TECHNICAL EFFICIENCY OF UPLAND RICE PRODUCERS IN SOUTH WESTERN UGANDA

BY

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DECLARATION

I declare that the work presented in this thesis is my original work and has not been published or submitted to any other university or institution for any award.

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Asiimwe K. Jude Date

This thesis has been submitted for examination with our approval as university supervisors.

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Dr. Theodora Hyuha Date

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Dr. Bua Anton Date

DEDICATION

To

Aijukwe Kyomugisha Juan.

May this work inspire you to aim higher.

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ABBREVIATIONS AND ACRONYMS

AAMP	Area based Agriculture modernization programme
ADC	Agribusiness Development Center
MAAIF	Ministry of Agriculture, Animal Industry and Fisheries
MFPED	Ministry of Finance Planning and Economic Development
NAADS	National Agriculture Advisory Services
NARO	National Agricultural Research Organisation
NERICA	New Rice for Africa
MT	Metric Tonne
PEAP	Poverty Eradication Action Plan
PMA	Plan for Modernisation of Agriculture
UBOS	Uganda Bureau of Standards
WARDA	West Africa Rice Development Association

ABSTRACT

Uganda's rice demand has been on an increase due to increasing population, urbanization and changing consumer preferences. The resulting effect has been increased importation of rice into the country consequently straining foreign exchange accounts. Insufficiency in the rice supply is related to the low national average yield of 1.5t/ha. New upland rice varieties that are high yielding have been introduced in the country to improve national supply, save wetlands, fight food insecurity and improve incomes of the rural poor. This study was conducted in South Western Uganda in the districts of Bushenyi and Rukungiri. It examined whether farmers were technically efficient in input use to generate the required output levels and the farm specific factors that were affecting their technical efficiency. A total of 196 respondents were randomly selected from four rice producing sub counties using a sampling frame generated by the sub county leaders. A Cobb Douglas production function was fitted to the data to generate results. Analysis was accomplished using frontier 4.1 programme. Results revealed that production of upland rice involved excessive use of labour (1136 person days/ ha) and seeds (154kg/ha) compared to the recommended rates. It was also found that technical efficiency of upland producers were below the frontier level averaging at 61% and the existing output was being achieved through land expansion. Attainment of primary five education significantly (P=0.076) improved efficiency of farmers. For farm level technical efficiency of upland rice to improve, yield improving and labour saving technologies need to be introduced notably soil enriching aspects like fertilizers. For labour saving technologies, use pre or post emergency herbicides and mechanization of the upland rice would be a better move in the right direction. Lastly promoting primary education and specialised extension services that target upland rice will improve efficiency greatly.

CHAPTER ONE

INTRODUCTION

1.1 Background

Rice is one of the principle cereals used by the world's inhabitants. It is an ancient crop consumed as a staple food by more than half of the world's population. It is estimated that rice is utilised by over 4.8 billion people in 176 countries and is the most important food crop for over 2.89 billion people in Asia, 40 million in Africa and over 150.3 million in Latin America (Biyi, 2005). During the past decade, interest in research and production has increased in many countries. The development of new and better varieties is intended to keep up with the pressure of increasing food demand. In Africa, the development of high yielding varieties is intended to address food insecurity and increasing urbanization issues.

Among the successes of rice development in Africa has been the release of the New Rice for Africa (NERICA). It is an upland rice variety with high yielding characteristics of Asian species as well as resistant to water stress, pests and diseases of African environment (Kijima, *et al*., 2006). Its yield has been estimated between 2.5 tons per hectare for low fertile soils and 5 tons for high fertile soils (WARDA, 2001), which is a promising innovation.

1.2 Rice Production in Uganda

Rice is not an indigenous crop in Uganda but is believed to have been domesticated around 1900 from East Asia (Hyuha et al., 2005). However, by mid 1950 and early 1960's, acreage designated to rice was still insignificant in the country (ADC, 2001). In the 1970's, considering the growing importance of rice, government initiated a large commercial farm at Kibimba and the smallholder farmer managed schemes at Doho and Olweny. These schemes, however, concentrated on production of mainly lowland paddy rice. This variety of rice by its nature grows in wetland and other submerged areas. This, therefore, was not sustainable in the long run and has overtime failed to meet national rice demands (UBOS, 2005).

In an attempt to save wetlands as well as meet the overriding goals of fighting poverty and improve food security, government and other rural development agencies involved in poverty eradication have actively promoted the New Rice for Africa (NERICA) series which are upland varieties.

In Uganda, NERICA was released in 2002 by National Agricultural Research Organisation (NARO), and many agencies popularised it through demonstration, trainings and provision of seed credit (credit support). Among the agencies were the Vice President Initiative (VPI), National Agricultural Advisory Services (NAADS), and Area based Agriculture Modernisation Program (AAMP) which have widely promoted it throughout the country as an in- kind seed credit (seed credit support) even where rice production had never existed. In this promotion strategy, seed is given to farmers who are then expected to pay back the seed and any other inputs after harvesting (Kijima *et al.*, 2006).

The variety being promoted is in the range of NERICA 1 – 18. These series of upland rice do better than the existing varieties both in poor and relatively high fertile soils (WARDA, 2001). Due to the mentioned attributes, it has been described as a promising technology to address food shortage in the Sub – Saharan Africa (Kijima *et al*., 2006).

The above scenario presents increasing importance of rice crop in the country. In 2003, the total national supply stood at 141,925 Mt while domestic production only contributed 93,000Mt (UBOS, 2005a, WARDA, 2005). This therefore implies that the country meets its rice demand from imports especially from Asia (Hyuha, 2006). Table 1.1 shows production and import figures for rice in Uganda and the rest of East Africa.

Table 1.1: Rice Production and Import Volumes of E. Africa and Uganda

Year	**1961-70**	**1971- 80**	**1981-1990**	**1991-2000**	**2003**
East Africa					
Yearly average production (MT)	10,558,818	1,390,590	1,542,777	1,716,739	1,705,500
Annual average import (MT)	67,378	172,116	356,840	293,765	737,616
Uganda					
Yearly average production (MT)	41,981	17,831	19,800	57,600	93,000
Annual average import (MT)	6,360	4,885	5,160	10,881	48,925

Source: WARDA, 2005

Table1.1 indicates an increasing supply deficit both in the country and the East Africa region. This implies that consumption in this region is out pacing production which calls for attention either through improved production techniques and strive to attain self sufficiency or meet the deficits through importation. The second option, however, is not viable in the long run considering the fact that foreign exchange is limited in most developing countries that depend on importing other essential commodities like drugs and capital goods.

The high consumption levels in the country and the rest of Africa has been attributed to changing life style and consumer preferences as well as increasing population and urbanization (Nwanze *et al*., 2006; Norman and Otoo, 2002).

To address issues of increasing rice demand, government of Uganda has stepped up efforts to increase production in the country by extensively promoting upland rice. There are signs of payoff for the efforts of government and other private engagement. In three years of introduction, area planted to upland rice is estimated to be over 10,000 ha (Nwanze *et al*., 2006) and total rice area and output in the country increased by 10% and 26% in 2005, respectively (UBOS, 2006).

Though there has been an unprecedented increase in cultivated area and output, yield has not significantly changed at national level. Figures 1.1 and 1.2 shows the variation in output, yield and area for rice in Uganda since 1990. It should be noted that the results represent both lowland and upland rice since there is no disaggregated data for individual variety.

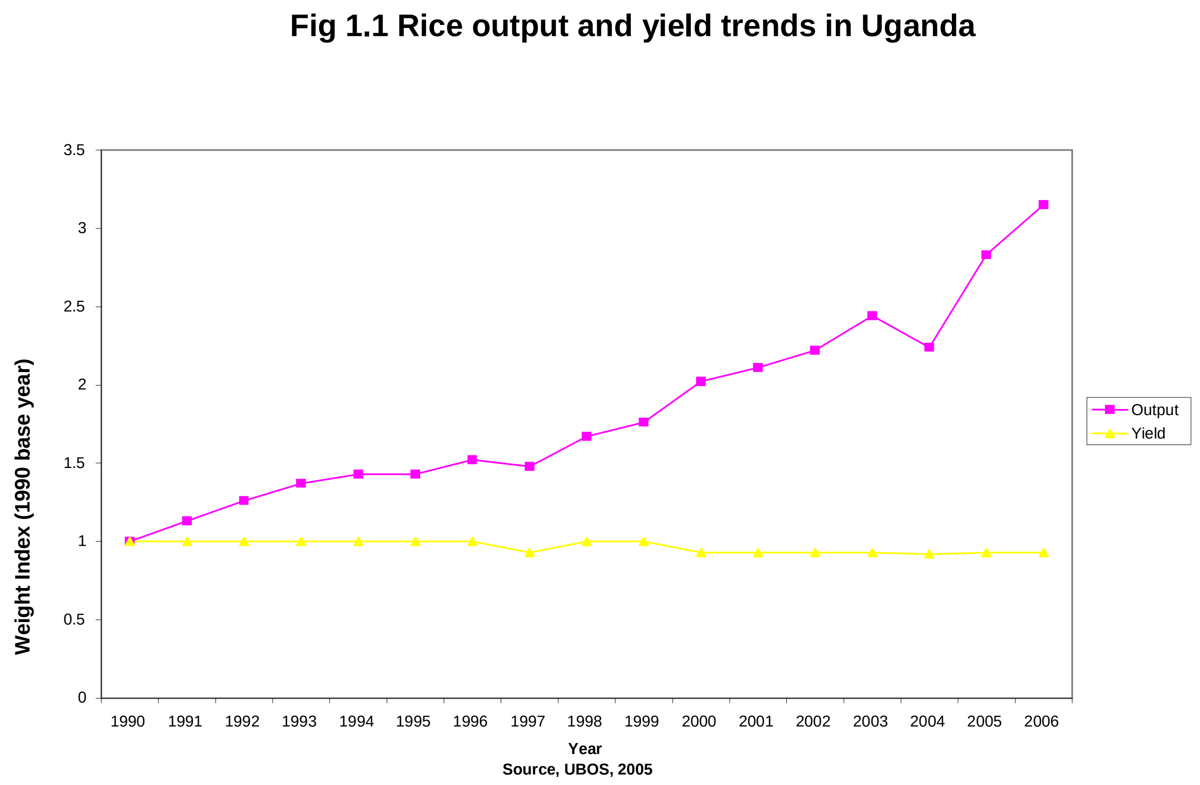

Fig 1.1: Rice Output and Yields Trends in Uganda

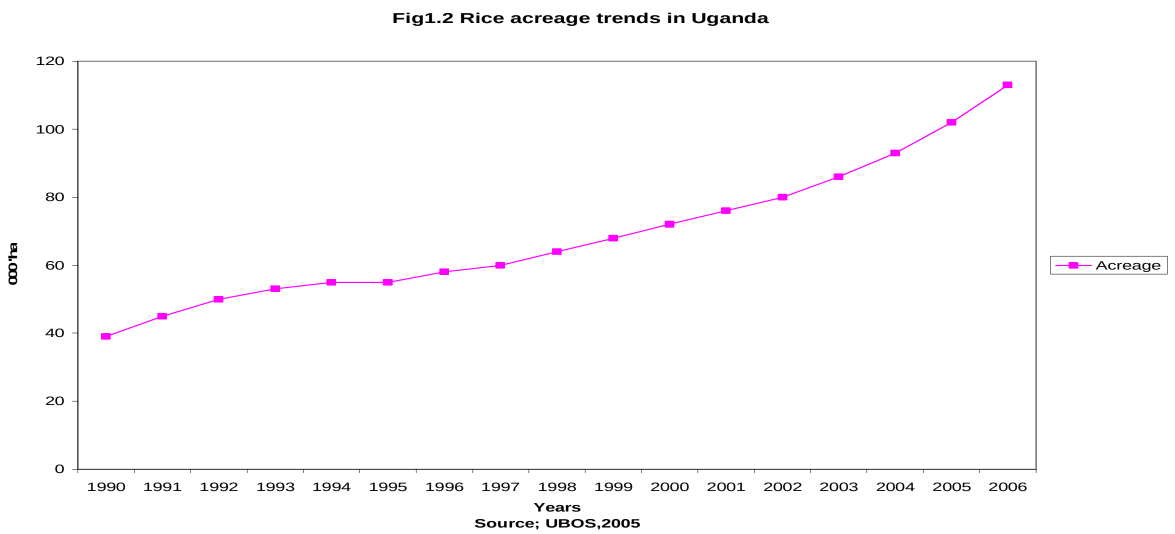

Fig 1.2: Rice Acreage Trends in Uganda

Rice output and hectarage has been increasing over time while yield has remained constant as observed in figure 1.1 and 1.2. This therefore raises an important question whether the increased promotion of upland rice will be sustainable in the long run since increased output is probably achieved through land expansion.

