EFFECT OF AGRICULTURAL INPUTS AND EXTENSION SERVICES ON HOUSEHOLD CROP PRODUCTION IN UGANDA.

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DECLARATION

I **Emmanuel Menyha**, declare that this is an original piece of work, which has been done by me and has never been submitted for any award before any other institution of learning.

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DEDICATION

To my wife (Ms. Nantume Menyha Clare), children (Trevor E. Menyha, Trevin Menyha and Trevi Menyha) and my mother (Mrs Federis Namutebi) who always encouraged me, even when the going had become tough.

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May God bless you all as “We Build for the Future”!

ABSTRACT

This study was based on results from the Agricultural Module of the Uganda National Household Survey (UNHS) 2005/06 by Uganda Bureau of Statistics (UBOS). The main objective of this study was to establish the effect of agricultural inputs and extension services on household crop production in Uganda.

Banana (food-type) and maize were investigated as two (2) of the five major crops in the Country (UBOS Agricultural Surveys, 1999-2004). The study involved 1,867 and 2,233 households growing banana (food-type) and maize respectively. It should be noted that though it was a crop by crop consideration, some households grew both crops.

A Multiple linear regression model (Meta production function) was used to establish the study's main and specific objectives. All the continuous variables were discovered not to be normally distributed and they were transformed by taking their natural logarithm.

From the study, the average banana (food-type) and maize production were 759.5 and 392 kg/acre respectively. The average area under banana (food-type) and maize were also estimated to be 1.5 and 1.6 acres respectively. The study also revealed that, from the banana (food-type) growing households, 24.2 percent had a member who had participated in a NAADS Training program, 30.9 percent changed practice with respect to agricultural technology and 12.0 percent had been visited by an extension worker in the last 12 months" respectively.

Household crop production in general and Banana (food-type) production in particular highly gained from farmers' proper application of both agricultural inputs and extension services, hired labour (in terms of labour days) on the plots reduced household crop production but this was however not significant, household agricultural investment in terms of purchases of inputs such as seeds, fertilizers, manure and pesticides on plots increased household crop production.

Similarly, household crop production gained highly from household member participation in NAADS training and use of child household member for labour on the crop plot.

The sex of the head of households (who most times take decisions on management of agricultural enterprises) had an effect on household crop production in that Male headed agricultural households realized a boost in crop production than those of their female counterparts.

Access and use of the above inputs and extension services is vital in boosting household crop production. The government through the Ministry of Finance, Planning and Economic Development (MFPED) should avail financial resources to the public and private sectors through the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) and it departments to implement an efficient agricultural inputs (fertilizer/manure) awareness system, which will benefit farmers by teaching them the effective application and economics of fertilizer/manure use. Government though Ministry of Gender, Labour and Social Developments (MGLSD) should continue to strengthen women emancipation strategies especially for women farmers to support them in areas like acquisition of low interest agricultural loans to enhance their household crop production. This will help increase production for female headed agricultural households in the country since women even provide more labour days on the plot than their male counterparts. The National Agricultural Advisory Services (NAADS) should be strengthened so that it quickly rolls out to all districts of the country for effective provision of demand driven extension services.

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ACRONYMS AND ABBREVIATIONS

ANCOVA	–	Analysis of Covariance
ANOVA	–	Analysis of Variance
ARDCs	–	Agricultural Research and Development Centres
CARD	–	Community Action for Rural Developments
CIS	–	Community Information System
EA	–	Enumeration Area
FAO	–	Food and Agricultural Organization
GDP	–	Gross Domestic Product
ICT	–	Information and Communication Technology
IDEA	–	Investment in Developing Export Agriculture
IDP	–	Internally Displaced Persons
IFPRI	–	International Food Policy Research Institute
IILS	–	International Institute for Labour Studies
JESE	–	Joint Effort to Save the Environment
MFPED	–	Ministry of Finance, Planning and Economic Development
MGLSD	–	Ministry of Gender, Labour and Social Developments
NAADS	–	National Agricultural Advisory Services
NARO	–	National Agricultural Research Organization
NASS	–	National Agricultural Statistics System
NGO	–	Non Governmental Organization
NGCU	–	Nyakatonzi Growers Cooperative Union
PASS	–	Permanent Agricultural Statistics System/Survey
PEAP	–	Poverty Eradication Action Plan
PMA	–	Plan for Modernization of Agriculture
PPS	–	Probability Proportional to Size
RDS	–	Rural Development Strategy
RNF	–	Rural Non Farm
SANE	-	South African New Economic Network
SPEED	–	Support for Private Enterprise Expansion and Development
SRS	–	Simple Random Sampling
SSA	–	Sub-Saharan Africa
TCC	–	Talent Calls Clubs
UBOS	–	Uganda Bureau of Statistics
UNDP	–	United Nations Development Programme
UNHS	–	Uganda National household Survey
UPE	–	Universal Primary Education.
USE	–	Universal Secondary Education
URA	–	Uganda Revenue Authority

CHAPTER ONE:
INTRODUCTION

1.1. Background

Agriculture is the dominant sector of Uganda's economy. This sector contributes about 21 percent to total Gross Domestic Product (GDP) and over 90 percent to total export earnings. It provides 80 percent of employment and most industries and services in the country are based on this sector. About 85 percent of the population live in rural areas of the country where they derive their livelihood from agriculture. Much of the agricultural production in Uganda takes place at household level essentially using household labour. It has been estimated that women contribute about 75 percent of the labour force. Agricultural production in the country is based on smallholder production. There are now about 2.5 million such holders who carry out rain fed agriculture and who, on average, cultivate less than 2 hectares mainly using a hand hoe (UBOS, 2007).

1.1.1. Government Strategy for Developing the Agricultural Sector

The Uganda Government has developed the Poverty Eradication Action Plan (PEAP) as the guiding framework for the achievement of poverty eradication. Since agriculture is the key to general improved economic performance, increased incomes and raising of the standards of living of households, as well as poverty eradication in the country, the government has in turn embarked on a major programme to modernise it. This includes provision of advisory services among other things, use of improved/advanced technology in production and application of inputs to increase quality of production with a view of adding value to the production. The National Agricultural Advisory Services (NAADS) and Plan for Modernisation of Agriculture (PMA) were designed and adopted by Government as the Master Plan for agricultural development in the country.

