fellow farmers. 17% of the farmers in Kumi did not have specific income, 3.3 in Lira and none in Hoima.

4.1.3. Main crops grown

The main crops that were grown in the 3 districts other than rice included; Cassava, rice, G-nuts, maize, millet, Cow pea, Sweet potatoes, Sorghum, Beans, Tobacco, Irish, Bananas, Horticultural crops-cabbages, onions, tomatoes, Simsim, Soya bean, Cotton and Pigeon pea.

Table 4: Percentages of the main crops grown by farmers in the 3 districts

Main crop 1	Kumi	Hoima	Lira
Cassava	65.5	6.7	13.8
Rice	12.9	33.3	51.7
G. nuts	9.7	6.7	0.0
Maize	6.5	20.0	0.0
Millet	0.0	0.0	3.4
S. Potatoes	0.0	3.3	0.0
Beans	3.2	13.3	31.0
Cotton	3.2	16.7	0.0

((MSc. Agro ecology 2014)

Based on the prevalence, rice was the most grown crop in Hoima and Lira while Cassava was the main crop for Kumi, though rice production also had a fair representation as shown in table 4 above.

In Kumi Cassava 65%was the main crop grown then rice with 12.9% and groundnuts with 9.7%. The main crops grown in Hoima were rice 33.3%, maize with 20% and beans 13% in Lira the main crop grown is rice with 51.7%, and secondly with beans 31%.

The findings indicated each of the 3 districts had a main cash crop grown. It is indicated that whereas 65.5% of the farmers showed that cassava was a main ach crop in Kumi, 51.7% of the farmers from Lira and 33.3% farmers from Hoima showed that rice was the main cash crop. It is also evident that in the 3 districts, farmers had an alternative crop grown in addition to the main crops grown. For instance, whereas 65.5% of farmers from Kumi grew cassava, they as well grew rice (12.9%), groundnuts (9.7%) as well as cotton and beans as indicated by 3.2% respectively. Famers in Hoima district grew maize (20% of them) in addition 16.7% farmers grew cotton and 13.3% beans. In Lira, 31% of the farmers produced beans and 13.8% farmers produced cassava.

The implication from the findings is that whereas there is a major crop grown, not all farmers in that particular district grow it. There are farmers who diversify and grow other crops on top of either the main crop and or other crops grown independent of the main crop in that district.

Farmers need more knowledge, skills and technology on other crops as well apart from rice on agronomic practices, improved varieties and farmer group involvement for easy adaptation of technologies.

Table 5: Weights of crops based on ranking

Crops	Kumi	Hoima	Lira	Total
Cassava	131	52	74	257
Rice	77	116	113	306
g.nuts	62	30	1	93
Maize	31	87	26	144
Millet	42	11	47	100
Cowpeas	19	0	0	19
Potatoes	51	29	12	92
Sorghum	32	3	1	36
Beans	12	69	110	191
Cotton	7	33	12	52
bananas	0	3	0	3
Tomato	0	3	1	4
Simsim	0	0	26	26
Soyabean	0	0	4	4
Pigeon pea	0	0	3	3
Cabbage	0	3	3	6

4.1.4. Land holding

In Kumi, majority of the farmers owned 4 and 5 acres while in Hoima most farmers owned 3 acres. For the case of Lira, most farmers owned 3 and 5 acres. On average farmers in Kumi and Hoima cultivated 1 acre of rice while those in Lira cultivated an average of 1.5 acres. For all the three districts, more farmers in Kumi had bigger pieces of land (up to 4 acres) than their counterparts in Hoima and Lira. Most of the land that farmers used for rice production was inherited as shown in table 5 below.

Table 6: Mode of Acquisition of land used for rice production in the 3 districts in percentage

Acquisition Mode	Kumi	Hoima	Lira
Inherited	93.3	66.7	96.4
Purchased	0.0	23.3	3.6
rented in	3.3	10.0	0.0
Borrowed	3.3	0.0	0.0

(Source Field Data)

In order to be able to grasp more understanding of the problem under study, the researchers established the land holding system and how this land was acquired. The findings presented in table 6 indicate that in all three districts, farmers inherited the land. The findings presented in table 6 revealed that 96.4%, of farmers in Lira representing the majority respondents inherited land compared to 93.3% of famers from Kumi and 66.7% of farmers from Hoima. However, whereas 23.3% and 3.6% of the farmers purchased land for rice growing in Hoima and Lira districts respectively, none of the farmers from Kumi district purchased land for rice production. It is instead revealed that, while 10% of the farmers from Hoima and 3.3% of the famers from Kumi rented land for rice growing no farmer from Lira rented land for rice production. It was only in Kumi where 3.3% of the farmers borrowed land for rice production.

The findings thus revealed that land holding among the rice farmers took four forms; namely, inheritance, purchasing, renting and borrowing. However, on a large scale, farmers inherited the land where rice production was on going. It was only in Kumi where farmers 3.3% borrowed land for rice production. Farmers can still borrow, rent and purchase land for rice growing in order to increase both profits and production

4.1.5. Rice land use systems

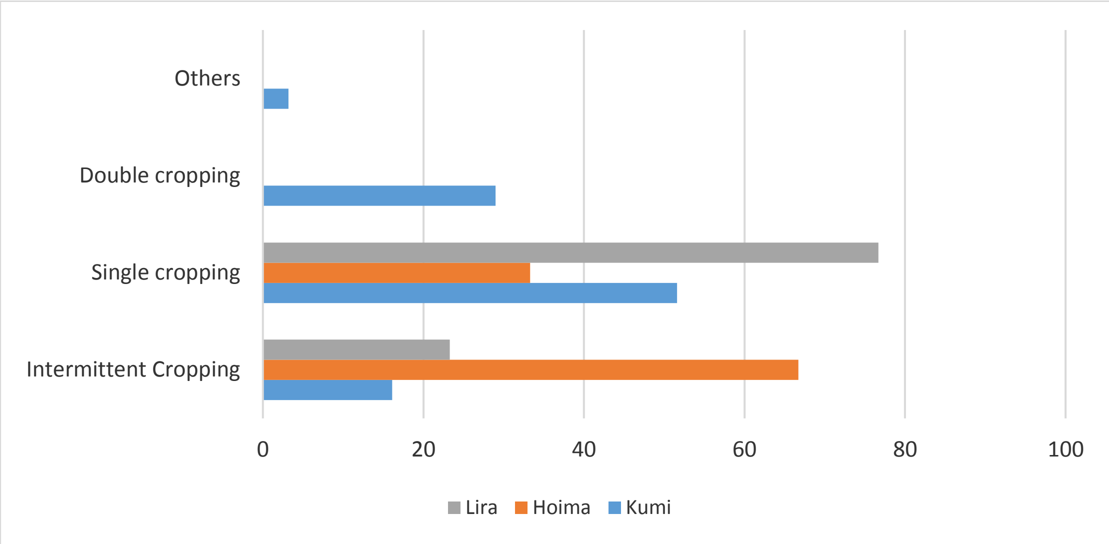

Figure3: Rice land use/cropping systems

As shown in figure 2 above, the most dominant land used system was single cropping. Single cropping was practiced mainly because there is enough water in either season one or season two but not much in both seasons within a year. Other farmers observed that rice grows only once a year while others pointed out the need for fallow period.

Intermittent cropping system was mainly practiced by farmers in Hoima, it is the growing of rice not continuously where some seasons are left out without growing rice. It was mainly practiced to avoid crop failure, maintain soil fertility, there was a lot of water in season one, for high yields, to grow other crops in first season and also allow for a fallow period to regain soil fertility. It was highly practiced by farmers in Hoima by64%, 22% in Lira and 17% in Kumi.