To understand the above question, farm level resource use need to be understood as well as factors hindering realization of desired output levels in rice production. This study therefore seeks to identify factors that are influencing technical efficiencies of upland rice in South Western Uganda.

1.3 Problem Statement

Uganda, like most other African countries is a net importer of rice, for instance, a total of 48,925 mt were imported in 2003 representing a value of US$ 13m (WARDA, 2005). The increasing demand is largely related to increasing population and urbanization (Kijima *et al*., 2006).

Rice production in the country has always been carried out in fragile ecosystems of swamps and marshy areas of Eastern and Northern parts of Uganda (ADC, 2001). Production in these areas was never adequate to cover the increasing gap of rice demand in the country. To reduce the deficit, government supported NERICA production across the country even where it had never existed. This promotion is mainly done through demonstrations, trainings and provision of seed credit support to some farmers. This is expected to act as an incentive for adopting and improving on national rice supply. The overriding objective for this is to address challenges of food insecurity, poverty and unsustainable paddy production (Kijima *et al*., 2006).

Despite the widespread promotion, national rice yield has not changed significantly in the last 10 years and has stagnated at about 1.5t/ha (UBOS, 2005a). Even at farm level, farmers have not managed to produce more than half of the research station reported yield of 5t/ha. The current upland rice yields at farm level are estimated at 2.46t/ha compared to the potential of 5t/ha (Kijima *et al*, 2006). The ever increasing national output can therefore be attributed to land expansion (Hyuha, 2006). This is not sustainable in the long run and might not improve rice sufficiency levels of the country.

To understand how the status quo can be improved, studies that determine farmers related constraints in production need to be identified. However, few studies have been conducted in the rice sector and specifically to determine technical efficiency of upland rice farmers in Uganda. Two studies have looked at economic evaluation of rice (Kijima *et al*., 2006 and Ssenteza, 1993) and most recently, Hyuha (2006), intensively studied efficiency of rice farmers in the East and Northern parts of the country. This latter study looked at lowland paddy rice and recommended further analysis in efficiency of upland rice. This study investigated technical efficiency of upland rice producers in South Western Uganda.

1.4 Objective of the Study

The overall objective is to examine the technical efficiency of upland rice farmers in South Western Uganda.

1.4.1 Specific Objectives

- To characterise input use levels of upland rice farmers in South Western Uganda
- To determine the technical efficiency of upland rice farmers.
- To determine the farm specific factors influencing technical efficiency levels of upland rice farmers.

1.5 Hypothesis

- Upland rice farmers are not producing along the production frontier.
- Farm and farmer characteristics do not influence efficiency levels of upland rice farmers.

1.6 Significance of the Study

Rice production in Uganda is mainly for cash generation (WARDA, 2005); therefore increasing production should improve incomes as well as food security of the rural poor. There exist deficit in rice demands in the country and the East African region which should provide an incentive to increased efficient production of rice in the country.

Production levels are not yet as desired despite the involvement of lead agencies in promoting and popularizing the NERICA variety. Farmers have responded to rice demand by opening up more land. Land allocated to rice has increased from 39,000 ha in 1990 to 93,000 ha in 2004, however with minimum improvement in yields (UBOS, 2005a).

The current national yield stand at1.5t/ha which is far below the potential of 5t/ha (Kijima *et al*., 2006). This implies that if resources are fully employed and farm factors addressed, yield can be substantially improved to address the short supply. This can be achieved by understanding farmer factors that constrain production and hence technical efficiency.

The study therefore intends to characterise input use, determine technical efficiency and establish factors that are affecting upland rice farmers in South Western Uganda. Increasing output will help the country reduce importation and increase on national supply of rice. At household level, increased output will ensure improved food security as well as incomes since rice is mainly grown as cash crop in Uganda (WARDA, 2005).

It can be deduced that not so many efficiency studies have been conducted in Uganda let alone on rice as a crop. Only one study (Hyuha, 2006), has extensively studied efficiency in rice and recommended further examination of upland rice efficiency in Uganda. Most studies therefore are broad in nature and not specific to upland rice, which thus calls for a study to consider technical efficiency of upland rice. This study considers the South Western part of the country but result can easily be extrapolated considering the fact that upland rice is becoming an important commodity in the country.

LITERATURE REVIEW

2.1 Introduction

This section presents relevant literature on technical efficiency and describes studies that are related to the study and the theory upon which it is based. The final section outlines factors that affect technical efficiency.

2.2 Efficiency in Production

Efficiency, as defined by the pioneering work of Farrell (1957), is the ability to produce at a given level of output at lowest cost. He proposed a division of this concept into technical and allocative efficiency. Technical efficiency is the ability of the farm to produce a maximum level of output given a similar level of production inputs. Allocative or price efficiency is the extent to which farmers equate the marginal value product of a factor of production to its price.

It is possible to have either technical or allocative efficiency without having economic efficiency. Therefore economic efficiency combines the two concepts. It is achieved when the producer combines resource in the least combination to generate maximum output (technical) as well as ensuring least cost to obtain maximum revenue (allocative). This study proceeds to examine technical efficiency component of upland rice in South Western Uganda in the context of above definition.

2.3 Technical Efficiency

This is the engineering concept for measuring performance of the system given the available resources. Technical efficiency is associated with behavioural objectives of maximization of output (Battese and Coelli, 1995). However, this production objective cannot be carried out in isolation since a farm can be considered as an economic unit with scarce resources. When a producer with the aim of maximizing profit makes allocation mistakes that result in inefficiency is considered allocatively inefficient (Kumbhakar, 1994).

According to Esparon and Sturgess (1989), technical efficiency deals with efficiency in relation to factor- product transformation. A farm to be called technically efficient has to produce at the frontier or “best” level. However, this is not always the case due to random factors such as bad weather, animal destruction and/ or farm specific factors which lead to producing below the expected frontier (Battese and Coelli, 1995). Efficiency measurement therefore attempts to identify those factors that are farm specific which hinder production along the frontier.

The above proposition sounds like technical efficiency is similar to productivity measurement since the former is concerned with input- output transformation. This however is not the case since efficiency goes beyond evaluation based on average production to one that is based on best performing among a given category (Battese and Coelli, 1995). Secondly, efficiency measurement provides an opportunity to separate production effects from managerial weakness (Ogundari and Ojoo, 2005). This study, therefore, proceeded to measure technical efficiency given its benefits over productivity measurement.

2.4 Theoretical Framework

In economic theory, a production function is described in terms of maximum output that can be produced from a specified set of inputs, given the existing technology available to the farm (Battese, 1992). When the farm produces at the best production frontier, it is considered efficient.

Therefore a farmer is assumed to maximise the quantity produced from the given inputs. The most common assumption is that the goal of the producers is profit maximisation, however, Debertin (1992), believes the objectives and goals of the producer are intertwined with his/ her psychological makeup. Therefore this study assumes that producers aim at maximising output subject to existing constraints.

Technical efficiency is achieved when a high level of output is realized given a similar level of inputs. It is therefore concerned with the efficiency of the input to output transformation. In other words the production function which traces out the maximum quantities of inputs under a given technology. The main function of this technical efficiency research is to understand factors that shift production function upwards (Esparon and Sturgess, 1989).

2.5 Technical Efficiency Measurement

The pioneer work on efficiency was begun by Farrell in 1957 to which the present estimation method originated. Over time, estimation of production frontier has tended to follow along two general paths; the full frontier where all observations are assumed to be along or below the frontier and the deviation from the frontier considered being inefficient. The other path has been the stochastic frontier estimation where the deviation from the frontier is attributed to the random component reflecting measurement error and statistical noise and an inefficiency component (Ogundele and Okoruwa, 2006).

The estimation of full frontier has been based on either non parametric approach where technical efficiency is estimated by solving the linear programming for each individual farm/firm or through parametric approach where the estimation is by statistical techniques. Under the parametric approach, there are two methods namely; deterministic and stochastic frontier method. The deterministic method just like the non parametric approach envelops all of the data of the firm data from above (Neff *et al*., 1994). The major drawback of these methods that forces all outputs to a frontier is the sensitivity to outliers which, if large distort efficiency measurements (Ogundele and Okoruwa,2006)**.**

The stochastic parametric method however incorporates the random error of the regression. The random error therefore captures the effect of unimportant left out variables and errors of dependent variables as well as the farm specific inefficiencies. It is because of this decomposition of error that makes this method of estimation superior to others. It provides the farm efficiency estimates with much lower variability than any other method due to the said decomposition (Neff *et al*., 1994). What should have been its major weakness as opposed to non parametric measurements was its inability to construct different frontier for every observation (Neff *et al*., 1994, Ogundele and Okoruwa, 2006). However, this was later overcome by measuring the mean of the conditional distribution of inefficiency (μ_i) given the random error (ε_i) (Jondrow *et al*., 1982). The weakness of the stochastic measurement however, is pointed out by Neff *et al*., (1994) who stated thus “while the ability of stochastic frontier to incorporate random disturbance term to account for events beyond management’s control is appealing, the need to use an estimate to measure inefficiency may result in very similar farm efficiency estimates”. But according to several studies that have used this method, this problem seems not to occur. This study therefore will use the stochastic frontier method to analyse the technical efficiency of farmers in South Western Uganda due to its stated advantages.

Production function estimation has been critised in recent times that it results into simultaneous equation bias (Akinwumi and Kouakou, 1997) leading to wrong conclusions. In such cases, estimation technical efficiency using product and input prices has been advocated. However, Neff *et al*., (1994), contends that prices in a given region are always homogeneous and uniform across farms. As such, "differences in efficiency measures are likely to reflect quantity, not price difference". It is because of the above proposition that this study adopted production function analysis to estimation technical efficiency and not allocative efficiency.

2.6 Factors Determining Efficiency in Production

A number of studies have been carried out to determine factors that influence efficiency of farmers especially on rice. Farrel's (1957) pioneer work on production efficiency that assumed constant returns to scale has been under going further improvements to increase the power of estimation (Ogundele and Okoruwa, 2006). Further modification of measurement went on to include other factors that were presumed to affect efficiency.