According to the National Budget Framework Paper for the Financial Years 2005/06 to 2007/08, the objectives of the Rural Development Strategy (RDS) include increasing farm productivity and household outputs, adding **value** to production and ensuring a stable market for selected agricultural products.

One way of monitoring these objectives is through the establishment of a well organized Community Information System (CIS) supplemented by National Agricultural Statistics System (NASS) building blocks of:

- Population and Housing Census – Agricultural Module,
- Uganda Census of Agriculture and Livestock,
- Agricultural Sample Surveys under UNHS,
- Permanent Agricultural Statistics System and
- Other Institutions such as Meteorology Department etc.

These need to regularly report on the human population that exists in a given location and their characteristics, their economic status, the income of their households and the overall welfare of the communities in which they live.

1.2. Problem Statement

Uganda, like many developing countries in the world particularly those on the continent of Africa continue to increasingly find it extremely difficult for their escalating populations to be food secure yet part of the low food production is sold by the population. The only approach of increasing the incomes of these entirely rural subsistence farmers who dominate the agricultural production systems in Uganda and with limited adoption to modern agricultural practices, is to increase agricultural production and its quality through provision and use of inputs such as pesticides, fertilizers, labour, machinery, high yielding seeds and above all extension services.

It should however be observed that with costs notwithstanding, Uganda registered a reduction in the number of people living in absolute poverty from 56 percent in 1992 to 38 percent in 2004. Despite Uganda's fertile soil and favourable climate, five percent of rural households continue to experience food insecurity. The economy grew by an average of 5.3 percent in the 2005/06 financial year, a reduction from 6.6 percent in the 2004/2005 period. The reduction in growth resulted mostly from a prolonged drought, leading to reduced agricultural production and other factors (FAO 2006). The hurdle is to know why despite all above applications (including introduction of drought resistant crops), the food security situation still remains some how un-certain and why most crop yields remain dropping towards under one ton/hectare (UBOS 2005) as seen in Table 1.1. It is therefore necessary to establish how inputs/extension services have actually tried to rectify the food production situation.

1.3 Objectives of the Study

The main objective of the study was to establish the effect of agricultural inputs and extension services on household crop production.

The specific objectives included:

1. To find out the relationship between inputs/extension services, and household banana production.
2. To determine the relationship between hired labour on plot and household crop production.
3. To establish relationship between "Cost on seeds/seedlings" and "Cost on Fertilizers, manure, Pesticides" on household crop production.
4. To find out the effect of Household member participation in a NAADS Training on household crop production.
5. To establish the effect household child labour on household crop production.
6. Determine the relationship between sex of the household head and household crop production.

1.4. Hypotheses

1. There is no relationship between hired labour on the plot, and household crop production.
2. Cost on “seeds/seedlings” and “Cost on fertilizers, manure, pesticides” have no relationship with household crop production.
3. Household with a member who participate in NAADS Training do not have increased household crop production.
4. Labour on plots by children from the household does not affect household crop production.
5. Sex of the head of household does not affect household agricultural production.

1.5. The Study Scope

The study utilized data from the Agricultural Module of the Uganda National Household Survey (UNHS) 2005/06, collected in the First season 2005. It covered two (2) out of the ten (10) major crops in Uganda and these include; Banana (Food-type) and Maize.

Banana (Food-type) and Maize are grown in almost all the four regions in the country except in the Northern region where not much of Banana (Food-type) is grown.

1.6. Significance of the Study.

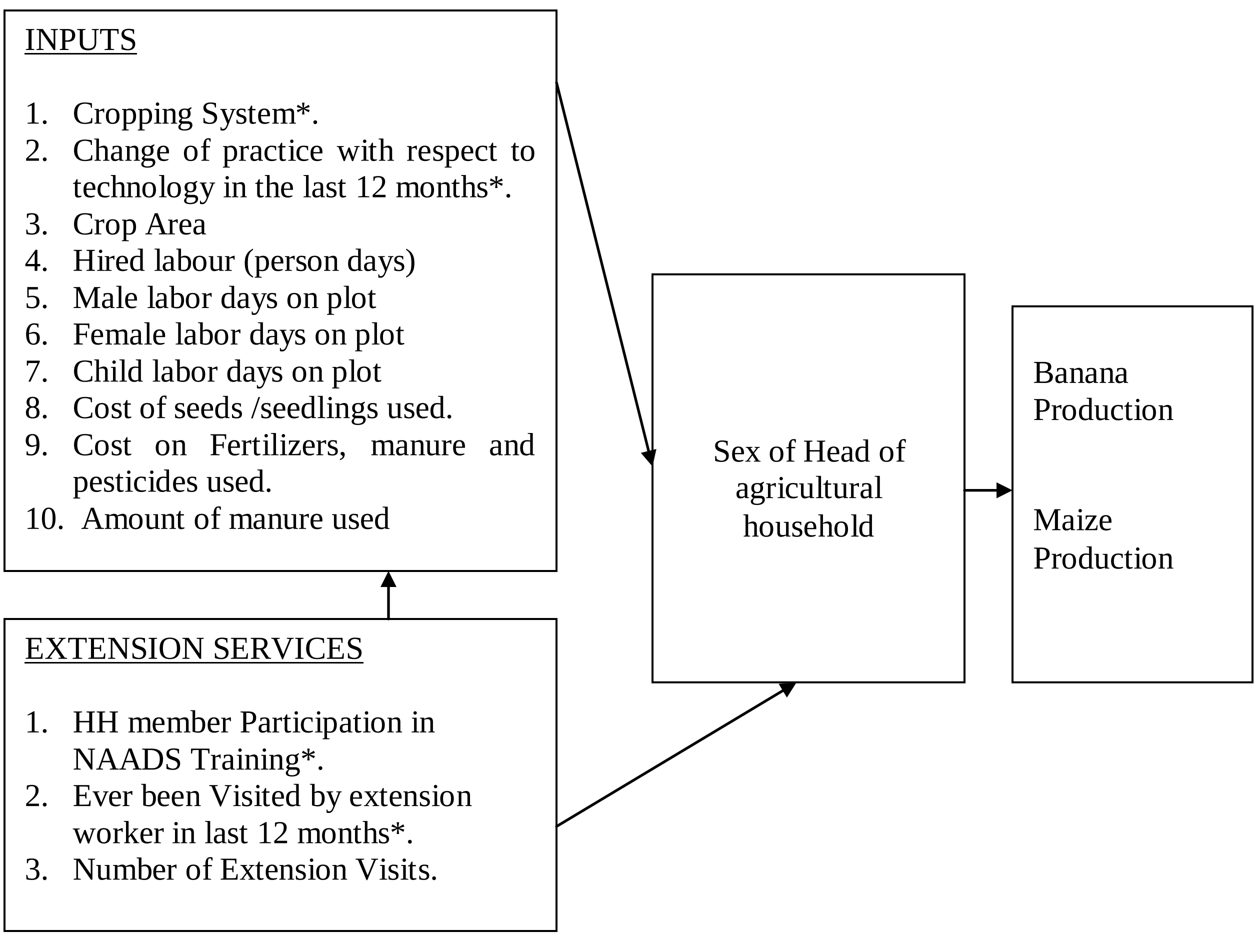
It should be recalled that much of the agricultural production in Uganda takes place at household level essentially using household labour. Agricultural production in the country is based on smallholder production with about 2.5 million such holders who carry out rain fed agriculture and who, on average, cultivate less than 2 hectares mainly using a hand hoe. The Uganda Government has an over-arching goal of poverty eradication through Poverty Eradication Action Plan (PEAP) as the guiding framework so that production, economic performance, increased incomes and raising of the standards of living of households can be realised.