Double cropping was mainly practiced to get high yields, get income twice a year and also to plant in two seasons and it was only practiced in Kumi by 50% of the farmers..

Single cropping system was practiced by growing rice once in a year because of enough water in season one and also to allow for a fallow period and it was practiced mainly in Lira by 78% of the farmers, 50% in Kumi and 32% in Hoima.

Farmers need training on rice production using different varieties, using double cropping system especially in Hoima where farmers have a problem of controlling water flow they only grow rice in second season taught on irrigation how to control water using hand dug channels for outlet when not needed and inlet when needed in order to plant rice in first season as well so as to increase rice production among farmers.

Table 7: Reasons for the various land use/cropping systems in percentage

Reasons for the Systems	**Intermittent Cropping**	**Single cropping**	**Double cropping**
Avoid crop failure	12.5	0.0	0.0
Benefit from diversification	6.3	0.0	0.0
Crop rotation	6.3	0.0	0.0
Enough water in season one	21.9	69.3	0.0
Fallow period	15.6	8.1	0.0
First season is for other crops	3.1	0.0	0.0
Get high yields	9.4	0.0	33.3
Get income twice a year	0.0	0.0	33.3
Grows once a year	0.0	8.2	0.0
Land scarcity	0.0	2.0	0.0
Maintain soil fertility	18.8	0.0	0.0
Many birds in season 1	0.0	2.0	0.0
Needs less labour	0.0	2.0	0.0
No financial support	0.0	2.0	0.0
To plant two seasons	3.1	0.0	22.2
Uses long term and short term varieties	0.0	0.0	11.1
Weeding not possible for two seasons	0.0	2.0	0.0

4.1.6. Weed control

Weed control among rice farmers was mostly by use of hand hoe and hand pulling. This method dominated in the three districts with farmers in Kumi by 93.3% and 76.7% in Hoima and Lira respectively using a hand hoe and hand pulling. 29% of the farmers in Lira used herbicide to weed their beans and 3.3% used the flooding method. The majority of the farmers weeded their rice twice in a season, though some cases of up to four weeds existed.

4.1.7. Categories of varieties of rice grown by farmers

It was observed that farmers grew mostly local rice varieties as in figure 3 below, Lira had the highest 98%, Kumi 94% and Hoima 50%. The proportion of farmers that grew improved varieties of rice was highest in Hoima 41.3% where as in Lira was zero or none among the respondents.

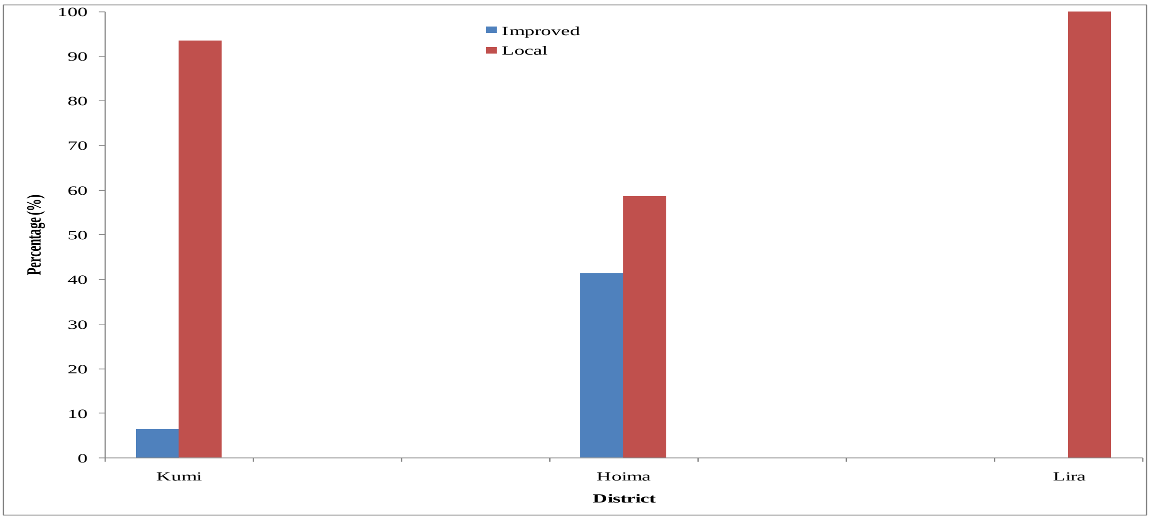

Figure 4: Proportion of farmers that grow improved varieties.

The rice varieties that were grown by farmers most were Kaiso, NERICA 4, Supa, Superica and white rice as shown in figure 5. Of these, the improved varieties were NERICA 4 and Superica. Hoima district had the greatest diversity of varieties.

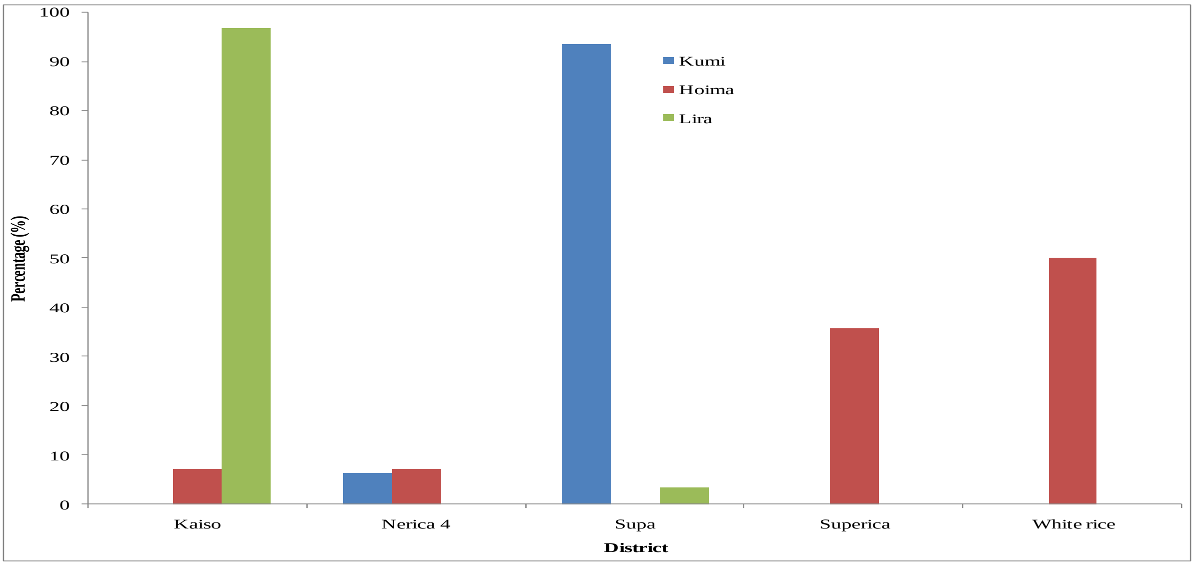

Figure5: Specific varieties of rice grown by farmers

The limited number of varieties grown shows a great level of concentration and specialization but also shows limited diversity within the rice ecologies. All varieties below were mainly grown for high yields and availability apart from NERICA. Other reasons for farmer preference of different varieties are shown in table 8.