Lau and Yotopolous (1971) estimated a profit function to determine differences in efficiency between large and small farms in India and found an inverse relationship. Kalirajan (1981) used a normalized profit function in estimating the economic efficiency of farmers growing high yielding irrigated rice in India. He compared large and small groups and concluded that there was no significant difference between the groups. This implied that when small farmers are accessed with inputs they respond the same way to economic opportunities as large farmers. However, he cautioned that this is only possible when institutions ensure equal access to these inputs. Though the institutions themselves may not solve the problem due to influence peddling of individuals (Kumbhakar, 1994).

Mubarik *et al.*, 1989, using an ordinary least squares estimated profit efficiency among Basamati rice growers in Pakistan. They found that there was general inefficiency of between 5 - 87% and socio-economic factors like household education, non farm employment and credit constraint and institutional constraint affected farm efficiency. Institutional constraints identified were late delivery of fertilizers and thus late planting which impact on technical efficiency of farmers. This method adopted a stochastic frontier approach for efficiency analysis which accounts for random and farm specific errors, however, the current study did not consider institutional factors because they are sometimes elusive (Kirsten and Vink, 2006).

In their study of relative efficiency of women and men as farm managers in Cote D' Ivoire, using a normalized profit function, Akinwumi and Kouakou, (1997), found that they both had similar capabilities in farm management given equal opportunities. They also found out that capital and land factors in rice production were highly inelastic (0.04 and 0.2, respectively). The results have a strong message to Ugandan upland rice farmers especially as regard to capital (seed) that is being extended to farmers. It seems to imply that provision of such inputs has little impact on output. This study therefore also seeks to find whether such inputs to farmers provide an incentive to improve upland production efficiencies.

Kumbhakar and Bhattacharyya, (1992), used a Cobb Douglas by adopting a restricted profit function in estimation of price distortions and resource use efficiency in India. They found that efficiency estimation based on market prices was not adequate because of existence of price distortions leading to imperfect markets and allocative inefficiency. They contended that opportunity cost of resources is not always reflected by market prices and the estimations based on such prices are bound to lead to wrong conclusions. As such, it can be said that prices may not lead to significant differences in estimation since they may be uniform in a given location (Neff *et al.*, 1994). The current study will concentrate on technical efficiency of upland rice farmers because it gives a representation of farmer practices.

The presence of government support or incentive may affect efficiency of farmers in one way or the other. Zaibet *et al* (1999), studying on efficiency of government support in horticulture in Oman using both the stochastic production function (SPF) and Data envelopment analysis (DEA), found out that the percentage of efficiency was as low as 17% while using SPF and 46% with DEA. This study only analysed technical efficiency and it dealt with a situation where the support was cross cutting. It therefore gives little room for comparison. The two methods used on the same data however give different outcomes which makes it inconclusive. The current study also will model for seed credit incentives and will only use SPF because it has been found to produce consistent results over other methods (Neff *et al.*, 1994).

Kumbhakar, (1994), estimated technical efficiency of Bengal farmers and found that best farmers were only efficient to a level of 85.8% and that the majority of farmers were under users of exogenous inputs such as fertilizer, seeds. The under use of resources was related to distortion of markets resulting from government regulations. This study apart from mentioning the effects of distortions did not indicate the percentage of inefficiency that is attributed to state regulations probably because it was beyond the scope of that study.

2.7 Factors influencing technical efficiency measurements

Hyuha (2006) estimated a translog profit function to determine the profit efficiency of rice farmers in Uganda. The study revealed wide variation in efficiency of between 2 and 100 % and the mean of 66%. This study also found that increase in profit would be achieved through increased expansion of land, a factor that may not be sustainable. Use of virgin land for increased output could a sign of the need to use fertilizers.

Ogundele and Okoruwa (2006) estimated a stochastic production frontier (SPF) to determine the technical efficiency differential in rice production in Nigeria. They found that farmers cultivating traditional rice and improved varieties shared relatively the same socio-economic characteristics except for farming experience and the number of extension visits. In terms of efficiency, the distribution was highly skewed with over 75% and 60% of the farmers having their technical efficiency above 90% in the traditional and improved technology groups, respectively. The results were never conclusive, which was attributed to variety mix up. Ogundari and Ojo (2005) estimated a stochastic production function in mixed crop food production in Nigeria. They found that farmers were 82 % efficient and that age and farming experience contributed to overall technical efficiency.

Sharma and Leung (2000), used also stochastic production frontier (SPF) to estimate the technical efficiency of carp production and compared extensive and semi- intensive producers in India. They found that extensive producers were inefficient at 0.658 compared to semi- intensive producers at 0.805.

Obwona (2000), estimated a translog production function to determine technical efficiency differential between small and medium scale tobacco farmers in Uganda using the SPF. Results showed that credit accessibility, extension service access and farm assets contributed positively to technical efficiency. The differences between farmer groups were explained with socio-economic and demographic factors.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

This chapter presents information about the study area, data and describes variables that were captured for empirical work. It also contains the empirical models and expected behaviour of included variable

3.2 Study Area, Data and Sources

3.2.1 Description of the Study Area

Data for this study were collected from two districts of Bushenyi and Rukungiri in South Western region of Uganda (appendix 2) in the period of March to April, 2007. South Western region comprises six districts (Appendix 2), that is; Bushenyi, Kabale, Kanungu, Kisoro, Mbarara, Ntungamo and Rukungiri (District handbook, 2005). Of the six districts, three grow upland rice and these are, Bushenyi, Kanungu and Rukungiri. For this study, two (Bushenyi and Rukungiri) were chosen. These districts represent areas where upland rice is relatively new which would eliminate possibilities of variety mix up resulting in inconclusive outcomes as the case of Nigeria (Ogundele and Okoruwa, 2006).

The South Western region represents an area of significant agricultural potential since it receives high rainfall precipitation except for some parts of Mbarara and Ntungamo. A section of the region lies within the Western rift valley which has fertile young alluvial soils.

Bushenyi district covers an area of approximately 4292 Km^2 with a population of 723,427 people. It has five counties of Buhweju, Bunyarunguru, Ruhinda, Igara and Sheema. Because of the high population and land scarcity, rice is grown only in two counties of Bunyarunguru and Ruhinda which are considered to have more land for expansion. In the two counties, four sub counties grow rice and they all lie within the rift valley. Therefore, the reason for this choice could be related to soil and weather in the rift valley. The four sub counties include Kiyanga and Kanyabwanga in Ruhinda county and Katerera and Kichwamba in Bunyarunguru county. One sub county was purposively selected from each county based on the fact that they are the main rice producers in the district (District Agriculture Office).

Rukungiri district covers an area of 1,525Km^2 with a population of 308,696 persons. It comprise of two counties of Rubaabo and Rujumbura. Rice is produced only in Rujumbura county. This county comprises of five sub counties and only two of them produce rice. These include, Bwambara and Bugangari, however, according to the District agriculture officer, Bugangari produces negligible quantities. This study therefore only selected Bwambara Sub county in Rukungiri district.

Bushenyi and Rukungiri districts were selected because upland rice production has been part of the farming system of these districts even before the introduction of NERICA (ADC, 2001) and they have projects like NAADS, AAMP, VPI operating and supporting NERICA production. These districts produce a wide range of crops that include; bananas, tea, coffee, and annual crops like beans, maize, sorghum and rice. Cattle are also a major economic activity in the region and indigenous breeds are predominant. The wide range of crops produced mean that the area consist mainly mixed crop farmers, a factor that may present challenges for upland rice production since it is labour intensive (Suyanto *et al*., 2005)

3.2.2 Sampling Procedure and Sample Size

The study followed a two-stage sampling technique. The first stage involved purposive selection of the two districts. Within each district, rice producing sub-counties were purposively selected basing on their production potential. In Bushenyi, two sub counties were purposively selected out of four while in Rukungiri one was purposively selected out of two. At the sub county level, three parishes (locations) were randomly selected from each sub county. The area leadership especially agriculture officer and chairpersons of community projects supporting rice were consulted to generate sampling frame.

However, in Katerera, the sampling frame was never present, so selection was random in each parish. In each parish, 25 farmers were randomly selected making a total of 75 farmers in each sub county. Overall, 225 respondents were selected and interviewed for this study. However, 29 respondents were not considered for analysis because they did not engage in production in the main season of 2006, leaving the number of respondents at 196.

3.2.3 Data Sources and Collection

Upland rice is grown following the two rain patterns received in a year for this region. The first season covers the period of March- June and the second from August – December (main season). Because this crop requires a considerable amount of rainfall, most farmers in the study area produced rice in the main season of August – December since it has a longer rainy period, of the 225 respondents, 196 produced during the main season, while 29 produced only in first season and thus were eliminated from the analysis. The final analysis considered farmers that produced during the second season that commenced from August to December 2006.

Primary data were collected from the field using a semi structured questionnaire with household as sampling unit. Both quantitative and qualitative data were collected for the last farming year (2006). From the field, information on total rice output, inputs like seed, chemicals, labour, and their prices (costs) were collected. Also socio-economic factors like extension contact, access of credit, age, income, household size and sex disaggregated data costs were collected for analysis. Prices and costs on factors of production were not utilised because the interest of this study was to look at technical efficiency which utilizes physical quantities. Fertilizer and herbicide use were very limited as such were left out in the analysis.

A well thought out questionnaire (Appendix 1) was designed to obtain crucial information about upland rice and specifically to address the objectives and hypothesis of the study. The research instrument had both closed and open ended questions that provided necessary checks to ensure correct answers were returned. Two research assistants that had attained education at degree level were employed in data collection and the researcher supervised and collected data.

3.2.4 Data Reliability and Validity

The research assistants were trained in data collection techniques as well as making them involved in pre-testing the study instrument. Role plays was used to emphasise the point to the assistants and how they should behave during data collection. They were taken through the do’s and don’ts of data collection and then made to practice in the pre-testing.

The research instrument was pre-tested in Katerera Sub County to ensure its validity and reliability. Questions that appeared redundant and misplaced were removed and those that the researcher felt were left out due to oversight were included. The instrument had a number of probing questions to ensure consistency of the information received.

After data collection, field editing was done to check out response errors and if possible corrected before leaving a given location. Data were entered in the Statistical package for social science (SPSS) to obtain descriptive and necessary transformation such as log linearization conducted. Variables needed for efficiency measurement were then transferred from SPSS to Frontier 4.1c programme for analysis

3.3 Analytical Approach

3.3.1 Model Specification

The study followed Battese (1992) and Battese and Coelli (1995) models to specify a stochastic frontier production function. The stochastic frontier model was originally proposed independently by Aigner *et al*., (1977) and Meeusen and Van dar Broeck (1977) and it is specified as follows;

$$Y_i = f(X_i;\beta)\exp(V_i - U_i) \quad \text{...(1)}$$

i = 1, 2….n

Where Y_i = is the output of the i^{th} farm, X_i is the Kx 1 vector of the input quantities, f(X, β) is an appropriate production function like Cobb Douglas or Translog, β is the coefficient vector of X_i, V_i is the random error having zero mean (associated with random factors like measurement error, weather, animal destruction) not under the control of farmers' control. U_i is a one sided error term called the inefficiency. The two components of V_i and U_i are assumed to be independently distributed. U_i is the non- negative random variables which are assumed to be identically independently distributed with half or normal truncations in mean and variance δ^2_{u}, $U_i \sim N(\mu, \delta^2_u)$.