All these needed major programmes like PMA and NAADS to modernise the agricultural sector through; provision of advisory services, enhancement on use of improved/advanced technology in production and application of inputs to increase quality of production with a view of adding value to the production.

Like in other countries, inputs are expected to reduce food shortages but trends of yields of crops over years are going down ward (UBOS Statistical Abstract 2006) and there is still substantial importation of some food into the country (URA 2006). This contemplates the effect of inputs, extension provision and technological development on production, its quality and hence value.

As the study seeks to establish the relationship between agricultural inputs, extension provision and technological development on crop production, it will benefit and direct the service providers, farmers, government and all stakeholders in agriculture or its statistics and poverty issues on the way-forward in terms of interventions

1.7. Conceptual Framework



* Categorical variable

The above stipulated conceptual framework demonstrates the exit criteria for the Household crop production based on Agricultural Inputs, Extension Services and Sex of Head of Households. Household Banana production and or Maize production were used as performance indicators to evaluate the effects of the independent variables on household crop production since they are the main crops in the Uganda (UBOS, 2006 and 1999/2000).

1.8. Outline of the Dissertation

This dissertation is composed of five chapters. Chapter one is the introduction that reviews the background of the study, highlights the problem statement, objectives of the study, the hypotheses, study scope, significance of the study and the conceptual framework. Chapter two presents the literature review on previous related studies of the effect of agricultural inputs and extension services on household crop production. Chapter three presents the methodology used, the data source, the sample size and data management and analysis.

Chapter four presents the findings from the univariate, bivariate and multivariate analysis of the effect of agricultural inputs and extension services on household crop production in Uganda. The last chapter (chapter five) gives the summary of findings, conclusions and recommendations of the study.

CHAPTER TWO:
LITERATURE REVIEW

2.1. Introduction

The Food and Agricultural Organization (FAO) of the United Nations (1990) indicated that there is mounting evidence that Rural Non Farm (RNF) income is an important resource for farm and other rural households, including the landless poor as well as rural town residents. However, the traditional image of farm households in developing countries has been that they focus almost exclusively on farming and undertake little rural non-farm (RNF) activity. This image persists and is widespread even today. Policy debate still tends to equate farm income with rural incomes, and rural/urban relations with farm/non-farm relations. Industry Ministries have thus focused on urban industry and Ministries of Agriculture on farming, and there has been a tendency even among agriculturists and those interested in rural development to neglect the RNF sector. One of the main reasons why the promotion of RNF activity can be of great interest to developing country policy-makers is in the face of credit constraints, where RNF activity affects the performance of agriculture by providing farmers with cash to invest in productivity-enhancing inputs. Furthermore, development of RNF activity in the food system (including agro-processing, distribution and the provision of farm inputs) may increase the profitability of farming by increasing the availability of inputs and improving access to market outlets. In turn, better performance of the food system increases rural incomes and lowers urban food prices (FAO, 1990).

The factor bias of agricultural technology (labour-intensive or capital-intensive) and the seasonality of farm labour requirements influence the supply of labour to RNF employment. Crop technology may use labour so intensively that little is left for the family to use in off-farm activities. Such an image of labour-using agriculture constraining off-farm labour availability can be found in Asia's "monsoon economy", with marked seasonality in rice cropping owing to rainfall patterns. Planting and harvesting occupy labour in peak seasons of farm employment. Demand for farm labour is generally low during the rest of the year, hence the need for off-farm sources of income during the slack period (FAO, 1990).

2.2. Inputs and Production

The International Institute for Labour Studies – IILS (2006) showed that access to agricultural land is a necessary condition for making an agricultural livelihood, but it is not a sufficient condition. Livelihoods based on land depend on the mobilization of other factors of production - the mobilization of labour and application of a range of productive inputs, such as fertilizers, pesticides, animal traction, agricultural technology and improved implements. Secure livelihoods also depend on the maintenance of yields and the avoidance of agricultural practices which lead to land degradation.

In indigenous land tenure systems in which a household is allowed to put under cultivation as much land as it can use, the ability to mobilize labour resources, through control of the household, is a central determinant of wealth and poverty when land is abundant (Binswanger and MacIntyre, 1987; Meillassoux 1981; and Smith 1991). As available land becomes scarce, the application of inputs which enhance land productivity become more important than expansion of the area of production in determining total production, and access to those inputs become more important in determining agricultural livelihoods. "Modern" inputs can offer a way of cultivating land intensively without degradation (though this is not always so).

With the commercialization of production, livelihoods also depend upon the ability to cultivate high-value crops and access to output markets.

These considerations mean that agricultural livelihoods depend on the interaction between access to productive inputs, high-value crops, and output markets. These interactions are complex. They are taking place within an international frame, in the sense that the prices of many of the agricultural commodities produced and agricultural inputs used in Africa are determined in international markets. Agricultural policies are also the subject of negotiations surrounding the implementation of structural adjustment programmes.