Table 8: Reasons for varietal preference by farmers in percentage

Reason for growing	Kaiso	Nerica 4	Supa	Superica	White rice
High yield	96.8	50.0	48.3	44.4	27.3
Insect pest resistance	0.0	0.0	3.4	0.0	0.0
High market demand	0.0	0.0	34.5	0.0	27.3
Early maturity	0.0	25.0	3.4	0.0	0.0
Drought tolerance	0.0	0.0	6.9	22.2	0.0
Seed is available	3.2	0.0	3.4	22.2	45.5
0Early maturing and drought tolerant	0.0	25.0	0.0	0.0	0.0
Heavy	0.0	0.0	0.0	11.1	0.0

(MSc. Agro ecology, 2014)

In Lira 96.8% grew Kaiso rice variety because it was high yielding and readily available, NERICA was grown mainly in Hoima for early maturity by 25% and for its tolerance to drought by 25% of the farmers. Supa was grown mostly by 48.5% of farmers in Kumi because of its high yield, market demand 34.5%, drought resistance 6.9%, early maturity insect pest resistance and seed availability by 3.4% of the farmers. Farmers still need to improve on their local varieties through agronomic practices, uniform growth of rice a lot of rice at the same time where bird pressure and water can be controlled especially in first season. Timely planting most farmers grow at different times within a season.

4.1.8. Crop establishment

The highest percentage of farmers used broadcasting as a mode of crop establishment mainly in districts of Kumi 96.8% and Lira 86.7% as shown in table 9 below.

Drilling was the second highest method used by farmers as a mode of crop establishment with 79.3% and 10% in Hoima and Lira respectively. Other methods of rice establishment was dibbling where rice is planted at a given agronomic spacing using sticks for planting; it was used mainly by farmers in Hoima 10.3% and Lira 3.3%. Transplanting was used in Kumi and Hoima among the respondents and are shown in table 9 below.

Table 9: Crop establishment mode in percentage

Mode	Kumi	Hoima	Lira
Drilling	0.0	79.3	10.0
Dibbling	0.0	10.3	3.3
Broadcasting	96.8	6.9	86.7
Transplanting	3.2	3.4	0.0

(MSc. Agro ecology)

The recommended crop establishment mode dibbling which was practiced by a limited number of farmers in Hoima and Lira districts. Farmers need to be trained on dibbling mode of crop establishment for increased rice production. Drilling and transplanting mode of plant establishment are as well good for easy management during weeding, fertilizer application, thinning, harvesting etc. unlike broadcasting mode of crop establishment which is not recommended for high yields.

4 .1.9. Seasonal variations in rice production

The highest number of farmers 92.86% in Lira and 53.33% in Kumi, begin their first rainy season in March while in Hoima, the rice season begins in July. For the second season, most farmers in Lira (92.85%) planted in May and for Kumi 77.8% planted in December. This shows a great variation in planting time for the different districts. Planting of rice was highly correlated with the onset of rains in a region. Also, harvesting times for first season rice varied among all farmers, in Hoima farmers started harvesting their rice in December, those in Lira started in September and October and Kumi in June and partly in July. The onset of the second season in Kumi was observed to be in July and 71.43% of the farmers planted in that month. In Hoima, the second season was in the month of August with 65.52% of the farmers planting in that month. Unlike other crops, planting of rice started with the onset of rains, second season harvests start in October, December and November for Lira, Kumi and Hoima respectively.

4.1.10. Rice plant spacing used by farmers

There was no concise spacing that was used by farmers on rice. Most farmers simply broadcasted their rice in Kumi (96%.8) having the highest percentage of farmers who broadcast rice. Since row spacing matters more in rice production then inter plant spacing, farmers used inter row spacing of 30 to 6 cm yet recommended spacing between rows is 30cm x 12cm dibbling method and 30 cm x 1.5cm on drilling method.

4.1.11. Intercropping

From the survey, 27.8% of the respondents are reported practicing intercropping of rice with other crops. The main crops that were intercropped with rice included, maize, millet and cowpeas. Of the farmers who intercropped, Kumi district had the highest number of farmers 66.7% that intercropped rice with other crops. Hoima had 16.7% of the farmers who intercropped rice, while Lira had no farmers who practiced intercropping. Farmers practiced intercropping for a number of reasons. Farmers in Kumi intercropped with maize to get money as the rice matures. Others intercropped to get food while others did so to minimize bird damage. Other reasons given for intercropping included land scarcity, other crops provide shade to rice, less competition often occurs between rice and other crops and other crops especially legumes fix nitrogen to the soil. Also, intercropping was done at varied stages of rice growth. In Kumi intercropping rice was done at planting time of rice by 70% of the farmers, while in Hoima 13.33% of the farmers intercropped at planting rice and 3.33% intercropped when rice was in tiller stage. For farmers who intercropped rice with maize at tiller stage, did so to avoid maize blocking rice. Those who intercropped at planting time did so because maize matures fast so it could be sold to earn money as rice matures. Others (8%) of the farmers intercropped at planting rice with the reason of avoiding destroying rice when planting maize. Cow pea was planted at planting rice because cow pea matures faster and thus provides shade for rice for both crops to sprout concurrently.

Table 10: Reasons for intercropping rice with particular crops in percentage

Why intercrop with that Crop	Maize	Millet	Cowpeas
Harvest maize before rice	5.88	0	0
Reduce bird damage on rice	11.76	0	0
Compatible with rice	5.88	0	0
Early maturing	11.76	0	0
Fix nitrogen	0	0	12.5
Food and income	0	0	12.5
Food while waiting for rice	17.65	100	25
Get more yield	5.88	0	0
Income while waiting for rice	5.88	0	0
Land scarcity	0	0	12.5
Less competition	5.88	0	0
More production	5.88	0	0
Sell to get money for weeding rice	23.53	0	25
To provide shade for rice	0	0	12.5

(MSc. Agro ecology)

4.1.12. Reasons for preference of mono-cropping

Some of the reasons given by farmers for practicing mono-cropping as opposed to intercropping are shown in table 11. Most farmers never intercropped because rice is unique and therefore no other crop can be grown under conditions in which rice grows in swamps.

Table 11: Reasons for preference of mono-cropping in percentage

Why prefer growing rice in same field	Kumi	Hoima	Lira
Do not mono-crop.	19.4	93.3	10.0
Rice grows well in swamp than other crop	9.7	0.0	0.0
After harvesting stalks are ploughed in	0.0	3.3	0.0
Availability of water in the swamp	3.2	0.0	0.0
Higher quality	3.2	0.0	0.0
Lack of enough land	3.2	0.0	0.0
Lacks swamp	3.2	0.0	0.0
Marketable	6.5	0.0	0.0
No other crop can grow in swamp	45.2	3.3	90.0
Too much water in swamp	3.2	0.0	0.0
Uses organic fertilizer	3.2	0.0	0.0

(MSc. Agro ecology 2014)

4.1.13. Crop rotation

A majority of farmers in Kumi and Lira never practiced crop rotation in their rice fields. The largest proportion of farmers that practiced crop rotation were from Hoima (90%). In Hoima farmers (56.7%) begin with rice followed by cotton or beans. Kumi and Lira had 100% and Hoima 42.86% of the farmers with no fallow period between plantings. Hoima had 28% of the farmers that used cotton as the fallow crop and 14.29% of the farmers used maize and beans as fallow crops. In Hoima the second crop in the sequence is beans planted by 40% of the farmer's, the lowest number (4%) grew rice as the second crop. In Lira 3.33% of the farmers used either sweet potatoes or beans as the second crop in the sequence.