The inefficiency (U_i) determinant function is as specified below,

$$\mu = \gamma_0 + \gamma_1 R_i + w_i \text{ ....(2)}$$

Where R_i is the vector of factors affecting the efficiency level, γ is the vector of parameters, and w_i is the error term. Early studies estimated equation 1 and 2 using a two step procedure (Pitt and Lee, 1981, Kalirajan, 1981), however, this method has been criticized that it violates the assumptions of error term (Ogundele and Okoruwa, 2006). The common and widely used procedure is to estimate both equations in a single stage procedure using the frontier programme (Battese and Coelli, 1995).

Selection of the functional form to represent the data and the distributional term of the error depends on imposition of restrictions (Coelli, 1992). Log likelihood test are conducted to select the appropriatness of the model to represent the data. The Null hypothesis forms the restricted version and alternative is the unrestricted form, the results are compared with critical values (Kodde and Palm, 1996).

Following Jondrow *et al*., (1982) technical inefficiency (TI) for individual farms (observation) is given by the expected value of U_i (inefficiency) conditional on $\varepsilon = (V_i - U_i)$ this is defined by;

$$TI = E\left(\frac{U_i}{\varepsilon}\right) = \frac{\sigma_u \sigma_v}{\sigma}\left(\frac{f(\varepsilon_i \lambda / \sigma)}{1 - F(\varepsilon_i \lambda / \sigma)} - \frac{\varepsilon_i \lambda}{\sigma}\right) \text{..} (3)$$

Where E is the expectation operator, f(.) and F (.) are the standard normal density and distribution functions, respectively evaluated at $\frac{\varepsilon_i \lambda}{\sigma}$. While $\sigma^2 = \sigma_u{}^2 + \sigma_v{}^2$ and $\lambda = \frac{\sigma_u}{\sigma_v}$, U_i represent the inefficiency term associated with given farmer and ε; is the error term associated with both random and farm specific inefficiencies

Technical efficiency of a given farm is defined to be the ratio of observed output (Y_i) to the corresponding frontier output (Yi^*) using the available technology and so the technical efficiency of the farm is denoted by;

$$TE = \frac{Y_i}{Y_i^*}$$

$$= \frac{f(X_i;\beta)\exp(V_i - U_i)}{f(X_i;\beta)\exp V_i}$$

$$= E[\exp(-u)] \text{...} 4$$

For technical efficiency to occur exp $V_i = 1$ and $U_i = 0$ since exp (0) = 1. Thus TE has values that range between 0 and 1, with 1 defining efficient farms and 0 inefficiency. It should be noted that the larger the U_i, the less the technical efficient the farmer.

The econometric specification of the study followed a Cobb- Douglas type of production given its statistical edge (section 4.4) and wide application in measurement of farm efficiency both in developed and developing countries. The test statistic conducted preferred it against a translog. For upland rice farmers in the study area, the specification of the function was as follows.

$$\ln Y_{ij} = \ln \beta_0 + \beta_1 \ln X_{1ij} + \beta_2 \ln X_{2ij} + \beta_3 \ln X_{3ij} + \beta_4 \ln X_{4ij} + V_{ij} - U_{ij} \quad \text{......(5)}$$

The subscripts i and j refer to the i^{th} farmer and j^{th} observation respectively, while

Y_{ij} = Total farm output of upland rice (Kg)

X_1 = total land owned (ha)

X_2 = land area under upland rice (ha)

X_3 = labour used for upland rice production (person days)

X_4 = quantity of seed planted (Kg)

V_{ij} = random error term with normal distribution N $(0, \sigma^2)$

U_{ij} = a non- negative random variable called technical inefficiency associated with the farmer.

ln = the natural logarithm

$\beta_0 - \beta_1$ = coefficients to be estimated

Estimation of equation 4 was accomplished by Maximum likelihood method in Frontier 4.1 (Coelli, 1996). The outcome of equation 4 contains the error term U_i which is regressed against specified farm factor to determine their effect on overall performance or efficiency. The programme (frontier 4.1), however, accomplishes the described procedure in a single step.

The inefficiency term (U_i) measured by the mode of half normal distribution were assumed (given the statistical advantage, section 4.4) (Kumbhakar and Heshmati (1995); Ogundele and Okoruwa (2006) to be a function of socio- economic specified in the inefficiency model below;

$$U_{ij} = \gamma_0 + \gamma_1 R_{1ij} + \gamma_1 R_{2ij} + \gamma_3 R_{3ij} + \gamma_4 R_{4ij} + \gamma_5 R_{5ij} + \gamma_6 R_{6ij} + \gamma_7 R_{7ij} \text{...................................} (6)$$

Where

U_{ij} = the inefficiency term

R_1 = number of years spent schooling

R_2 = number of extension contacts per season

R_3 = household size

R_4 = farming experience (upland rice only)

R_5 = age of the farmer

R_6 = seed credit support dummy with 1 for supported farmer and 0 otherwise

R_7 = group/ association membership dummy with 1 where a farmer is member and 0 otherwise

γ_{0-7} = estimated inefficiency model coeficients

The frontier efficiency model (equation 4) and the inefficiency model (5) were estimated jointly by maximum likelihood. This was achieved by the software programme frontier 4.1 developed by Coelli (1996). This programme uses a three step estimation method to obtain the maximum likelihood estimates. First, unbiased estimates of the β parameters are obtained through ordinary least squares (OLS). Secondly, a two phase grid search of γ (gamma) is conducted with β set to the OLS estimates and other parameters set at zero. Lastly an interactive procedure to obtain maximum likelihood estimates is done.

3.4 Rational for Inclusion of Variables in the Frontier and Inefficiency Models

3.4.1 Frontier Model

Variables in this model relates to input- output transformation. Therefore, they are considered for inclusion if they contribute towards production of output. Inputs like seed, labour and land area have been used by a number of technical efficiency studies (Ogundele and Okoruwa, 2006, Ougandari and Ojoo, 2005). This study considered farm size (land owned), land allocated to rice, labour employed in upland rice production and the quantity of seed planted. Use of other critical inputs like fertilizers and herbicides were minimally used as such they were not considered for inclusion in modeling. Proper use of available inputs determines the efficiency of a given farm.

The relationship between farm size and efficiency has not been conclusive in recent times. A number of other studies have reported an inverse relationship (Yotopolous and Lau, 1972, Kalirajan, 1982). However, some studies have reported a direct relationship (Antonio and Carlos, 2004 and Townsend et al., 1998). Considering the small land plots that are said to be less than 2 hectares (MAAIF and MFPED,2000), this study assumed a positive relationship.

Farm size variable was constructed by aggregating all productive land available to the farmer both under livestock and crop production, similar to Helfard and Edward (2004), and the aggregate converted into hectares. Some studies, Ogundele and Okoruwa (2006), considered farm size as total area under rice, however, this study differs by considering total land utilized to represent this variable given the fact that in developing countries, farmers engage in mixed cropping as a way of reducing risk and uncertainity (Ellis, 2003). Therefore consideration of farm size as single crop area might lead to wrong conclusion.

Area cultivated to rice is related to farm size. Where a farmer has a large land area under rice, the more output is expected to harvest. In the recent study of Hyuha (2006), it was observed that to increase rice profitability, farmers had to increase land holdings under rice to increase output. This variable was also measured in hectares allocated to rice.

The amount of seed planted in a given area is important to attain desired output. This therefore requires that recommended quantities be planted with the recommended practices if the farmer is to achieve the desired efficiencies. Importance of certified seed production is recognized as key to increased yields, however, earlier reviews by Crawford *et al*., (2003), show that there is minimal use of these inputs in Sub Saharan Africa. For upland rice, there are development agencies that provide quality seed to some farmer, hence the factor is considered to be positively related to efficiency. The variable is measured in kilograms of seed planted.

Rice is considered a labour intensive crop, (Suyanto *et al.*, 2005) and therefore energy demanding (Ogundele and Okoruwa, 2006). Farmers who are young and energetic are expected to engage in this enterprise. Where the owners are not involved, it is expected they would engage hired labour. Thus to achieve desired results, farmers have to engage labour timely to ensure they do not lose yield due to delayed accomplishment of crucial activities such as planting and weeding.

Measurement of labour variable follows Helfad and Edward (2004), by considering men and women in provision of equal amount of labour as long as they work for six hours a day. Children under 14 years were considered to provide half of what adults provide as long they work for the same amount of time. The unit of measurement was man day (Person day), if a man or woman worked for six or more hours and half man day if the child under 14 years worked the same time in the rice field. Adding the total from the three categories gave the total labour units utilized in rice production.

3.4.2 Inefficiency Model

Measurement of farm specific technical efficiency is based on deviations of realized output from the frontier output. The observed deviations from the frontier production are assumed to result from farm specific factors which are modeled in equation 6 (Coelli, 1996). For this study, the following factors that were considered to influence inefficiency among upland rice farmers; education of the household head (years of schooling), rice experience (years), Household size, access to extension education dummy with accessing farmer taking on one and zero otherwise, access to credit dummy with accessing farmers taking on one and zero otherwise and membership to farmer groups dummy with member taking on one and zero otherwise.

Education of an individual plays a significant role in improving efficiency of farmers by aiding adoption of requisite technologies and analysing them. Well educated households are expected to make rational decisions that improve efficiency. The factor has been studied and more often incorporated in empirical work (Lockheed *et al*., 1980). Measurement of the variable follows Ogundele and Okoruwa, (2006), Kibaara (2005), by considering the years of continuous education. The expected sign in relation to the inefficiency model was negative.

Farming in most developing countries involves a significant degree of risk and uncertainty (Ellis, 2005). Therefore, one's experience in doing a given activity contributes towards risk reduction. The longer a person stays on the job, the better that person becomes in management and decision making. Ogundari and Ojoo (2005), found a negative relationship between experience of mixed croppers and inefficiency. The expected sign for rice farming experience is negative.

Rice growing is an energy demanding enterprise; it therefore requires vigour and determination on the part of the farmer. This requires youth or mid aged people to engage in its production. Kibaara (2005), studying on technical efficiency of maize farmers found a positive relationship with age, however, it was not significant. Ogundari and Ojoo (2005), studying efficiency of mixed croppers in Nigeria, found a significant relationship of technical efficiency and age. The rational for this variable is that it sums up the effect of physical strength that may be needed to carry out rice production which is considered labour intensive (Suyanto *et al*., 2005). Age is measured in years for the decision makers in the household and the expected sign here is negative.

The labour demand in rice production implies that it is either provided by the household or obtained on the market. Where wages are high or the farmer is poor, that farmer resorts to family labour in the household. Therefore household size plays a significant role in determining rice production through provision of labour. Ogundele and Okoruwa (2006), found a negative relationship of technical inefficiency among rice farmers in Nigeria. The expected sign for this study also is negative. This variable was measured in terms of the number of people staying in a household.

Access to extension education plays a big role in determining accessibility of recommended agricultural practices. Applying recommended practices would significantly improve efficiency of rice production. Rahman (2003), studying on profit efficiency among Bangladesh farmers found weak negative relationship of extension and inefficiency. While Lockheed, et al. (1980), reviewing other efficiency studies found significant negative relationship with extension education. The expected sign is negative for this study. The variable was measured as a dummy, where 1 represented a farmer who has had extension contact in the previous year on upland rice and 0, otherwise.