2.3 Access to "Modern" Inputs in Sub-Saharan Africa

A principal feature of African agriculture is that agricultural commercialization has proceeded rapidly throughout the continent during this century, but in a spatially uneven way. Commercialization has also been unbalanced, in the sense that many producers are engaged in commercial sales, with or without production for self-provisioning, but they do so with a low level of capitalization in terms of purchase of inputs. Reyna and Downs (1988), who emphasize the importance of this "unbalanced agricultural commercialization", indicate that the utilization of agricultural inputs is much lower in **Africa south of the Sahara** than in other Third World areas, and they dramatize the situation by stating that "although most farmers now produce for the market, they do so with essentially Neolithic tools".

A recurrent theme of development policy in Africa in the postcolonial period has been to "modernize" agriculture. This has many strands (Bernstein 1992), but an important component has been the promotion of greater marketed output, increased production and improved productivity through the application of modern inputs (fertilizers, new varieties, pesticides, herbicides). Bernstein suggests that there are three major approaches to "modernizing" agriculture when production is organized on the basis of peasant farms: (i) "the smashing of the peasantry through direct dispossession typically achieved by violence";

(ii) "'bypassing' peasant farming" through large scale production (capitalist or state farm) on unoccupied cultivable or grazing land;and

(iii) "to 'lock in' peasants (or at least those commanding adequate resources) through higher - and controlled- levels of input and credit use, and controlling (increased) output through the organization of marketing and processing, thus achieving greater commoditisation, specialization, and standardization".

In Africa, the first approach was applied in white settler and plantation regions in the colonial period, and there are localized examples of dispossession and usurpation of land since independence from the former colonial masters. There also examples of the second approach (such as the expansion of rice farming in Northern Ghana). However, it is the third approach which has provided the main way of "modernizing" agriculture in Africa. It has been highly selective in that it has focused:

i) on high potential areas with higher and more reliable rainfall versus lower potential and marginal areas.

ii) on farmers with more resources versus those with fewer resources.

iii) on men versus women farmers, which tend to be associated with (ii) (Bernstein 1992:9).

FAO (1958) also demonstrate sustained production and conservation as aims of agriculture but the population worldwide falls short of meeting this aim as there is still food shortages and soils are deteriorating because of decrease in fertility and organic matter. Loss of soil fertility leads to low crop productivity and inputs such as fertilizers facilitate the farmer to raise yields of crops such as maize, banana(Food-type), rice and coffee. Therefore, all efforts made to increase agricultural efficiency and hence production / productivity, more inputs, agricultural technology as well as extension advise receipt is paramount.

2.3.1. Access to Agricultural Inputs in Uganda

The current productivity observed in the Ugandan farming community is very low, in many cases much lower than the genetic potential expressed under optimal conditions in research stations (NARO, Annual Reports, 2000–2005). This low productivity is due to soil fertility depletion, heavy reliance on basic indigenous technology including the use of unimproved and low-yielding planting material, limited practice of crop protection, high postharvest losses arising from inadequate storage and processing capacity, etc. (Ministry of Finance, Planning and Economic Development, 1998).

Accordingly, the PMA seeks to improve agricultural input market access through various strategies, including: 1) improving the availability and timely distribution of high yielding, quick maturing, pest and disease-resistant planting and stocking materials; 2) encouraging the participation of the private sector in seed multiplication, processing and marketing; 3) promoting the use of fertilizers by farmers; and 4) developing an effective network of stockists to make vital inputs available and accessible to the farming community (Government of Uganda 2000).

Seed is a crucial input determining yield (Muhhuku 2002). If bio–fortified varieties are to attain rapid, widespread distribution through an efficient seed scheme must be in place. For grain crops this will be available with the setting–up of Uganda Seeds Limited (USL) and the proposed close linkages with NARO and NAADS. However, to date neither the Uganda Seed Project (USP) nor USL have dealt with vegetatively–propagated crops which are more prone to carrying disease from one generation to the next, have a slow rate multiplication and are often highly perishable. A case in point is sweetpotato, where experience throughout East and Central Africa have demonstrated that the maintenance of stocks to have a timely and adequate supply of planting material at the onset of the rains is a major production constraint. Uganda Seeds Limited has hitherto only been concerned with grain crops, thus alternative schemes must be developed for the vegetatively propagated crops.

A major factor influencing yield is seed quality. The seed industry in Uganda is largely undeveloped, with farmers relying almost entirely on their own low-yielding seed supplies. The Government of Uganda recognizes that both the public and private sectors have critical roles to play in the development of the seed industry. The major interventions include:

Uganda Seeds Limited (USL), a limited liability company wholly owned by Government, was incorporated in 1999 to assume the functions of Uganda Seed Project formerly under the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF), which is in line with the conditionality of the African Development Bank that funded the former Government project, Uganda Seeds Project, on condition that Private Sector Participation would be introduced in the operations of Uganda Seeds project to ensure sustainability and efficient delivery of improved seeds to the farming community in Uganda (United Nations Industrial Development Organization, *2005*).

a) Within the framework of NARO and NARS, the public sector is being encouraged to play the lead role in seed research, including production of foundation seed and development of a national gene bank.
b) The private sector is being encouraged to multiply foundation seed and engage in seed certification, processing and marketing.
c) A seed certification service for quality control and issuance of phyto-sanitary certificates has been set up through the MAAIF.
d) MAAIF and NAADS are cooperating to facilitate seed stockists and the adoption of improved seed varieties by farmers.

e) Institutional arrangements are to be put in place to maximize the opportunities offered by the international development of improved seeds and planting materials, while minimizing the potential dangers of such importation.

2.4. Female-Headed Households and access to Inputs

IILS (2006) showed that it is worth underlining the position of female-headed households with agricultural livelihoods, who are often poor because of limited ability to mobilize labour for farming, restrictions on access to credit and inputs, and exclusion from off-farm income. These are an important "excluded group" in sub-saharan Africa, where a common pattern is for the men to migrate to work in the urban areas and the women to work land to which they have access through continued use under indigenous tenure systems (see Bush, Cliffe and Jansen 1986). The internal dynamics of these "doubly-divided' households is complex, and conflicts, and abandonment, may particularly reflect the impossible position both women and men find themselves given their allotted gender roles in conditions of economic stress (Whitehead 1990 for a brief, but subtle account).