4.1.14. Fertilizer application

In table 12 below: The use of fertilizers was very low in the study sites. From the survey, 93.3% of the farmers were found not to be using fertilizers in Lira while 90% and 86.7% of the farmers in Kumi and Hoima never used fertilizers respectively. For those that used fertilizers, the main types that were used included; Urea, DAP, Organic manure and Super grow as shown in table 12.

Table 12: Type of fertilizer used by rice farmers in percentage

Fertilizer type	Kumi	Hoima	Lira
None	90	83.3	93.3
Urea	0	6.7	6.7
DAP	3.3	0	0
Organic manure	6.7	3.3	0
Super grow	0	6.7	0

(MSc. Agro ecology 2014)

Fertilizers were applied at different stages of rice growth. 6% of the farmers in Kumi applied fertilizers before planting and 3.33% Fertilizers were applied at different stages of rice growth. 6% of the farmers in Kumi applied fertilizers before planting and 3.33% of the farmers applied fertilizers at flowering. In Hoima 6.90% of the farmers applied fertilizers at milk stage of rice and 3.45% at heading. Kumi had no rate in the application of fertilizers. Hoima had 3.45% of the farmers applying in different (rates of 10kg, 20.5kg and 30kg/acre. Fertilizer rate is 20kg/acre there was under and over use of fertilizers, and no knowledge about fertilizer rates.

4.2. Factors that affect production

To establish factors that affect rice production, a simple linear regression analysis was run with the yield as the dependent variable against a number of explanatory variables that were thought to affect production. The results of the regression analysis are shown in table 13.

The regression model had an R-Squared value of 0.215 which if fair given the nature of that which involved mostly recall. The model however significantly explained the observed interaction between yield and predictor variables given that the f statistic was significant.

Table 13: Factors that affect rice production in percentage

Independent variable	Beta	T	Sig.
(Constant)		8.263	.000
Gender	-.049	-.371	.712
Education	.256	1.806	.076
Age of the farmer	.209	1.137	.260
Variety Type	-.414	-2.808	.007
Applied Fertilizers	.079	.638	.526
Belong to a Farmer Association	-.265	-2.174	.033
Farmer had farming training.	.064	.472	.638
Duration in Farming	-.131	-.687	.494
F-Statistic = 0.040,	R-Square = 21.5		

The findings above show that the most significant factor that affects rice production is the variety type at sig value 0.007 which concur with Reardon et al (1995) who observed that a variety type affects a farmers yields.

According to the results above, it does not matter which gender level of education, and the age of the farmer that affected the rice production other than the type of rice itself. However as it is seen from the analyzed data above, the level of education (Sig value.076) and belonging to farmer groups (sig .033) are some other factors that could be built on to improve rice production.

The overall F-statistic= 0.040 indicates that some factors affect rice production when fully combined.

Table 14: Regression ANOVA

Model	Sum of squares	Df	Mean square	F	Sig
Regression	10.022	8	1.253	2.188	0.040
Residual	36.641	64	0.573		
otal	46.663	72			

As shown in table 13 above from the regression analysis, there were only three variables that significantly affected rice yield: The level of education of the farmer, the type of rice variety grown and whether or not a farmer belonged to a farmer group.

The type of variety grown affected yield negatively; most farmers grew local varieties, and growing local varieties negatively and significantly affected the yields that farmers obtained their overall performance in rice production. There are a number of improved rice varieties which have been produced: that are high yielding, disease tolerant and early maturing. These are generally superior to the local varieties. Other studies have also observed that the type of rice variety grown affects farmer's yields for example (Reardon *etal*, 1995). Feder*et al*. (1985) observed that asset endowment has a strong impact on the adoption of new technologies; lack of cash and other assets reduces the ability to pay for new technologies. Improper labour markets and the heavier labour requirement in rice production compared to other food crops e.g. maize and beans therefore availability of family labour also affects the adoption of NERICA and other varieties. The study established that farmers who grew improved rice varieties obtained significantly higher yields than their counterparts.

The variable belonging to a farmer association also had a negative relation with the total yield of rice obtained. In this case, not belonging to any farmers association negatively and significantly affected the yields that farmers obtained. Belonging to farmers associations always has positive benefits to the farmers. It enables them exchange knowledge, attend trainings together, market together and obtain inputs and other support services. A majority of farmers (64.8%) in the survey however did not belong to any farmers associations. They therefore never benefited much from advantages of collective action and thus the native relationship. Rice crop is growing in importance and adoption in Uganda's communities, and On-farm yield is at 1.5 t ha for both wetland and upland rice production systems against their respective potentials of 4.5 and 5.5 tons ha which has resulted in a minimum yield gap of 3.0 tons ha (FAO STAT, 2005; FAO, 2004; NAADS, 2002; USAID 2003). The yield gap was attributed to rice production constraints due to lack of information on production constraints.

On the other hand, the level of education of the farmer had a positive relationship. Therefore, the more educated the farmer is, the better his/her rice yields will be. These results are expected since education improved the application of a number of good agronomic management practices that are required in rice production. Other studies were done on Assessing the Impact of Training on Lowland Rice Productivity in an African Setting: Evidence from Uganda Original Research Article. The study attention assessed the impacts of a training program on the adoption of improved cultivation practices, the productivity of rice farming, and the income and profit from rice production by using ex-post non-experimental data in Uganda. Participation in the training program increased the adoption of the improved cultivation practices. The profit from rice production was also found to have increased by the training program. These findings support the hypothesis that one of the major constraints on the growth in productivity of rice farming in sub-Saharan Africa is the absence of effective extension systems. (World Development, Volume 40, Issue 8, August 2012, Pages 1610-1618 Yoko Kijima Yukinori Ito Keijiro). These have shown that there is a positive relationship between farmer productivity, production or efficiency and education.

As shown in table 13 from the regression analysis, there were only three variables that significantly affected rice yield. (i) The level of education attended by the farmer, (ii) the type of rice variety grown and (ii) whether or not a farmer belonged to a farmer group. The type of variety grown by the farmers negatively affected yield. Given that most farmers grew local varieties, growing local varieties negatively and significantly affected the yields that farmers obtained and thus their overall performance in rice production.

The variable belonging to a farmer association also had a negative relation with the total yield of rice obtained. In this case, not belonging to any farmers association negatively and significantly affected the yields that farmers obtained. On the other hand, the level of education of the farmer had a positive relationship. Therefore, the more educated the farmer is, the better his/her rice yields will be.

4.3. Rice production constraints

The major production constraints that farmers faced included; financial constraints, pest damage, unavailability of seed among others as shown in Table 15 below. The constraints are diverse and varied by location.

Table 15 Percentages of Major production constraints

Constraint	Kumi	Hoima	Lira
Insects	13.3	13.8	46.7
Diseases	6.7	0.0	3.3
Limited land	16.7	6.9	6.7
Financial constraints	20.0	31.0	16.7
Unavailability of quality seed	6.7	10.3	10.0
Unavailability of chemical inputs	10.0	6.9	0.0
Shortage of water	6.7	0.0	13.3
Birds	0.0	27.6	0.0
Drought	16.7	0.0	0.0
Hailstorm	3.3	0.0	0.0
Animals	0.0	3.5	0.0
Weeds	0.0	0.0	3.3

The major constraints in Kumi were financial constraint by 20% of the farmers, Limited land and drought 16.7%, insect pests 13.3% and unavailability of inputs 10% of the farmers. Other constraints included diseases, limited land, drought and hailstone.