Where inputs are missing in rural areas due to structural or institutional constraints, provision of seed credit improves access of certified inputs. The seed credit that is being provided in Uganda has been said to increase rates of adoption of upland rice because it enables the resource poor to have access to important inputs (Kijima *et al.*, 2006). Credit availability therefore is considered to influence positively efficiency of farmers by providing them with quality seed and if possible in required quantities. Slow rates of credit availability were found to restrict the level of production and growth of rice producers in Vietnam (Kompas, 2002). This variable was measured as a dummy by taking on 1 where a farmer has accessed the seed credit in the season of consideration and 0, otherwise and the expected sign was negative in relation to inefficiency.

Lastly, belonging to an association can be said to reduce risks that are always associated with agriculture especially in rural areas. This is by pooling resource to access inputs and help in marketing of output. In some areas, groups provide labour to fellow farmers such that activities can be timely done. Being a member therefore provides an incentive to produce efficiently. Belonging to cooperative association have been reported to improve on efficiency in Brazil (Helfard and Edward, 2004). Therefore the expected sign on this variable was negative.

Table 3.1: A Prior Expectation of Variables in the Inefficiency Model

Variable	Expected sign
Education level	-
Extension contact	-
Household size	-
Farming experience (rice)	-
Age	-
Seed credit support	-
Membership to associations	-

All the above socio-economic factors were expected to have a negative sign against the inefficiency term.

CHAPTER FOUR

RESULTS AND DISCUSION

4.1 Introduction

This chapter presents a detailed account of results from the study. This section also describes results for each objective, hypothesis testing and technical efficiency estimates. The last part presents results for factors influencing technical efficiency of upland rice farmers.

4.2 Socio- economic Factors of Upland Rice Farmers

A number of socio-economic factors were considered for this study. They included age, education level, household size, general farming experience and rice farming experience (Table 4.1).

Table 4.1: Socio- economic Characteristics of Upland Rice Farmers

Variable	Mean (n=196)	Standard deviation
Age (years)	39.2	0.87
Education (years of schooling)	5	0.22
Household size	7	0.25
Farming experience	19.6	0.86
Rice farming experience	4.4	0.23

Source; study survey data, 2007

Rice production activities such as land opening (cultivation) weeding and spraying requires energy and strength. These activities therefore require youthful vigour and strength to carry out. According to Ogundele and Okoruwa, (2006), the productive age group lies between 20- 40 which is the early youth hood and prime life of a person. For this study the average age was 39.2 and therefore can be considered to be still energetic to carryout with rice labour demands. Else where, Ogundari and Ojoo, (2005), found the average age among mixed crop farmers in Nigeria to be 42 and it significantly influenced technical efficiency of these farmers.

Education of the farmer plays an important role in decision making and accessing crucial production information which is normally in English. It helps farmers in gaining skills and adapt new technologies. Results in Table 4.1 indicate that the average years in school in the study area were 5 years. This is a primary level of education and according to Hyuha (2006), education level of primary was necessary to increase profit efficiency of rice farmers in Uganda. With this level of education one can be said to have some literacy and numeracy that is important for production and business transactions. Education level of more than 4 years has been reported to improve efficiency of farmers (Sharma and Leung, 2000, Lockheed *et al.*, 1980).

Agriculture in most developing countries rely more on manual labour for production. Upland rice in particular is labour demanding (Suyanto *et al.*, 2005). Household size therefore determines the number of persons available to provide labour for rice production. This may be crucial during peak labour demand periods when the cost of hired labour is high, crowding out resource constrained farmers out of the labour market. In the study area, the average size was 7.1 which is greater than the national figure of 4.7 (UBOS, 2005b).

However, the findings of the study were close to 7.56 found by Kijima *et al*., (2006), among upland rice farmers in ten districts of Uganda.

Productivity of labour however, does not depend on the magnitude but rather on its ability to engage in production. For instance, a family of seven may comprise of school going children and infants. In that case, only two people in the household are engaged in production. Therefore relative size of a household does not automatically guarantee labour availability especially for school going children, but rather an indicator for potential labour availability.

The longer one stays on a particular job, the better that person becomes in terms of skills to accomplish tasks. A farmer, therefore, learns how to adapt to risks and uncertainty with experience. Agriculture being a risky venture (Ellis, 2003), all production techniques can never be got from formal extension education. Therefore, experience plays a significant role in improving production. In this study, the average number of year spent on upland rice production was 4 years. This confirms the fact that upland rice is relatively new to this region, which is consistent to an earlier study by Kijima *et al*., (2006) of 10 upland growing districts in Uganda.

4.3.0 Objective One: Input use characteristics of upland rice farmers

Objective one set out to characterize input use levels of upland rice farmers in South Western Uganda. This examines the current input use status compared to standard recommendation and how it relates to farmer efficiency. Inputs considered were seed, fertilizer, herbicides and machinery. Also, services like access to extension education, seed credit and belonging to association were considered.

4.3.1 Input use in Upland Rice

Upland rice production is fast becoming a major source of livelihood in many parts of the country. With the introduction of new early maturing varieties about 3 years ago, more than 10,000 hectares have been allocated to this crop (WARDA, 2005) and a number of agencies have picked up its promotion across the nation. However, yield has not significantly improved only increasing from 1.4 t/ha in 1990 to 1.5 t/ha in 2000 and stagnating (UBOS, 2005). This implies that attention has been placed on increased output with little concern over yield.

The probable reason for the observed low yields could be related to resource utilization especially the yield improving technologies such as fertilizers and herbicides. Table 4.2 shows input utilization in upland rice in the study area.

Table 4.2: Input Usage and Service Access in Upland Rice Production

	Input utilization (n=196)	
	Users	**Non- users**
Input	**Percentage (%)**	**Percentage (%)**
Improved seed	53.1	46.9
Fertilizer	0.01	99.99
Herbicides	9.7	90.3
Machinery	1.5	98.5
Services		
Access to extension education	36.7	63.3
Seed credit access	31.7	68.4
membership to farmer associations	51.7	48.3

Source; study Survey data, 2007

The Table 4.2 clearly shows that use of yield improving inputs were minimal for this study area. Despite the generally consensus that fertilizer returns are high (Crawford *et al*., 2003), only 0.01% used this valuable input in this region. Whereas improved seed was planted slightly more than half of the respondents (53.1%). This is probably due to agencies (AAMP and NAADS) that provide seed to farmers. This demonstrates use of low quality seed which translates into poor rice yields. This presents some sustainability challenges for upland rice production and requires increased awareness campaigns about yield enhancing technologies like fertilizer use and adherence to agronomic practices.

Herbicide and machinery when utilized, serve to reduce on labour and drudgery that is associated with rice production most especially land preparation and weeding. However, for this study, 9.7% and 1.5% used herbicides and machinery, respectively.

According to Suyanto *et al*., (2005), upland rice is labour intensive and so technologies aimed at lowering such labour demands are necessary to increase production and efficiency. Results in Table 4.2, show the generally known view about developing countries agriculture that, it is characterized by low input usage (Crawford *et al*., 2003) probably due to poor revenue returns or lack of awareness.

On the services, slightly more than half of the farmers belonged to farmer association (51.7%), but less than half of them accessed extension education (36.7%) and seed credit (31.6%). These latter services are accessed mainly by members of the association but for this case, fewer members accessed the mentioned services. This might imply that farmers are engaged in other farming groups that may be giving other services like finance credit.

Seed credit was accessed the least among the services captured, an indication that it represented a cost, which can be borne if it is to be provided to the whole population (Ellis, 2003). For cases where the input is completely missing, such credit is crucial in promoting the technology but effectiveness will depend on utilization and recovery of the provided service.

Extension education was also reaching fewer farmers (36.7%) than those in groups, a factor that may result into low adoption and utilization of better agricultural practices (Rahman,2003). This also could be the reason for the observed low usage of yield improving technologies like fertilizers.

Due to low usage of fertilizer, herbicides and machinery, they were omitted in efficiency estimation model. Table 4.3 presents the production characteristics of upland rice that were estimated.

Table 4.3: Per hectare Average Input use in Upland Rice

Variable	Mean	Standard error
Yield (kg/ha)	2537.5	114.0
Total land owned (ha)	2.3	0.19
Rice cultivated area (ha)	0.56	0.29
Labour (person days)	1136	52
Seed (kg/ha)	154	12.1

Source; Study survey data, 2007

From Table 4.3, it is clear that yield in the study area is relatively high compared to national yield of 1.5 t/ha (UBOS, 2005), despite the low input usage. This compares well with the assertion that NERICA in low input use conditions, yields about 2.5t/ha which is 50% more than the local varieties (Nwanze *et al*., 2006). Two reasons however, could be advanced for the observed yield. One is that there could be computation problems leading to under reporting in the national figures. Because another study conducted by Kijima *et al*., 2006, in ten districts on upland rice in Uganda found yield to be 2.5 t/ha for farmers who had experience of above 4 years and 1.7t/ha for those that had never had experience.

Secondly, the observed yield could be attributed to fertile soils characteristic of the rift valley areas where rice is commonly grown in this study area. Production based on rift valley soil fertility is not sustainable in the long run.

Land owned determines the area under which to allocate rice, thus a farmer who has a relatively bigger area might allocate more land to rice. Average land ownership was 2.3 hectares. The average area cultivated to rice was 0.56 hectares, which is small (24%) compared to overall land ownership. This has implications that farmers are engaged in various crop enterprise mix probably as a measure to guard against uncertainty (Ellis, 2003).

Previous studies indicate that rice production in developing countries is heavily dependant on land expansion (Hyuha, 2006, Ogundele and Okoruwa, 2006). The average area under rice (0.56) obtained was also similar (0.545) to what Kijima *et al.*, 2006, found among other upland rice growing areas in Uganda. This small land area compared to the total probably indicates that farmers are employing the “stepwise” approach to first experiment with these new upland varieties before expanding.

Labour requirement is abnormally high, for instance, one hectare required 1136 person days to produce upland rice in one season. Implying that for one hectare of upland with one farmer and no machines, takes more than three years to accomplish all tasks. This confirms the fact that upland rice is labour intensive (Suyanto *et al.*, 2005). It follows therefore, that efforts need to be stepped up towards introduction of labour saving technologies such as machinery and use of herbicides, if this enterprise is to fully integrate into the existing upland farming system.

Seed planted is crucial for production, however, the quality of seed is very critical. A number of farmers (46.9%) in the study area planted reserved seed from previous seasons. The amount of seed planted per hectare in the study area was 154 Kg, which is twice the recommended rate of 75- 85 Kg/ha (ADC, 2001). This provides an indication of an inefficient method of planting that waste seed most likely broad casting, which serves to reinforce the point that extension was not reaching all farmers.

Agricultural labour in Uganda is provided mostly by women, contributing over 80% of total labour requirement in food production (Elson and Evers, 1997). Table 4.4 shows the labour contribution by sex in upland rice production.