There is a strong correlation between the destitute, 'poor peasant' families and the women-headed households who number roughly 30% of rural households in most of southern Africa. Many of these are without regular remittances of earnings from elsewhere and their own production is massively constrained as they have less chance of access to land, and to oxen for ploughing, and are also short of labour at crucial seasons, with the result that, in Botswana, 80% of all those working for rations' in drought relief projects were women. (Bush, Cliffe, and Jansen 1986: 298-99).

Chipande (1986) in his study on “exclusion of women from credit and inputs in an agricultural development scheme in Malawi” documents said the inability of female-headed households to mobilize labour led to a poor credit rating for those households and, as a result, severe restrictions on access to inputs.

2.5. Use of Agricultural Inputs in Uganda

In Uganda, agriculture is the source of livelihood for over 80% of the country's population, 95% of which are resource-poor small-scale farmers. Declines in soil fertility, low availability of land, scarcity of fuel wood, and new unpredictable rainfall patterns have reduced food production and the ability of households to generate food and income (UBOS, 2007).

Most national research efforts carried out at research stations with no farmer participation have not solved these problems. The lack of resources within the Department of Agriculture Extension Service (for example, there is one extension worker for every 4,000 farm families) has made it impossible for relevant research findings to make it to farming communities. The high price of agricultural inputs has further impeded the spread of Green Revolution technology among farmers (IFPRI 1998).

The above situations have been compounded by the many years of social turmoil which lasted until 1985, which further increased poverty and established a land tenure system which does not provide secure ownership to many farmers, thus resulting in increased pressure on the land. In the last five years, changes in rainfall patterns with unexpected periods of drought are further stretching the limits of traditional farming, with increasing loss of topsoil and soil nutrients.

Given these trends, most farmers continue practicing traditional methods of farming, which provide risk aversion but exhibit low productivity. Recently, various NGOs have assisted farmers with organic and low-input technologies in order to enhance the productive potential of small farmers. Such efforts became an important foundation for the development of new agricultural technologies for poor farmers.

Some data on adoption rates of the various techniques promoted have been collected. All South African New Economic Network (SANE) Ugandan NGO partners emphasize similar agroecological practices (intercropping, zero grazing, agroforestry, botanical pesticides, etc.). The adoption level by farmers of the various techniques promoted by Talent Calls Clubs (TCC) and Joint Effort to Save the Environment (JESE) located in Goma Sub-county on the outskirts of Kampala yielded some results. It is interesting to note that those techniques requiring the purchase of equipment or other inputs, even modest, tend to have low adoption rates. For example, due to the simplicity and efficacy of the method, it was expected that liquid "manure",

a fertilizer made from green leaves, would be widely adopted. However, out of 25 farmers trained in making liquid manure, only 9 were seen using this technique in follow-up visits. The Community Action for Rural Developments-CARD (active in Lugolole parish, a savanna area in Eastern Uganda 1989) staff explained that the purchase of the relatively cheap containers needed to hold the liquid prevented wider adoption. Similarly, demonstrations on making solar ovens did not lead to the adoption of the technique because the ovens require glass, which costs US $20.
In contrast, techniques that are low-cost or based on local resources exhibited wider adoption. For example, a workshop conducted by CARD with farmers on making fuel-efficient mudstoves using locally-available clay resulted in 75 out of 100 farmers adopting this kind of stove. Similarly, 30 farmers received training on mulching as a way to retain moisture, control weeds, reduce soil erosion, and add organic matter to the soil. The mulch is made of crop residues available on-site and was adopted by 42 farmers. As a last example, all 48 farmers receiving training from TCC on intercropping banana or plantain, with other crops like beans and passion fruit, eventually ended up practicing intercropping and application of other inputs (Toler, D.L. 1996.).

The International Food Policy Research Institute Country note for Uganda under "*Theme 1—Technology, Productivity, and Investment Promotion*" looked at three important aspects as; Efficient use of input, Determinants of input availability and accessibility, and Return to input use among others as below:

(a). Efficient use of input. Uganda has one of the lowest crop and livestock yields in Sub-Saharan Africa (SSA), despite an excellent agroclimatic environment (yields on research stations are 2 to 5 times higher than farm yields). It is widely believed that the stagnation of agricultural productivity in Uganda can be traced to little use of modern inputs, yet about 30 percent of Ugandan soils are categorized as being of low productivity.
One of the important factors underlying the low level of modern input use is lack of an efficient distribution system that would ensure timely availability of inputs at reasonable prices. To increase agricultural productivity in Uganda, there is need to use productive inputs like fertilizer, pesticides, high-yielding crop varieties, and improved livestock breeds. There is need to carry out

studies on productivity efficiency and input use, and to determine product-input combination and product-product mix (IFPRI, 2003).

(b). Determinants of input availability and accessibility. Government has, for the past decade, undertaken a number of policy reforms to encourage and promote the private sector's role in input distribution to producers. Despite the reforms, the majority of farmers still do not have access to productive inputs. It is not clear whether the low rate of use of such inputs is related to their supply or demand. It is, therefore, necessary to conduct policy research on the following areas: domestic production vs. importation of inputs; government input distribution policy; capacity of private sector to distribute inputs; incentive structures for the private sector; institutional and structural barriers to trade in inputs; effect of input prices on rates of adoption by farmers and production incentives; key inputs needed; and regulatory and monitoring mechanisms to prevent environmental damage and underground water pollution.

(c).Return to input use. Return to factors of production is very low in Uganda. Most farmers are not able to realize a return to their efforts. This is primarily due to low market prices, poor yields, and poor access to markets. What is required is policy research to address the following questions: What are the returns to investment under different production systems? What are the opportunities for the private sector to invest in agriculture and what are the constraints and available incentives (IFPRI, 2003)?

2.6. Constraints of input use

2.6.1. Disaggregation

Insufficient disaggregation of inputs implies the inability to assign inputs to particular outputs. For example, the total amount of fertilizer or labour may be known, but how they are allocated among agricultural products may not. This is of particular importance when allocation of inputs is skewed to a minority of producers or crops such that reallocation could greatly improve total agricultural output.

Perhaps a greater problem exists with public expenditures and how to allocate them to agriculture. Rural development projects, for example, may have an agricultural component, but may not have an exclusively agricultural focus. Public education and training is rarely exclusively for agriculture, creating problems of how to allocate the expenditures to agriculture. Private education and training investments also are difficult to separate out an agricultural component.