The major constraints in Hoima district were financial constraint by 31% of the farmers, birds 27.6%, insect pests 13.8%%, insect pests 13.3% and unavailability of inputs 10% of the farmers. Other constraints included limited land unavailability of inputs and animals

The major constraints in Lira among farmers were insect pests with 46.7%, financial constraint 16.7%, shortage of water 13.3%, un availability of quality seed 10% others included limited land, diseases and weeds.

Table 16:Weights of production constraints based on ranking by District

Production constraints	Kumi	Hoima	Lira	Total
Insects	57	72	106	235
Diseases	30	7	59	96
limited land	65	37	69	171
financial constraint	78	90	96	264
unavailability of quality seed	28	68	65	161
unavailability of chemicals inputs	30	38	22	90
shortage of water	10	8	20	38
Birds	0	40	0	40
Drought	31	0	2	33
Hailstorm	21	0	0	21
Animals	1	13	0	14
Weeds	4	0	5	9
Transport	2	0	0	2

The major constraints according to importance in the 3 districts were financial constraint, insect pests, limited land, unavailability of quality seed, diseases and unavailability of chemical inputs.

Table 17: Correlation matrix ANOVA of major rice production constraints in the 3 districts

			ANOVA			
		Sum of squares	**Df**	**Mean square**	**F**	**Sig**
Insects	Between Districts	4.807	3	1.602	11.664	0
	Within Districts	11.815	86	0.137		
	Total	16.622	89			
Diseases	Between Districts	0.088	3	0.029	0.901	0.444
	Within Districts	2.812	86	0.033		
	Total	2.9	89			
LimitedLand	Between Districts	0.324	3	0.108	1.196	0.316
	Within Districts	7.776	86	0.09		
	Total	8.1	89			
FinancialConstraints	Between Districts	0.333	3	0.111	0.628	0.599
	Within Districts	15.222	86	0.177		
	Total	15.556	89			
unavailabilityofQualitySeed	Between Districts	0.034	3	0.011	0.136	0.939
	Within Districts	7.255	86	0.084		
	Total	7.289	89			
unavailabilityofChemicalInputs	Between Districts	0.193	3	0.064	1.224	0.306
	Within Districts	4.529	86	0.053		
	Total	4.722	89			
Shortageofwater	Between Districts	0.186	3	0.062	1.178	0.323
	Within Districts	4.536	86	0.053		
	Total	4.722	89			
Birds	Between Districts	1.289	3	0.43	6.158	0.001
	Within Districts	6	86	0.07		
	Total	7.289	89			
Drought	Between Districts	0.684	3	0.228	4.854	0.004
	Within Districts	4.038	86	0.047		
	Total	4.722	89			
Hailstorm	Between Districts	0.025	3	0.008	0.375	0.771
	Within Districts	1.93	86	0.022		
	Total	1.956	89			
Animals	Between Districts	0.028	3	0.009	0.424	0.736
	Within Districts	1.927	86	0.022		
	Total	1.956	89			

The regression analysis of major rice production constraints in the 3 districts show that there are basically three constraints. These include insects with sig value=.002<0.05. This implies that insects have a significant negative effect on rice production. In addition, birds affect rice since the Sig value is =0.001<0.05 level of significance and as well drought which has a sig value =.0004<0.05. This agrees with Passioura, (2007) complexity of drought itself plant's behavior, responses to drought are complex and different, mechanisms are adopted by plants when they encounter drought. The rest of listed constraints above do not have a significant effect on the production of rice apart from insects and birds as well as drought. The major constraints affecting the 3 districts were birds and drought

4.3.1 Coping mechanisms for different constraints identified

Given the challenges in table 17, there are a number of coping strategies that farmers used as shown in table 18. These copping strategies were derived from a number of sources as shown in figure 6. Most farmers used their own experience in solving a number of constraints they faced. Also, all farmers depended on fellow farmers to get solutions to their problems, information from extension workers and input dealers was also key in offering farmers solutions.

Table 18. Coping mechanisms to different constraints

Coping Mechanism	Insects	Diseases	limited land	Financial	Quality seed unavailability	shortage of water	Birds	drought	Hail stone
Non	58.3	33.3	44.4	25	33.3	66.7	0	20	100
bio control	0	33.3	0	0	0	0	0	0	0
dig water channels	0	0	0	0	0	0	0	60	0
use family labour	0	33.3	11.1	31.3	0	16.7	0	0	0
Pesticides	25	0	0	0	0	0	0	0	0
renting land	8.3	0	11.1	0	0	0	0	0	0
Scaring	0	0	0	0	0	100	0	0	0
Local/own seed	0	0	0	0	0	0	0	0	0
Maximize available land	0	0	50	6.3	0	0	0	0	0
Sell other crops first	12.5	0	0	37.5	0	0	0	0	0
Use family labour	0	0	28.6	0	0	87			
Spraying	22.2	0	0	0	0	4.3			
Local/own seed	0	0	0	0	0	0	0	9.7	

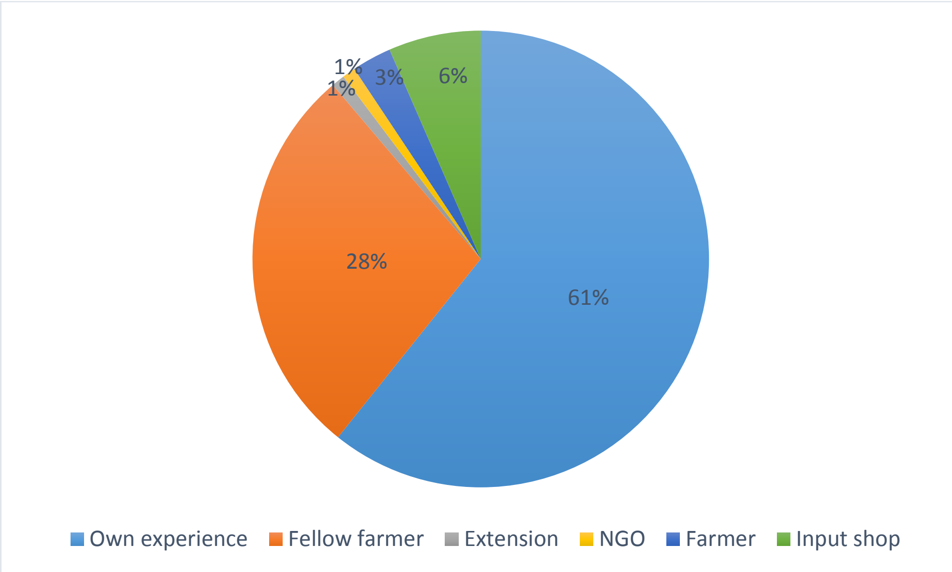

Figure 6: Percentage of major sources of information that farmers used to minimize constraints they faced

In the 3 districts of Kumi, Hoima and Lira 61% of the farmers used their own experience as a source of information to minimize the constraints they faced. 28% of the farmers depended on fellow farmers as a source of information to minimize the constraints they faced. 6% of the farmers used personnel from input shops, 3% used the fellow farmers, 1% used NGOs and 1% used extension workers to minimize the constraints they faced.

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Farmers need serious training to understand different constraints and their copping mechanism, how to control and where to get the right information for solving constraints in rice production.

4.3.2 Major biotic constraints

Given that biotic stresses were among the major challenges that farmers faced, the key stresses included rodents, birds, weeds, disease and insects The highest biotic constraint in Kumi 53,3%and Lira 73.3%was weeds while in Hoima was Birds with 53.3%. The second biotic constraint in Kumi 40%was disease as well as Hoima with 60%. While Lira was
51.6% insects. Other biotic constraints are shown in table 18 below.