Table 4.4: Gender labour profile in upland rice production

Labour (person days) n =196					
Activity	**Men**	**Women**	**Difference**	**t-ratio**	**P-v²**
Land preparation(1st ploughing)	110	49	61	5.1(11.9)	0.000
Second ploughing	92	54	38	3.9 (9.63)	0.000
Planting	24	65	- 41	-6.13 (6.69)	0.000
First weeding	34	191	- 157	-10.01 (15.69)	0.000
Second weeding	22	107	- 89	-7.34 (11.50)	0.000
Scaring birds	100	15	85	10.0 (8.54)	0.000
Harvesting	64	101	-36	-4.04 (9.02)	0.000
Total	**456**	**586**	**- 130**	**-3.15 (41.14)**	**0.002**

Source; Survey data, 2007; value in parenthesis represent standard deviation

[2]Calculated using excel programme(=TDIST(x,DF,tails) where x is the t value, DF degrees of freedom and tails, the hypothesis tails

Results in Table 4.4 reveal that labour utilisation differences exist in all upland rice activities. All mean differences except total are significant (P<0.001 and total labour difference P< 0.05) which provides an insight that women are loaded in production of upland rice production. Overall, women employed 586 days towards producing upland rice for one hectare per season, while men provided 456, a difference of 130 days.

For specific activities, men were mostly engaged in energy demanding activities like land preparation and to a lesser extent in scaring birds. While women provided more labour in less tasking but yet time demanding activities like planting, weeding and harvesting.

To conclude this objective, it can be stated that the upland rice enterprise in this region can be characterized as a low input venture which if worked upon can result in significant returns. To achieve this, farmers need to sensitized and input becoming accessible in terms of quality, quantity and time. The low input usage therefore, signifies low technical efficiency of farmers.

4.4.0 Objective two: Determining the technical efficiency of upland rice farmers

The second objective forms the main gist of this study, it set to examine upland rice farmers' technical efficiency in South Western region. However, before this objective is analysed, the first hypothesis of the study which tests whether upland producer were producing along the frontier need to be analysed. This requires carrying out test statistic for the mentioned hypothesis to have useful inferences.

4.4.1 Test statistic

The first test involved selection of the functional form of the model, whether a Cobb-Douglas or translog function was suitable for the data. Secondly, whether we should assume half normal or a more general truncated normal distribution. Thirdly, testing whether inefficiencies exist or not. Lastly whether production is along the frontier, which is the gist of the first hypothesis of the study.

Testing for these hypotheses require imposition of restrictions on the model or the functional forms (Battese and Coelli, 1995) and using the log likelihood values to compare outcome values with those provided in Kodde and Palm (1986).

The log likelihood (LL) test statistic compares the log likelihood values from the restricted model (LR) (Null hypothesis) and the unrestricted log likelihood (LU) model (the alternative). The value obtained is multiplied by negative two and then compared with the critical values in Kodde and Palm (1986) with the degrees of freedom equal to the parameters excluded in the unrestricted model.

The appropriateness of the functional model was tested by estimating both the Cobb Douglas and the translog production functions. The null hypothesis (LR) was the Cobb Douglas log likelihood values because it is the restricted form of the translog function. Results are presented in Table 4.5. The null hypothesis was not rejected and as such a Cobb Douglas was considered to best represent the data. Esmeali (2006), while estimating technical efficiency in Iranian Persian fishery also did reject a translog production function, while Hyuha (2006), rejected the null hypothesis. Therefore selection of the functional form depends on statistic tests.

The second test statistic was that of selecting the appropriate distribution formal of the error term. This test is normally ignored by efficiency studies, Ogundari and Ojoo (2005), Ogundele and Okoruwa, (2006), but Coelli, (1995), recommended that such tests be conducted. The null hypothesis was the half normal distribution and the alternative (LU) was the general truncated normal distribution. The decision was not to reject the null hypothesis.

The third test involved evaluating presence of inefficiency. In other words, assessing farm specific factors and their effect on the overall technical efficiency of farmers. The null hypothesis was the functional form that had no inefficiency factors and the alternative had the inefficiency factors (equation 6). Included factors were age, rice farming experience, seed credit, association to farmer groups, access to extension services and education of upland producers. The null hypothesis was rejected implying that included factors in the model were contributing to the inefficiency of upland rice farmers.

Finally, the hypothesis that upland rice farmers were producing along the production frontier that is, $\gamma_m = 0$ as the null hypothesis and the alternative $\gamma_m \neq 0$. Results indicated that upland rice farmers were not producing along the frontier thus the null was rejected. This confirms the fact that production levels are still below the expected potential yield of 5 t/ha (WARDA, 2005). Results also compare well with an earlier study on profit efficiency of rice farmers in East and Northern parts of the country (Hyuha, 2006). Details of the above test static are contained in the Table 4.5.

Table 4.5: Log likelihood Tests for underlying Hypothesis

Null hypothesis	λ^*	Degrees of freedom (d.f)	Critical values[1]	Inference
Frontier is Cobb Douglas	9.16	8	14.85	Not rejected
Half normal distribution (μ=0)	0.98	7	13.40	Not rejected
$\gamma_m = \gamma_1 = \gamma_2 = \gamma_3 = \gamma_4 = \gamma_5 = \gamma_6 = \gamma_7$	26.2	8	14.85	Rejected
$\gamma_1 = \gamma_2 = \gamma_3 = \gamma_4 = \gamma_5 = \gamma_6 = \gamma_7$	17.1	7	13.40	Rejected

Source; survey data, 2007

$\lambda^* = LL = -2[\ln\{L(H_0)\} - \ln\{L(H_1)\}]$, [1]Obtained from Kodde and Palm (1986)

The null hypothesis that upland rice farmers were producing along the production frontier was rejected and took the alternative that they were not producing along the frontier. The implication for this is that, input combination of farmers does not result in maximum or expected output (Coelli, 1992). The scope for raising their technical efficiency levels therefore exist and need to be explored.

4.5 Technical Efficiency of Upland Rice Farmers

This section analyses factors affecting efficiency of rice farmers and presents their efficiency levels. Table 4.6 presents results of the maximum likelihood estimates and 4.7

presents the distribution of technical efficiency levels among upland rice farmers in South Western Uganda. Significance level is determined by the probability values generated from the analysis. Values of sigma squared and gamma are provided in Table 4.6.

Table 4.6: Maximum likelihood estimates of the stochastic frontier

Variable	**Parameter**	**Coefficient**	**Standard error**	**t- ratio**	**p-v**[2]
Constant	β_0	5.081	0.522	9.736	0.000
Land owned (ha)	β_1	0.066	0.049	1.352	0.178
Rice area cultivated (ha)	β_2	0.615	0.085	7.265	0.000
Labour (person days)	β_3	0.320	0.082	3.889	0.000
Seed (kg)	β_4	0.225	0.069	3.270	0.001
Inefficiency model					
Age	γ_1	0.005	0.008	0.637	0.525
Education	γ_2	- 0.075	0.042	- 1.781	0.076
Rice farming experience	γ_3	0.061	0.028	2.228	0.027
Household size	γ_4	0.006	0.031	0.202	0.840
Extension education (Accessing = 1, 0 otherwise	γ_5	0.499	0.289	1.724	0.086
Seed credit access	γ_6	- 0.286	0.247	- 1.156	0.249
Membership to association (member =1 and 0 otherwise)	γ_7	- 0.172	0.256	- 0.671	0.503
Sigma squared	σ_u^2	0.541	0.134	4.038	0.000
Gamma	γ_m	0.745	0.105	7.169	0.000

[2]Calculated using excel programme (=TDIST(x,DF,tails) where x is the t value, DF degrees of freedom and tails, the hypothesis tails.

Source, Study survey data, 2007

Results with β- parameters in Table 4.6 are the frontier estimations which indicate that area cultivated to rice, labour and seed planted were significant ($P<0.001$). However, land owned by the farmer was not significant ($P= 0.178$). This implies that total land ownership does not significantly lead to increase in rice output. This could be true considering the fact that soils in the study area are relatively fertile and thus farm size not being crucial in determining rice output. Gamma (γ_m) value was significant at one percent ($p<0.001$), which confirms the previous proposition that upland rice farmers in the study area were not producing along the frontier level. Gamma (γ_m) is bound between zero and one (Battese, 1992). Where it is zero, inefficiency effects do not exist in the model and if it is one, inefficiency is significant and is not random. This implies that the observed inefficiencies are related to farmer practices.

Area cultivated to rice was significant ($P < 0.001$) and had the highest coefficient of 0.615. This implies that most of the observed output was heavily dependent on cultivated land. Therefore, to achieve greater yields, farmers in the study area have to expand on land cultivated. This is similar to what Hyuha (2006), obtained in the study of paddy rice in East and Northern Uganda. This however, is not environmentally sustainable in the long run since soil degradation and deforestation will result. The said scenario is not only common in Uganda but similar to what Ogundele and Okoruwa (2006), noted in Nigeria for rice farmers.

The coefficient of labour utilised was positive and significant at one percent. The average person days employed per hectare in one season was 1136. This posses some challenges for the sustainability of the enterprise since the upland area already has other crops being cultivated. The second challenge posed by this high labour demand is the possibility of an increase in wages which might crowd out low income earners from the labour market thus rendering them less effective in production. Efforts should therefore concentrate on designing labour saving technologies that reduce labour demands and improve on efficiency.

Since the Cobb Douglas production was estimated, the coefficients estimated represent individual elasticities. The elasticity on all input parameters were less than one, (Table 4.7) implying that a unit increase in the respective input use would result in less than a unit increase in rice output.

Table 4.7: Elasticity on Input Parameters for Upland Rice

Variable	Coefficient	Elasticity
Land owned	0.066	0.066
Rice area (ha)	0.615	0.615
Labour (person days)	0.320	0.320
Seed (Kg)	0.225	0.225

Rice area had the highest coefficient and elasticity of 0.62 followed by labour, seed quantity and land owned. The high elasticity on rice area implies that significant increase in output come from land expansion. However, mindful of the consequences of land expansion like soil degradation, loss of soil cover and bio diversity, efforts need to be devoted to yield enhancing technologies especially soil fertility improvement.

On one hand, a unit increase in labour would result in 0.32 unit of rice output. The increase is not significantly high since farmers are already utilizing more labour units. A unit increase in seed planted would result in an increase of 0.225 unit of rice output. The elasticity on seed is small probably because farmers were applying more than the recommended rates. This has implications in the study area where projects provide seed credit to farmers, the scheme would perhaps help those farmers who do not have access to seed but results imply that increase in seed planted does not increase output significantly. Similar results were reported in Cote De ‘Ivore by (Adesina and Djato, 1998).

The seed coefficient was positive and significant ($P<0.001$), with weak elasticity (0.225). This confirms earlier results in section 4.3 that seed was being over utilized (Twice the recommended) and so minimal output increase can be achieved with a unit increase in this input because already the optimal amount was exceeded.

Lastly, the Frontier programme generates efficiency values for individual farms and overall value. This section therefore addresses the second objective of estimating the efficiency level of upland rice farmers. Below is the frequency distribution table of technical efficiency of upland rice farmers in the study area.

Table 4.8; Frequency Distribution of Technical Efficiency of Upland Rice Farmers

Range	Frequency	Percentage
10- 20	4	2.0
21- 30	7	3.6
31- 40	17	8.7
41- 50	22	11.2
51- 60	37	18.8
61- 70	43	22
71- 80	43	22
81- 90	23	11.7
Mean	60.5	
Standard error	17.2	
Minimum T.E	12.4	
Maximum T.E	89.1	

Source: Study survey data, 2007

The efficiency distribution table above indicates that, efficiency of upland rice is distributed across a wide range and no farmer has attained the frontier level of a hundred percent. The highest efficiency level was eighty nine percent (89%) and the lowest was twelve percent (12%). The average value for this study was sixty one (61%) percent which is below the frontier level.