2.6.2. Measuring Inputs and Outputs

A recognized problem is simply in measuring output. Kelly et al. (1995) estimate that data collection methods underestimate African agricultural production by up to 50 percent. This is because mixed cropping is common, crop by-products are not enumerated, crops are consumed at home or as inputs to other household production activities, or farmers have diversified into new products that are poorly enumerated in national surveys. On the input side, little data is available on small capital investments such as implements and land improvements, especially the family labour in land improvements.

2.6.3. Valuing Natural and Human Resources

Neither technology nor human capital can be quantified directly. Expenditures on research and extension have been successfully used as proxies for technology. Proxies for human capital are more problematic. Education level is generally available only at the national or regional level, not for the agricultural sector, thus is only a rough estimate of the level of agricultural human capital.

2.7. Agricultural Extension Services in Uganda

2.7.1. Agricultural Extension evolution

Agricultural extension in Uganda has undergone a number of transformations from regulatory 1920- 1956, advisory 1956-1963, advisory education 1964-1971, dormancy 1972-1981, recovery 1982- 1999, educational 1992-1996, participatory education 1997-1998, decentralized education 1997- 2001 and now agricultural services under contract extension systems. Each of those up to 1997- 2001 had strengths to build on and weaknesses to change or improve, but had challenges of the socio-economic and political environment. In addition there have been marked changes in the concept of agriculture, which is increasingly seen in terms of commercial or farming for market with emphasis on modernization of agriculture and use of participatory approaches in the process.

All evolutions over time through transformation into unsustainable service were for several reasons; There was no policy on agricultural extension until the establishment of National Agricultural Advisory Services (NAADS), the transformation of extension did not build on the strengths of the past, the relied upon expert advice has mainly been foreign more than local and the dependence on donor funding; The policy and mechanisms to empower the farmer to demand, pay and control extension services are in place (*Semana, 1999*).

The dilemma is that the majority of the Ugandan farming community is predominately peasantry /subsistence with a small fraction that can be regarded emergent farmers. Such population may not respond sustainably to the now farmer owned contract extension system including changing patterns of donors.

2.7.2. Agricultural Extension: The National Agricultural Advisory Service (NAADS)

The National Agricultural Advisory Service (NAADS) equates to the first pillar of the PMA and began operations in 2001, but was officially promulgated in the National Agricultural Advisory Services Act (2005). The mission of the NAADS, which replaces the previous extension services, is to increase farmer access to information and technology through effective, sustainable and decentralized advisory services with increased private sector involvement (Government of Uganda 2000). The NAADS is strongly orientated towards commercializing agriculture and improving the linkage between farms and markets and focuses on a decentralized, demand-driven approach to the provision of extension services. Farmer contributions and matching grants from local and national government authorities, along with farmer contributions, are used to contract private service providers to advise them on technology, thereby replacing the old bureaucratic extension system with a programme that offers the farmers a much greater level of ownership and accountability (ASWG, 2003; Faye et. al, 2005).

The NAADS Programme initially covered 6 districts in 2001/02, but an aggressive rollout from 2004 into early 2006 brought the total coverage to 47 districts and 344 sub-counties (ASPS II 2005). The programme expansion was planned in a geographically-phased manner to ensure that sufficient capacities, both in terms of staff and target groups, were available for successful implementation. According to this plan, all districts should be incorporated into the NAADS Programme by the end of 2008 (ASWG, 2003).

As of July 2003, 5005 farmer groups had registered with the NAADS, and a further 3633 groups had registrations pending. Notably, approximately 60 percent of the group members were female. In addition, 2243 technology development sites had been developed at an approximate cost of 540 million Uganda Shillings, and were being utilized by 42,918 farmers. A total of 51 different improved technologies relating to a range of enterprises, including temperate fruit trees, honey production, livestock and fish, were being tested at these sites (ASWG, 2003).

In the districts and sub-counties that had not yet been included in the NAADS Programme, graduates of the programme were employed to provide advisory services to farmers. MAAIF provided logistical support, mainly in the form of motorcycles and training, and most of the operational expenses were covered by the local governments.

As of December 2004, the NAADS was serving approximately 17,000 farmer groups, with an average of 19.7 farmer households per group. Thus, some 400,000 rural households (approximately 2.5 million individuals) had received or were receiving advisory services from NAADS at that time (Faye et. al, 2005).

The formation of farmer groups under the NAADS programme has resulted in: (a) improved organization and financing of beneficiaries (farmers) at the local level, allowing them to demand better service provision; (b) improved access to information, including better technology at the technology development sites; and (c) farmers having greater input into planning processes at the local government level, resulting theoretically, at least in plans that should meet local-level needs more effectively (ASWG, 2003).

2.7.3. Quality Agricultural Services for Uganda's Farmers

Low productivity of Ugandan farmers is attributed to research and extension services that are not adequately demand-driven and low use of new technologies by farmers even when they are available. Uganda's Plan for the Modernization of Agriculture assigns first priority to agriculture extension and research, focusing on achieving greater relevance in both the research and extension programs. This effort is supported by a multi-donor National Agricultural Advisory Services Project (NAADS)–designed to make poor farmers aware of and equipped to adopt, improved technology and management practices. By the end of 2006, the project was operating in 37 districts out of a total of 80. By the end of 2007, it is expected to have reached 64 districts. Surveys carried out in 2006 indicated that farmers in those counties covered by the NAADS Project are adopting technologies that lead to real improvements in yields and farm incomes. Productivity of those farmers is reported to be 27 percent higher than those in areas not currently served by the project (IDA/World Bank, 2007).

It should be noted that;

- The NAADS project continues to expand rapidly.
- 64 percent of farmers groups have reported replicating some aspects of the new project technology on their own fields.

2.8. Agricultural Research and Technology Development

Agricultural transformation is seen to start by increasing the productivity per unit area through adoption of high-yielding, pest and disease-resistant crop varieties, use of appropriate crop and animal husbandry practices, maintenance of soil fertility through use of organic and inorganic manures, and the development of soil water management skills (MAAIF/MFPED, 2000).

In an effort to make agricultural research more needs-oriented, the Government of Uganda carried out an extensive review of the entire National Agricultural Research System (NARS), under the auspices of the PMA in 2001. The overall objective was to create a more decentralized and demand-led NARS. Based on the findings of this review, a National Agricultural Research Policy was produced and approved by Government in 2004 (MAAIF, 2004).