Table 18. Percentages of major biotic constraints

Biotic Constraints	Kumi	Hoima	Lira
Rodents	38.7	40	32
Birds	37	63.3	22.2
Weeds	53.3	31	73.3
Diseases	40	60	48.3
Insects	33.3	40	51.6

The major abiotic constraints within the 3 districts according to importance were weeds, birds diseases, rodents and insects and others were monkeys according to weights in table19 bellow

Table 19: Weights of biotic constraints based on ranks

Biotic constraints	Kumi	Hoima	Lira	Total
Rodents	101	74	58	233
Weeds	108	74	134	316
Diseases	99	46	98	243
Insects	60	77	56	193
Birds	72	134	83	289
Monkeys	0	3	0	3

The highest number of farmers in all districts had a problem of weeds 316 farmers which was controlled by family labour which is not enough for rice maximum production. The second constraint was birds which is controlled manually through family labour by scaring birds. The third biotic constraint in rice production was diseases which 243 farmers generally had no control and rodents the fourth constraint 233 farmers as well had no control. The fifth biotic control was insects which could not be controlled. Monkeys which was the fifth biotic constraint was not a serious constraint in all the 3 districts of Kumi, Lira and Hoima.

Table 20: percentages diseases in the 3 districts

Diseases	Kumi	Hoima	Lira
Bacterial Leaf Blight (BLB)	10	0	0
Leaf Blight (LB)	26.7	0	0
Bacterial leaf streak (BS)	3.3	0	0
Neck blast (NBS)	3.3	0	0
Panicle Blast (PB)	36.7	90	96.7
Rice yellow mottle virus (RYMV)	20	10	3.3
Total	100	100	100

Table 21: Weights of the diseases based on ranks

Disease	Kumi	Hoima	Lira	Total
BLB	25	0	3	28
LB	59	0	2	61
BS	11	0	37	48
NBS	7	0	4	11
PB	73	90	145	308
RYMV	64	26	121	211
BLS	1	0	0	1

The main diseases that were identified and affected the 3 districts were Panicle Blast and Rice yellow mottle disease as shown in table 18 and 19. In terms of disease diversity, Kumi district had the greatest diversity of rice diseases others included leaf blight, bacterial leaf blight, neck blast and bacterial leaf streak.

4.3.3 Coping mechanisms against the different diseases

As shown in table 19, most farmers had no copping strategies for the main diseases they faced. There was however a good number of strategies that farmers used to cope with a number of constraints.

Table 22: Coping mechanisms against the different diseases

Coping Mechanism	BLB	LB	BS	NBS	PB	RYMV
Non	50	25	100	100	79.6	88.9
Early sowing	0	37.5	0	0	11.1	0
Adjusting fertilizer	0	12.5	0	0	0	0
Use resistant varieties	50	0	0	0	0	11.1
Spraying especially using rocket	0	12.5	0	0	9.3	0
Intermittent cropping	0	12.5	0	0	0	0

Generally most farmers had no coping mechanisms against diseases. On leaf blight 37.5% and panicle blast 11.1% of the farmers controlled through early sowing, 12.5% controlled leaf blight by adjusting fertilizer, 50% of the farmers controlled bacterial leaf blight by use of resistant varieties, spraying especially using rocket. 12.5% of the farmers controlled Leaf blight and 9.3% controlled panicle blast through spraying with rocket. Others 12.5% controlled leaf blight through intermittent cropping system.

4.4 DISCUSSION

This study on the on factors that affect Rice production in Agro ecological ecosystems in Uganda taking Kumi, Lira and Hoima districts was undertaken to achieve three objectives. These were to; characterize the rice agro-ecosystems, determine factors that affect the yield of rice and to identify rice production constraints among rice producing households of in Kumi, Hoima and Lira districts. This study found out that, that Kumi district had the highest number of farmers with primary level education amounting to 72.4% compared to Lira with 44.8% and Hoima at 33.3%. The findings further indicate majority farmers from Lira (55.2%) had attained secondary education when compared with Hoima (53.3%) and Kumi with 17.2%. Whereas there were no farmers with university education.

Rice growers in Lira had spent more years producing rice (27.7%) compared to farmers in Kumi (21.8%) and 15.5% of the rice producers from Hoima. It is evident that all the rice farmers reasonable experience in rice production. Apart from Hoima farmers spent less years in rice production, farmers from Kumi had spent more years in rice production up to 15.9% compared to farmers in Lira at 11.5%. Majority of the rice producers were literate, and had experience in rice production.

In all the three districts, the major income source was crop farming. It is clearly indicated that 96.7% of farmers in Lira, 96.5% farmers from Hoima 83% of farmers from Kumi derived their income from crop farming.

The findings indicated each of the 3 districts had a main cash crop grown. It is indicated that whereas 65.5% of the farmers showed that cassava was a main ach crop in Kumi, 51.7% of the farmers from Lira and 33.3% farmers from Hoima showed that rice was the main cash crop.

That 96.4%, of farmers in Lira representing the majority respondents inherited land compared to 93.3% of famers from Kumi and 66.7% of farmers from Hoima. 23.3% and 3.6% of the farmers purchased land for rice growing in Hoima and Lira districts respectively, none of the farmers from Kumi district purchased land for rice production. It is instead revealed that, while 10% of the farmers from Hoima and as well 3.3% of famers from Kumi rented land for rice growing no farmer from Lira rented land for rice production. It was only in Kumi where 3.3% of the farmers borrowed land for rice production.

That 58% of the farmers in Hoima grew local varieties compared to 42% of the famers that grew improved varieties of rice. It is also seen that only 6% of the farmers in Kumi grew improved rice variety. The findings presented above show that 94% of farmers in Kumi grew Supa rice, compared to only 6% of them who grow NERICA 4 variety. Also, it was established that, 98% of the farmers in Lira grew Kaiso when they are compared with only 2% of them that grow supa rice. Also in Hoima, 50% of the farmers grew white rice while 35% grew Seperica. It is further shown that 9% of the farmers in Hoima grow NERICA 4 and as well 9% of them grew Kaiso.

The study established that the most significant factor that affects rice production is the variety type at sig value 0.007 which concur with Reardon et al (1995) who observed that a variety type affects a farmers yields.

The regression analysis of major rice production constraints in the 3 districts show that there are basically three constraints. These include insects with sig value=.002<0.05. This implies that insects have a significant negative effect on rice production. In addition, birds affect rice since the Sig value is =0.001<0.05 level of significance and as well drought which has a sig value =.0004<0.05. The rest of listed constraints above do not have a significant effect on the production of rice apart from insects, birds and drought.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.0 Introduction:

Based on the research findings presented, interpreted and discussed in line with the reviewed literature and in accordance with the study research objectives summary, conclusions and recommendations were made.

5.1 Summary

The following are made: The variety of rice grown determines the yield of rice and identity. Rice production across Kumi, Lira and Hoima had 3 constraints insects as were attested by a sig value=.002<0.05, birds; Sig value =0.001<0.05 level of significance as well as drought which has a sig value =.0004<0.05. The presence of insects, birds and drought significantly affected rice production. A Half of the population of the two districts Kumi and Hoima were not educated except Lira had all farmers educated. It does not matter which gender level of education, and the age of the farmer that affected the rice production other than the type of rice itself. However as it is seen from the analyzed data above, the level of education (Sig value.076) and belonging to farmer groups (sig .033) are some other factors that could be built on to improve rice production. At advanced level of education, Kumi and Hoima had the highest number and Lira had none. The majority of the farmers were illiterate. This implies that any technology should be packaged so as to fit all members of a given education level. This can be a basis for farmer-to-farmer technology dissemination for a class of farmers with a given education level.