In conclusion, the low levels could be related to low input usage (Section 4.3) as well as farm specific factors such as lack of specialised extension education. Scope for improving the existing technical efficiency level to that of the best farm in the region or relatively different level is possible. This is by placing emphasis on farmer education and extending targeted or specialised extension education which are considered low cost methods for attaining increased technical efficiency (Ellis, 2003).

4.6.0 Objective three: Determining farm specific factors that affect technical efficiency

This objective aims at isolating farmers specific factors that result in variations in technical efficiency of farmers. It was analysed by Frontier 4.1c programme together with the main model, as such, results are contained in the same Table 4.6. Factors that were considered include; age, education level, number of extension contact, household size, farming experience, credit support to farmers and membership to groups.

4.6.1 Inefficiency Model

The lower section of Table 4.6 contains results of the inefficiency model. In other words, factors that are considered to influence efficiency of upland rice farmers in the study area.

The coefficients on education, seed credit access and association membership had the expected negative sign. The negative sign in the inefficiency model indicate positive effect on the efficiency levels of the farmers. It follows therefore, that increasing education of a farmer, encouraging group formation and provision of input seed credit would reduce inefficiency of upland rice farmers.

Among the correctly signed variables, only education was significant ($P < 0.01$). Implying that, increasing ones education would improve technical efficiency levels of the farmer. Education reduces inefficiency by helping farmers acquire skills and adopt required technologies for production. Similar results have been reported in other areas on maize and rice (Kibaara, 2005, Hyuha, 2006). A review of the efficiency studies and education found that 4- 6 years of schooling provided a threshold upon which its effect on efficiency was pronounced (Lockheed *et al*., 1980). For this study, the average years of education was 5 and significant ($P<0.01$) which is consistent with earlier studies.

Provision of seed credit on the other hand alleviates the problem of lack of capital especially for resource constrained household to acquire certified seed on time to take advantage of early rains. This scheme was designed with the assumption that inputs are expensive and inaccessible. However, Ellis (2003), cautions that the relative costliness should be considered before such ventures are undertaken. This variable was not significant ($P=0.249$) which indicates that though it improves efficiency of farmers, it is not a contributing factor for this study.

Membership to rural groups (association) is phenomenon presently in Uganda. It is expected that development assistance to rural poor, especially the most coveted prosperity for all, will be channeled through such associations. Other than the anticipated promise, associations play a significant role in development by reducing risks associated with production and marketing in mobilizing resources especially labour and capital. Therefore belonging to an association reduces inefficiency to farmers. For this particular study, the variable was not significant ($P=0.503$) meaning their contribution towards reducing inefficiency was not extensive.

All the other variables had the unexpected signs, they include; age, household size, rice experience and extension education. Rice farming experience and extension education access variable were significant though with a positive sign. This sign in the inefficiency model implies a negative effect on the efficiency of the farmers.

The significant (P=0.027) and positive sign on rice farming experience was striking, however, similar results were obtained by Ogundele and Okoruwa, (2006) among improved rice farmers in Nigeria. For the upland rice farmers, this could be related to the fact that rice is relatively a new crop enterprise (average four years) to most households in the region.

Given the high labour demand of this enterprise, it follows that as one advances in growing rice, the desire to grow reduces based on the fact that it is labour intensive which may force that person to opt out of production or engage in part time production.

The positive and significant (P= 0.076) coefficient of extension education access could be related to the fact that farmers may be accessing broader extension services not targeting rice production as such not contributing to better upland production but rather encouraging production of other crops. It was observed earlier that a small fraction (0.56 ha) of the total land owned (2.3 ha) was allocated to rice production. This means the rest of the area is allocated to other crops which could be a priority for accessing extension service.

For this region and the country at large, general extension education that emphasizes production of all crops is the rule other than an exception. Specialization to a given crop applies to the three rice schemes in the country, hence for this study area, extension could be emphasising a wide range of crop enterprises thereby not providing the farmer with the necessary knowledge to improve upland rice efficiency.

The second possibility for the unexpected behaviour of the variable could be that the extension education provided is not relevant to the needs and aspirations of the upland rice farmers thus ignoring or making partial implementation of the recommended practices. This therefore requires understanding of the appropriate problem that may be causing extension services not reducing inefficiency in upland rice for this particular area, which is beyond the scope of this study.

On the other hand, the small proportion of farmers (36.7%) that accessed extension service could be a strong factor for the observed behaviour. This is similar to what Rahman, 2003, found among rice farmers in Bangladesh.

Age and household size had the unexpected positive sign and not significant. The age of the farmer has been said to positively influence the efficiency of rice farmers (Ogundele and Okoruwa, 2006). This is because rice is labour demanding enterprises that require strength and energy. The positive sign on age contradicts this view for this study, implying that as one grows older, the less inefficient that person becomes. This could be correct since it has been found in the previous presentations that upland rice labour demand is high as such demanding attention and commitment. This cannot be done by an aged person but someone who is relatively fresh and strong. However, for this study, the coefficient is not significant meaning that this variable is not a strong contributing factor in improving efficiency of upland rice farmers.

The positive sign on the household size indicate that efficiency reduce with size of the household. This could be due to the fact that in most households, size is increased by children who are never at home but in schools. With the free universal primary and secondary education in the country, this is bound to happen. Thereby not having any input in the production process (Ogundari and Ojoo, 2005).

In summary, to increase upland rice farming efficiency, efforts need to be invested in improving farmers' education through either enhancing the universal primary education or providing adult literacy courses which are being implemented in local communities. Also encouraging viable and long lasting group, provision of seed credit, provide relevant extension education and availing labour saving technologies will improve efficiency of upland rice production.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

Elimination of extreme hunger and reducing hunger by 2015 is a millennium development goal that is important for developing countries. Upland rice production in Uganda has been identified as a key component in achieving such goal. However, given the low yields (1.5t/ha) and technical efficiency (61%) being experienced in the country, desired results will not be achieved unless efforts of improving technical efficiency of upland rice farmers are stepped up.

To achieve rice sufficiency as a country, efficiency improving strategies need to be pursued. The study revealed that increasing rice output is being achieved by land expansion (elasticity on rice area 0.65). This is not sustainable as it will lead to loss of soil fertility, soil cover and encroaching on fragile ecosystem which is contrary to the very reason upland rice is being introduced. Thus yield improving technologies especially fertility enhancing and appropriate weed management practices should be encouraged and promoted.

Labour utilization was high (1136 person days) and was significant ($P<0.1$) this confirms how labour intensive this enterprise can be. It is particularly high during weeding and harvesting. Fortunately, these activities can be mechanized through herbicide use and tractor harvesting. It is therefore, possible to reduce the labour intensity to manageable levels for enhanced efficiency.

Seed planted had weaker elasticity (0.225) which implied that increasing seed quantity planted does not improve on existing output. This is particularly true since upland rice farmer were planting (154 Kg/ha) twice the recommended rates of 75- 85kg/ha. This means therefore, that the method of planting was broad casting rather than the recommended line planting, which further calls for rice focused extension information that will address such disparities and boost farmer yields and efficiency.

The study also indicated that increasing primary education of farmers to at least five years of schooling will improve technical efficiency as well as output of rice farmers. The current effort of universal primary and adult community education in the country should therefore be encouraged and emphasised.

It was found that as rice farming experience increased, the less efficient a farmer became. This is contrary to the commonly held view that experience is the best teacher. This contradiction could be stemming from the fact that upland rice is labour intensive, as such could be discouraging farmers as they advance in its production. As they either drop out or reduce on area cultivated. Policies aimed at reducing labour requirements such as creating conducive environment for private tractor system could be explored to reduce on labour dependence. Secondly, weed management strategies should be studied and recommended since the appropriate methods will halve labour demands in production.

Another surprising factor that contradicted the expected findings was the negative relationship between access to extension education and efficiency. The reasons for this could be; one that the crop is relatively new to the farming system as such little attention is devoted to the crop by the extension agents. Secondly, that the extension services being offered are not appropriate for rice production leading to being ignored by the target beneficiaries. This does not take away the importance of extension education but emphasise the need to provide rice targeted extension services.

5.2 Recommendations

For farm level technical efficiency of upland rice to improve, quality inputs need to increase such would include yield improving and labour saving technologies such as fertilizers and herbicides (Currently,0.01% and 9.7% respectively). Secondly, Labour saving technologies, such as pre or post emergency herbicides and mechanization of the upland rice would be a better move in the right direction. Primary education and specialised extension services that target upland rice need to be encouraged.

Extension education was found to be contrary to improving technical efficiency of farmers. However, this does not take away the essence of extension education in promoting and improving crop production. What is needed is to improve extension coverage from the current level of 36.7% to more than half the population for farmers to address simple farming anomalies such as excess utilization if planted seed and inaccessible yield improving technologies. Emphasis therefore should be to offer targeted and specialised extension services that are appropriate to the needs and aspirations of rice farmers needs.

Generally, the scope for improving technical efficiency of upland rice farmers in South Western Uganda from the current level of 61% exists. Emphasis just like Ellis, 2003, puts it, emphasis should be placed on farmer education and extension education which represent the least cost way of achieving technical efficiency.

This study dealt considerably on technical efficiency of upland rice in South Western Uganda. In efficiency studies, this is considered an engineers concept. To effectively gain a broader picture of upland rice system in Uganda and how it may improve on rice sufficiency of the country, allocative and hence economic efficiency studies need to be undertaken. This would provide an insight into how prices are influencing economic decisions of the farmers. Secondly, resource use among upland rice farmers was poor, therefore studies aimed determining optimal resource use in this sector are necessary.

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Appendix 1.

FARM LEVEL SURVEY QUESTIONAIRE IN SOUTH WESTERN UGANDA

ON

TECHNICAL EFFICIENCY IN UPLAND RICE PRODUCTION

Questionnaire number…………………………………
District……………………. County……………………………
Sub-county………………. Parish……………………… Village…………….
A) BACKGROUND INFORMATION
1) Respondent's Names………………..…….. (2) Sex (a) Male (b) Female
3) Marital status (a) Married (b) single (c) Widowed
4) Age……….. (5) Education level and highest class attained………..
6) Household size …………… 7) Adults………… 8) Children……………..

Age group	Sex	
	Male	Female
0 - 7		
8 -18		
19 - 64		
64 +		
Total		

(8) For adults in the household

Member of Household	Sex	Age	Education level	Main occupation	No of years at work

9) Which of the following form your major occupational activity?

Activity	Farming	Trading	Formal employment	Casual work
Ranking (1-4)				
Years in the activity				

10) Do you grow upland rice? A) Yes ( ) No ( )
11) How long have been growing the above rice? …………..
12) Which varieties do you grow on your farm? 1)……………. 2) ………………… 3)………………

B) LAND UTILISATION

13) Land allocation (all in acres)

1st season of 2006 January - June				2nd season of 2006 July - Dec			
Land owned	Land hired	Land rented out	Total land cultivated	Land owned	Land hired	Land rented out	Total land cultivated

(14) What crops do grow in order of preference 1)……………. 2) ……………. 3)…………….. 4)……………………

(15) Land allocation to crops by order of preference

1st season January – June 2006				2nd season July – Dec 2006		
Crop	Owner's land used (acres)	Hired land used (acres)	Total cropped area (acres)	Owner's land used (acres)	Hired land used (acres)	Total cropped area (acres)
1)						
2)						
3)						

C) PRODUCTION INFORMATION ON RICE

INPUT UTILISATION

16) Do you use the following inputs in your upland rice gardens? A) Improved seeds Yes ( ) No ( ) B) Fertilizer Yes ( ) No ( ) C) Agro- chemicals Yes ( ) No ( ) (D) Heavy machinery Yes ( ) No ( ).