The new policy will ensure that: (a) technology decisions are made only after the issue has been discussed by representatives of all groups likely to be affected by the activities/decisions; (b) each new technology will be considered in terms of its costs and benefits, including the opportunity costs of the required inputs and the market prospects for increased output; and (c) researchers and advisors will examine potential risks and labor requirements and their possible effects on different categories of people in rural households and will discuss their findings with the relevant groups (e.g. farmers) prior to enactment. In this way, it is hoped that the future technologies developed and made available under the NARS will better reflect and address the problems experienced by various categories of farmers, especially resource-poor individuals such as women and children (ASWG, 2003).

Enactment of the National Agricultural Research Policy was delayed until June 2005. However some activities within the Agricultural Research Programme began at the start of fiscal year (FY) 2004/05 (Government of Uganda 2004; TJRPMA 2004). Recent efforts by NARO to increase its outreach activities and decentralize research under the new NARS policy have resulted in the initiation of an Outreach and Partnership Initiative (OPI) for establishing Agricultural Research and Development Centers (ARDCs), which are located in key ecological zones, where they intend to: 1) improve the efficiency and effectiveness of agricultural research services; 2) promote and solicit for specific zonal agricultural demands; and 3) assess technologies suited to particular zones. The OPI initiative has resulted in a high level of participation from farmers and other individuals in the private sector, and the ARDCs are run by steering committees composed of district officials, politicians and farmers who are tasked with planning and implementation from the zonal to sub-county levels. At each level, workshops quite often precede research activities, and in many cases, the private sector has become involved in promoting the new technologies (ASWG, 2003).

CHAPTER THREE:
METHODOLOGY

3.1. Data Source

The Data used in this study was from the Crop Survey module of the Uganda National Household Survey 2005/06. This was the sixth module of this kind since the start of the household survey programmes in 1989. It was brought back as the core-module with the continuing socioeconomic and community modules in the Uganda National Household Survey, 2005/06. This survey covered the household crop farming enterprise with emphasis on land, crop area, inputs, outputs and other associated characteristics.

3.2. Sample Size

The study covered 1,867 and 2,233 banana and maize growing households respectively. It should be recognized that though Uganda has over 72 crops, there are 10 major crops of which banana and maize are more prominent in most parts of the country.

3.2.1. Dependent variable

The dependent variable was the crop production, of the selected crops that was measured as a continuous variable, depending on the different inputs used, extension services, technology used and the sex of the head of the household.

3.2.2. Independent variables

These included:

(i) INPUTS including use of purchased seeds and seedlings, chemical fertilizers, variety seeds, pesticides and manure used.

(ii) AGRICULTURAL TECHNOLOGY including adoption of practice with respect to: soil fertility management, crop protection and farm management; cropping system (pure and inter-cropping).

(iii) EXTENSION: visit by any extension worker, number of visits, and participation in NAADS training programme.

(iv) LABOUR: household labor days by male, female and child; hired labor.

(v) AREA: Farmers' Area estimates

3.3. Data Management and Analysis

The UNHS 2005/06 data was entered in ACCESS and transferred to STATA version 9. It was in this statistical software package that the analysis for this study was performed.

3.3.1. Univariate analysis

In order to summarize data, univariate analysis was performed. Descriptive statistics and frequency tables were produced for continuous and categorical variables respectively.

3.3.2. Bivariate analysis

Bivariate analysis was performed to assess for association between any two variables.

Categorical variables and crop production

Analysis of variance (ANOVA) was performed to assess the effect of any of the categorical variables on the household crop production (of each of the two crops). The model below was used

$y_{ij} = \mu + \alpha_i + \varepsilon_{ij}$ ....(3.1)

Where

y_{ij} =the jth observed household crop production for the ith input/extension service.

α_i = effect due to the ith input/extension service

μ = general mean of household crop production

ε_{ij} = random error / error term.

Continuous variable and household crop production

To assess for association between any continuous variable and household crop production for each of the crops maize and banana, a simple linear regression model was fitted.

Model lay out

$$y_i = a + bx_i + \varepsilon_i \text{...}(3.2)$$

Where

y_i = household crop production

a =constant

x_i = independent variable

b = coefficient of x_i

3.3.3. Multivariate analysis

Multivariate analysis was performed to assess the factors that explain household crop production of each crop and their effect.

The general linear regression model from which equation 3.4 was obtained is as below:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \text{..............} + \beta_k X_k + \varepsilon_i ----------(3.3)$$

Where;

Y = Dependent variable (Household crop production)

β_0 =Constant term

β_i =Co-efficient of the ith independent variable

ε_i =Random term

A Multiple linear regression model (meta production function) of the form shown in Equation (3.4) was deduced. All the continuous variables were discovered not to be normally distributed and they were transformed by taking their natural logarithm.

$$\ln Y_i = \beta_0 + \beta_i X_i + \beta_j \ln X_j + \varepsilon_i \text{ ----------------- } (3.4)$$

Y_i = *Household Crop production*

β_0 = Constant *term*

β_i = *Co – efficient of the* i^{th} *Categorical variable*

β_j = *Co- efficient of the* j^{th} *continuous variable*

X_i = i^{th} *Categorical independent variable* , *í = 1, 2,…5*

Xj = j^{th} *Continuous independent variable j = 1, 2,…..10*

ε_i = *Random Error or Error Term*

Where categorical covariates (independent variables) include:

- Sex of household head dummies
- Cropping system dummies
- Change of practice with respect to technology in the last 12 months
- Household member participation in NAADS Training
- Ever been visited by extension worker in last 12 months dummies

Continuous covariates (independent variables) include:

- Farmers' Area estimate;
- Labour days on plot by male household members;
- Labour days on plot by female household members;
- Labour days on plot by child household members;
- Hired labour days on plot;
- Expenditure on fertilizers, manure and all pesticides used;

- Expenditure on seeds /seedlings used;
- Amount of Manure used;
- Number of Extension Visits to household

X assumptions:

- None of the X_is is a linear function of each other.
- They should be uncorrelated with the error term: $E(\varepsilon_i x_i)=0$
- The matrix (X^1X) is non singular

β_j's are the elasticities of the respective continuous predictors, from **β** = $\frac{\partial Y}{\partial X_i} x \frac{X_i}{Y}$, j=1,2…9.