Hoima had the highest number of youth involved in farming implying that in this area of the country, labor is not a production constraint as compared to other districts. Lira had the highest number of experienced farmers as compared to Hoima and Lira implying that agricultural technologies that have proven successful for a long time could be adopted by farmers with little experience in farming. Since crops such as cassava, rice, g. nuts, maize, millet, sweet potatoes, beans and cotton were widely grown in the three districts, farmers could be trained on proper crop rotation so as reverse and avoid soil degradation. This is supported by the fact most farmers were small scale holder farmers owning 0.5-10 acres of land.

About 80 percent of rice farmers in Uganda are small scale farmers with acreage of less than two hectares using simple technologies including use of rudimentary tools, little or no fertilizer use, poor quality seed, with little or no irrigation and poor water management practices among others (MAAIF, 2007). About 5 percent rice farmers are large scale with land under cultivation over six ha. Among the large scale farmers are rice schemes with acreage of over 1 000 ha (Gitau, et al, 2011).

Given that for most farmers land was inherited from parents, land wrangles are minimal especially in Lira and hence this presents opportunities for increased rice production as compared to other areas like Hoima.

Rice is mainly grown almost throughout the country but mainly in the Eastern and Western Uganda due to availability of lowlands with high moisture contents throughout the growing season. Major Rice growing districts include Apac, Pallisa, Lira, Tororo, Kamwenga, Bugiri, Jinga and Iganga. Other producing districts include Amuru, GuluKitgum, and Pader in Eastern and Northern Uganda, and Hoima, Kibaale, Masindi, Kabarole, Runkungiri, and Kanugu in Western Uganda. (NAADS 2006)

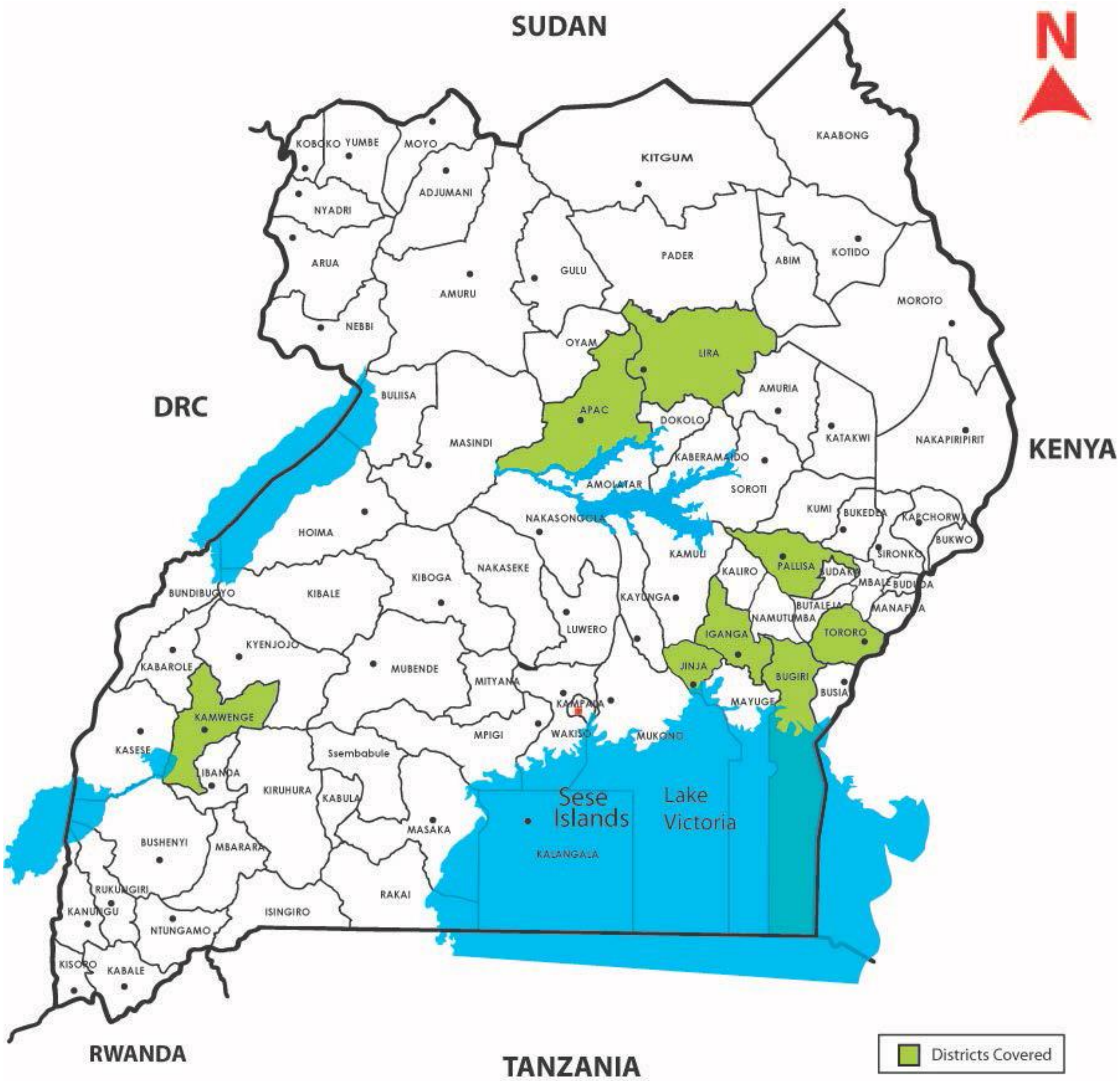

Figure 7: Major Rice Producing areas in Uganda

In 2003, the Government of Uganda introduced NERICA, a high yielding upland variety, as one of the strategies to eradicate poverty and increase food security. NERICA yields as high as 2.5 tons per ha.

Most farmers planted rice for only one season because rainfall intensity is not the same in all seasons and depending on the rice variety, most long-duration varieties can only be planted for a single season in a year. This is also advantageous in that it allows fallowing to be practiced. However, given the fact that weed control by hand hoe and hand pulling is the major weed control method, cultivating on a fallowed land may be tedious and hence the need for tractors and other motorized machinery to facilitate cultivation on such land.

5.2 Conclusion

The level of education of household heads, contact with extension and training and ease of access to rice seed and membership to farmer groups are the factors that positively influenced rice production. Adoption of such improved varieties can only be beneficial if farmers are taught proper crop establishment methods such as row planting. This can be valuable to especially farmers in Lira and Kumi who mostly used broadcasting as a mode of crop establishment. However, under intercropping, broadcasting may be of little value and hence the farmers need to be advised to practice row planting to benefit both rice and the other intercrop. This was witnessed in all the three districts where a recommended seed rate of 75 kg/ha was not used. The seed rate used in Hoima was too much above the standard while the one used in Lira and Kumi was too low. The major constraints according to importance in the 3 districts were financial constraint, insect pests, limited land, unavailability of quality seed, diseases and unavailability of chemical inputs.