17) Do you access inputs from government agencies Yes ( ) No ( )

18) If yes, how much was received……….(Kg)

19) Input utilization in upland rice for last year

1st season 2006						2nd season 2006				
Input type	Quantity used (Kg/ lts)	Price / unit (Ug. Shs)	Distance to source (Kms)	Source/ Provider indicate C for cash and L for credit	For credit amount to be repaid	Quantity used (Kg/ lts)	Price/ unit (Ug. Shs)	Distance to source (Kms)	Source/ Provider indicate C for cash and L for credit	For credit amount to be repaid

20) Have you received any form of training on use of input in upland rice production? A) Yes ( ) b) No ( )
21) If yes, who provided the training?
a) Extension agent (b) NGO (c) Farmer (d) other specify……..
22) For the above service provider, fill the table below on the number of times they rendered service per season.

Service provider	1st season 2006	2nd season 2006
Extension agent (Govt)		
NGO		
Farmer		
Others specify		

D) LABOUR INPUTS IN UPLAND RICE PRODUCTION
23) What is the main source of labour for upland rice production?
a) Family labour (b) Hired labour (c) Both
24) How many labour units in total worked in the rice field in the last two seasons of 2006

	1st season				2nd season			
Type	Men	Women	children	Tractor	Men	Women	children	Tractor
Family labour								
Hired labour								
Total								

25) Activity labour demands in rice for last season

Activity	Type of Worker			
	Men	Women	Children	Tractor

	No.	Days	Cost	No.	Days	Cost	No.	Days	Cost	No.	Days	Cost
Land prep 1st.												
2nd ploughing												
Planting												
Fertilizer application												
1st weeding												
2nd weeding												
Spraying												
Scaring birds												
Harvesting												
Threshing (drying, packaging and storage)												
Transport to market												

Key: men/ women = > 18yrs, children <18. 1 Man- day = 6 person hours for a man = (0.75*6) person hours for woman = 12 child hours.

E) CROP OUTPUT

26) Do you sell rice produced on you farm a) Yes ( ) b) No ( )

27) If yes, please fill the table below.

season	Harvested area (acres)	Quantity harvested (Kg)	Quantity sold (Kg)	Price/ Kg (Ug.Shs)	Point of sale	Cost of sale (tax, transport) (Ug.Shs)	Quantity consumed (Kg)	Quantity given out as donation
1st season								
2nd season								

28) What problems do you face in marketing of upland rice

……………………………………………………………………………………

…………………………………………………………………………………….

…………………………………………………………………………………….

……………………………………………………………………………………..

29) How do you solve the above problems?

…………………………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………………………………

F) GENERAL INFORMATION

30) Do you belong to any group or Association? A) Yes ( ) b) No ( )

31) If yes, what service do you receive from such association?

………………………………………………………………………………………….

…………………………………………………………………………………………..

………………………………………………………………………………………….

32) How many times did you meet last month…………………

33) What problems do you face while producing upland rice?

……………………………………………………………………………………..

…………………………………………………………………………………………..

………………………………………………………………………………………….

………………………………………………………………………………………….

…………………………………………………………………………………………..

34) Please estimate your total seasonal income (Ug.Shs) from the following source.

Sources	1st season 2006 (Ug. Shs)	2nd season 2006 (2006)
Crop enterprise		
Livestock/ products		
Non- farm income		
Remittance		

35) Which of the two seasons do you consider as favourable in this area?

……………………………………………………………………………….

36) How do you rate rainfall in this area?

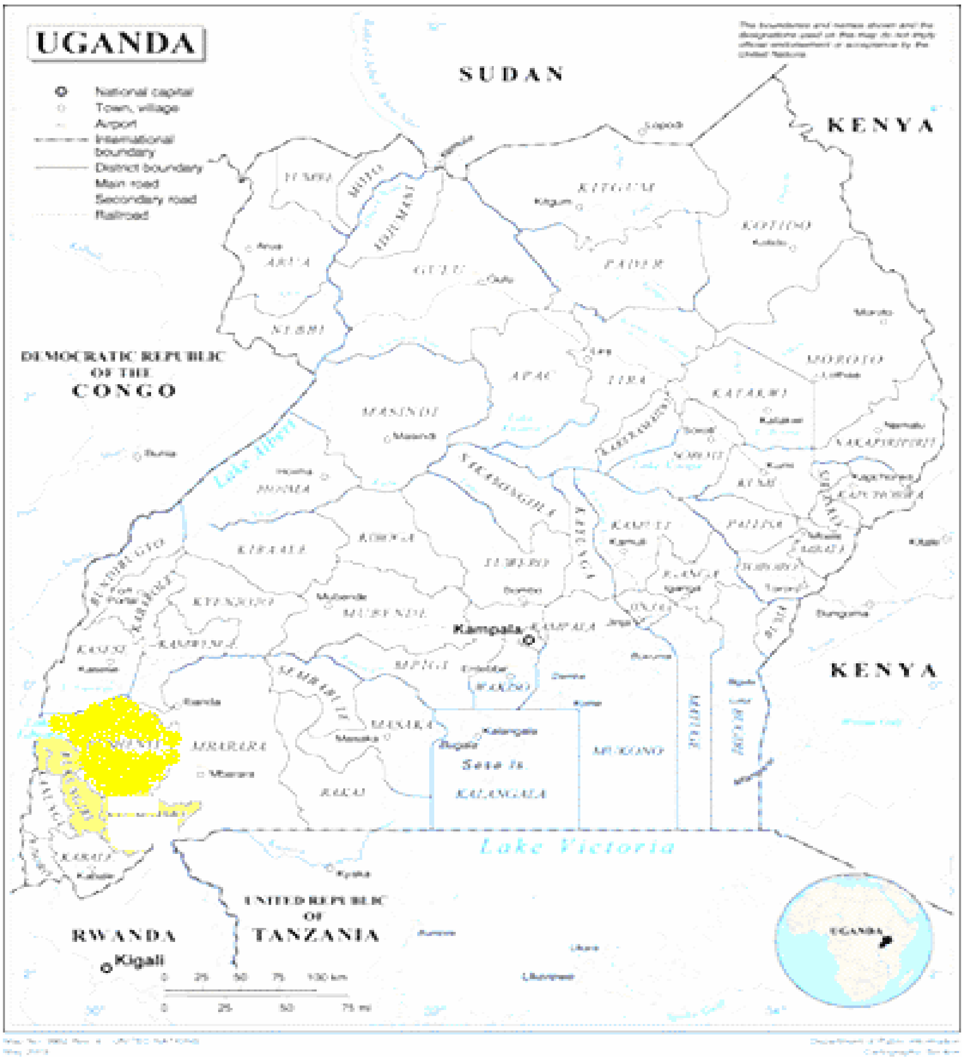
(a) Reliable (b) Average (c) Unreliable

37) How do you rate the fertility of the soils on your farm as compared to other farms you have visited?

(a) Poor (b) Good

THANK YOU

Appendix 2: Map of Uganda showing Study Area



Appendix 3- Results

the final mle estimates are :

	coefficient	standard-error	t-ratio	
beta 0	0.50809561E+01	0.52189872E+00	0.97355213E+01	
beta 1	0.66119099E-01	0.48905394E-01	0.13519797E+01	Land owned
beta 2	0.61511673E+00	0.84663764E-01	0.72654073E+01	rice area
beta 3	0.31973742E+00	0.82209615E-01	0.38892947E+01	ttmdys
beta 4	0.22481464E+00	0.68822706E-01	0.32665766E+01	inpdsd
delta 1	0.51389230E-02	0.80638018E-02	0.63728290E+00	Age
delta 2	-0.75473760E-01	0.42371894E-01	-0.17812222E+01	Education
delta 3	0.61425261E-01	0.27575199E-01	0.22275546E+01	rice experience
delta 4	0.62684651E-02	0.31091656E-01	0.20161246E+00	Hh size
delta 5	0.49954356E+00	0.28971823E+00	0.17242393E+01	extn dmy
delta 6	-0.28562433E+00	0.24714365E+00	-0.11557017E+01	seed credit dmy
delta 7	-0.17156325E+00	0.25567246E+00	-0.67102749E+00	Assocn dmy
sigma-squared	0.54146930E+00	0.13410528E+00	0.40376435E+01	
gamma	0.75409637E+00	0.10519215E+00	0.71687516E+01	

log likelihood function = -0.15888381E+03

LR test of the one-sided error = 0.26201579E+02
with number of restrictions = 8
[note that this statistic has a mixed chi-square distribution]

number of iterations = 22

(maximum number of iterations set at : 100)

number of cross-sections = 196

number of time periods = 1

total number of observations = 196

thus there are: 0 obsns not in the panel

technical efficiency estimates :

mean efficiency = 0.60513707E+00

Translog Estimates

the final mle estimates are :

	coefficient	standard-error	t-ratio
beta 0	0.12177200E+02	0.52062917E+01	0.23389393E+01
beta 1	0.32985399E+00	0.72126631E+00	0.45732622E+00
beta 2	0.17664956E+01	0.12717501E+01	0.13890272E+01
beta 3	-0.17115576E+01	0.16134756E+01	-0.10607893E+01
beta 4	-0.34404269E-01	0.86047520E+00	-0.39982872E-01
beta 5	-0.30550592E-01	0.10835090E+00	-0.28195974E+00
beta 6	-0.50586486E-01	0.98872282E-01	-0.51163466E+00
beta 7	-0.96866944E-02	0.85657522E-01	-0.11308633E+00
beta 8	-0.27671632E+00	0.17718276E+00	-0.15617564E+01
beta 9	0.14613900E+00	0.15901519E+00	0.91902543E+00
beta10	0.84053346E-01	0.15776652E+00	0.53277050E+00
beta11	0.15814060E+00	0.82203158E-01	0.19237777E+01
beta12	0.13984103E-01	0.25883410E+00	0.54027282E-01
beta13	0.24775062E+00	0.27572414E+00	0.89854525E+00
beta14	-0.39792287E-01	0.13044091E+00	-0.30505987E+00
delta 1	0.65296508E-02	0.70805967E-02	0.92218934E+00
delta 2	-0.56506390E-01	0.33453785E-01	-0.16890881E+01
delta 3	0.56736414E-01	0.25215313E-01	0.22500777E+01
delta 4	0.14469953E-01	0.27314815E-01	0.52974744E+00
delta 5	0.46641751E+00	0.25632463E+00	0.18196359E+01
delta 6	-0.24492621E+00	0.22171856E+00	-0.11046717E+01
delta 7	-0.22962996E+00	0.23839950E+00	-0.96321492E+00
sigma-squared	0.48818608E+00	0.10936853E+00	0.44636795E+01
gamma	0.77767825E+00	0.11694675E+00	0.66498492E+01

log likelihood function = -0.15444945E+03
LR test of the one-sided error = 0.25157899E+02
with number of restrictions = 8
[note that this statistic has a mixed chi-square distribution]
number of iterations = 32
(maximum number of iterations set at : 100)
number of cross-sections = 196
number of time periods = 1
total number of observations = 196
thus there are: 0 obsns not in the panel
technical efficiency estimates :

mean efficiency = 0.57858025E+00