The constraints that had a significant effect on the production of rice were insects, birds and drought in the 3 districts. Farmers need to be sensitized and trained on different rice constraints affecting rice production and coping mechanisms to address available constraints in rice production

5.3 Recommendations

As a result, the men are starting to pitch in, even if their participation is hardly the same like for the women. For example, with weeding, the men mostly help out in the second of the three rounds, when they can use a hoe. The more exhausting first and third rounds, when the weeds have to be uprooted by hand, are still carried out mainly by women and children. If the household hires outside labor to help, as is typically the case for the man's job of preparing the land for planting, it will be for the second weeding, and it will be channeled to plots managed by the man or the household, not those managed by women The increased focus on gender research across the CGIAR Research Programs offers an opportunity to take on the challenge of ensuring that women, and children, reap equitable benefits from upland rice production with sustainable, time-saving methods compatible with their resources and changing roles. By more fully understanding how rice production affects gender dynamics within the household and addressing the policy and technology challenges raised in this research work, CGIAR researchers and partners can help shift the success of boosted rice production in Uganda from one measured solely by growths in household income and production to one that also transforms women's lives. (Bergman Lodin, J. Nov 2012.).

Provision of motorized weeding machines could help farmers reduce the labor used for weeding and devote it to other activities where agricultural machinery cannot operate easily. Lack of improved varieties of rice could worsen the effect of weeds on rice because most farmers grew local varieties such as Kaiso, and Supa especially in Lira and Kumi yet these varieties yield below their potential. Improved varieties such as NERICA 4 yielded highly and could be adopted by farmers to replace low yielding varieties.

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Intercropping as a measure to guard against food insecurity may result into spread of pests and diseases amongst the intercrops. This was evidenced in Hoima and Kumi where farmers intercropped rice with maize yet these two crops share most pests such as stem borers. Leguminous intercrops are preferred because few/no pests are shared between legumes and cereals. Most of these intercrops were introduced at the time of planting and hence tend to compete with rice right from the seedling stage to maturity. Hence, farmers need to be advised to introduce intercrops at tilering stage.

Interventions such as crop rotation help restore soil fertility, however in areas like Kumi and Lira, crop rotation was not practiced. Even in Hoima, where it was practiced, crops like cotton have little effect on restoring soil fertility and hence leguminous crops need to be emphasized in order to have long-term effects on soil fertility regeneration. Rice varieties that grow under upland conditions need to be intensified in these districts in order to enable more crop combinations other than concentrating on rice cultivation only in the low lands.

Intensification of rice production needs to be done with other incentives to production such as fertilizers. It was observed that farmers in Lira district did not apply fertilizers at all while in Hoima and Kumi, low fertilizer rates were used. This calls for training of farmers on fertilizer application especially in farmer field schools. Farmer field schools could also be a better opportunity for farmers to be trained on how to overcome constraints such as drought, birds, financial assistance and insects. Abiotic constraints such as water shortage and financial assistance could be solved through early planting since this will eliminate most of the financial needs especially those relate to labor. This is because under early planting rice escapes effects of most biotic and abiotic constraints such as drought and pest attacks.

Diseases affect rice by inhibiting the plants from reaching their yield potential. Given that most farmers had no control over most rice diseases, yields are below their potential and hence farmers devoted most rice for home consumption and little for marketing. This could be an entry point for all stakeholders involved in rice as a crop to deliver tested-technologies against rice diseases particularly resistant varieties. Such varieties are economical to use since the cost is incurred only once chemicals that need to be purchased over and over again. Since farmers are able to describe the diseases, input dealers can get a clear picture of the disease and hence deliver the variety that is resistant to such disease.

Resistant varieties translate into higher yields and hence more profits given that rice is the major income source in all the three districts. However, profits may not be realized if farmers are not organized in marketing their own products. This was observed in all the districts whereby rice was sold when there arose a need and this was mostly to fellow farmers. This calls for farmers need to be organized in groups and sell to big organizations and thereby increasing their bargaining power for higher prices. This will ensure that quality attributes such as clean, white, stone-free and unbroken rice are adhered to in addition to enhancing record keeping amongst farmer groups. Marketing incentives such as weighing scales will also be easy to be obtained by farmers given that most weighing scales were owned by the buyer and hence rendering the farmers susceptible to cheating. Related to marketing, challenges such as low prices and poor roads could be solved by provision of proper storage facilities so that farmers can sell at a later time when prices are high while for poor roads, urgent repairs are needed to avoid transferring the expenses to the buyers and thus elevating prices.

Farmers in Ugandan need to get newly recommended varieties which have been released. Farmers have been growing Kibimba rice varieties popularly known as K-Series or paddy rice and Supa, whose production has declined by half to between two and three tons per hectare. Nerica 6, Komboka, WITA9, Agoro and Okile rice varieties are tolerant to the yellow mottle virus disease that causes premature yellowing of leaves. Nerica 6 is highly tolerant to yellow mottle virus; it came in as an upland variety but it also does well in lowland areas. Komboka an aromatic rice ranked best during rice testing for preference, was first released in Tanzania in 2011 and in Kenya a year later. WITA9 performs well in most areas, including upland, and Agoro is high-yielding, early maturing and strongly aromatic. Okile rice variety is high yielding and has good grain characteristics. The new varieties have a short maturity period of between 105 and 110 days, compared with the earlier varieties that take between 130 and 150 days (New rice varieties introduced in Uganda By ISAAC KHISA, The East African Saturday, June 7, 2014 at 12:50) From 2002 to 2013, Uganda's National Agricultural Research Organization released nine rice varieties all upland varieties.

The major constraints to rice production were mainly linked to lack of adequate sensitization of farmers on proper methods of farming. The starter material (seed) is the most important factor for crop production; however farmers still relied on local seed, whose quality is questionable. Even if quality seed is provided, but farmers are not sensitized on proper farming methods, yield improvements from improved seed will still be very low. Hence, there is need to strengthen extension services to ensure that improved technologies generated through research achieve their yield benefits.

Most farmers are illiterate and with low education level effective training is urgently needed on types of improved seed, how to manage seed post-harvest handling, use of fertilizers to increase production and management of crops at different stages of growth.

Farmer field schools need to be established in order to teach farmer's proper agricultural practices particularly crop agronomy. Farmers learn better when they share experiences in groups and learn new practices in technology easily when introduced.

Farmer-to-farmer extension methods need to be strengthened in order to transmit area specific technologies to fellow farmers. Improvement on the ratio of extension to farmers: for easy learning and attention by extension workers at least 1:5.

Rice production in Uganda is projected to increase; following the introduction of five new lowland varieties as well the upland varieties released earlier. Farmers in Uganda are to get access to high yielding varieties; from seed companies to increase rice production new varieties have a short maturity period of between 105 and 110 days, compared with the earlier varieties that take between 130 and 150 days. Emphasis should be put on the cultivation of upland rice varieties the high yielding, most farmers live in rain fed ecosystem: farmers with no swamps so that rice production can be increased using right agronomic practices especially rice recommended spacing.

Exchange visits where farmers learn agronomic practices at fellow farmers, research demonstrations to improve production technology rather than by keeping prices high, prices may only encourage extensive production at the expense of consumers.
Rice farmers' manuals for rice production: to be provided from Research, District Agricultural office and from extension workers so as to improve in knowledge, understanding and technology.

Sensitizing and training farmers on recommended technologies, marketing and provision of subsidies to farmers: Agricultural inputs at a reduced price by government; for example hoes, pangas, seed/planting materials, fertilizers etc. for better production of rice.

The timing of rice planting in every season is different according to month in the 3 districts of Kumi, Hoima and Lira. There would be increased production if farmers agree on timing at the same time. In Kumi most farmers plant in December, Hoima in July and Lira in March. There is need for training and to hold demonstrations of rice fields planted in every district at right timing for farmers to understand right timing of rice growth in every district.

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