Interpretation was made in the form e^{β} for categorical variables and in the form **β** for continuous variables i.e;

- A unit change in the independent categorical variable would on average change Y by e^{β} times.
- A one percent change in the continuous independent variable would lead on average to **β_j** percent increase in Y, holding other factors constant.

ε_i = random error and should be independent r.v that is: N~ $(0, \delta_e^2)$

3.3.4. Goodness –of –fit for the model

R –square was used to evaluate the overall goodness of fit of the model. It measures the proportion of total variation in the dependent variable explained by the independent variables.
The individual variables were evaluated using the t-statistic.
The random error was assessed for normality.

CHAPTER FOUR:
EFFECT OF AGRICULTURAL INPUTS AND EXTENSION SERVICES ON HOUSEHOLD CROP PRODUCTION IN UGANDA

4.1. Univariate analysis

Univariate analysis was performed in order to summarize the data. Descriptive statistics and frequency tables were produced for continuous and categorical variables respectively.

4.1.1. Distribution of categorical inputs/ extension service for Banana (Food-type) growing households

There were 1,867 households that grew banana (food-type) and of these, 62.0 percent practiced inter-cropping (mixed cropping) of the crop while only 38.0 percent practiced pure stand. Only 24.2 percent of the households had a member who had participated in a NAADS Training program and 30.9 percent changed practice with respect to agricultural technology. The majority of the households (75.5%) were headed by males as opposed to their female counterparts, as seen in Table 4.1

The investigation also indicated that a relatively small proportion of households (12.0%) had been visited by an extension worker in the last 12 months.

Table 4.1: Distribution of categorical variables for Banana (food-type) growing households

Variable	**Frequency**	**Percentage**
Cropping System		
Pure stand	709	38.0
Intercropping	1,158	62.0
Total	**1,867**	**100.0**
HH member Participation in NAADS Training		
No	1,416	75.8
Yes	451	24.2
Total	**1,867**	**100.0**
Change of practice with respect to technology in the last 12 months		
No	1,290	69.1
Yes	577	30.9
Total	**1,867**	**100.0**
Sex of Household Head		
Female	458	24.5
Male	1,409	75.5
Total	**1,867**	**100.0**
Visit by extension worker in last 12 months		
No	1,643	88.0
Yes	224	12.0
Total	**1,867**	**100.0**

4.1.2. Description of continuous inputs/extension services for Banana (Food-type) growing households

The average area under banana (food-type) was estimated to be about 1.6 acres with a standard deviation of 4.44. Regarding labour, the average household member labour days contributed to a plot for male, female and children were about 11, 29 and 8 respectively.

The investigation also indicated that the highest average expenditure by the households that grew banana (food-type) was on “seeds draft animals and machines used” (Ug. Shilling 6,850) and the least cost was incurred on “Fertilizers, manure, pesticide, herbicides & fungicides used” (Ug. Shillings 3,240) as seen in Table 4.2. On average furthermore, an agricultural household was visited 3 out of 10 times by the extension worker in the season. The study revealed an average banana (food-type) production of about 759.5 kg/acre.

Table 4.2: Summary statistics of continuous variables for banana (food-type) growing households

Variable	Mean	Standard deviation	Range
Area Farmers estimate (acres)	1.6	4.44	0.004 - 161.25
Hired labour (person days)	5.4	22.67	0 - 400
Male labor days on plot (person day)	10.9	18.97	0.01- 178.08
Female labor days on plot	29.4	35.53	0.4 - 556
Child labor days on plot	8.3	18.67	0.1 - 220
Cost of seeds/seedlings used (Ug Shillings)	6,850.0	24,718.70	0 - 500,000
Cost on fertilizers, manure, pesticide, herbicides & fungicides used (Ug. Shillings per kg)	3,240.0	14,123.17	20 - 277,000
Amount of manure used (kg)	111.7	594.44	0 - 20,000
Extension Visits number (number)	0.0	1.164	1-20
Banana Production (Kg/acre)	759.5	1086.61	25-9,600

4.1.3. Distribution of categorical inputs/extension services for Maize growing households

There were 2,233 households that grew maize and of these, 69.0 percent practiced inter-cropping (mixed cropping) of the crop, while only 31.0 percent practiced pure stand. Only 18.6 percent of the households had a member who had participated in a NAADS Training program and 28.8 percent of maize farmers changed practice with respect to agricultural technology. Like in the case of banana (food-type) farmers, the majority of the households that grew maize (77.8%) were male headed as seen in Table 4.3.

The investigation further indicated that few households (15.4%) had been visited by an extension worker in the last 12 months.

Table 4.3: Distribution of categorical variables for Maize growing households

Variable	**Frequency**	**Percentage**
Cropping System		
Pure stand	693	31.0
Intercropping	1,540	69.0
Total	**2,233**	**100.0**
HH member Participation in NAADS Training		
No	1,818	81.4
Yes	415	18.6
Total	**2,233**	**100.0**
Change of practice with respect to technology in the last 12 months		
No	1,591	71.3
Yes	642	28.8
Total	**2,233**	**100.0**
Sex of Household Head		
Female	496	22.2
Male	1,737	77.8
Total	**2,233**	**100.0**
Visit by extension worker in last 12 months		
No	1,890	84.6
Yes	343	15.4
Total	**2,233**	**100.0**

4.1.4. Description of continuous inputs/extension services for Maize growing households

The average area under Maize was estimated to be 1.5 acres with a standard deviation of 1.84. Regarding labour, the average household member labour days contributed to a maize plot for males, females and children were about 14, 32 and 11 respectively.

The investigation also indicated that the highest average expenditure by the households that grew Maize was on "Seeds/seedling used" (Ug. Shilling 8,770) and the least cost was incurred on "Fertilizers, manure, Pesticide, herbicides & fungicides used" (Ug. Shillings 1,410) as seen in Table 4.4. Furthermore, an agricultural household was on average visited 2 out of 10 times by the extension worker in the season. An average Maize production of about 392.0 kgs/acre was revealed from the study.

Table 4.4: Summary statistics of continuous variables for Maize growing households

Variable	**Mean**	**Standard deviation**	**Range**
Area Farmers estimate (acres)	1.5	1.84	0.025 - 19.5
Hired labour (person days/season)	6.5	22.65	0 - 400
Male labor days on plot (person day)	13.6	17.31	1 - 217
Female labor days on plot	32.3	33.42	0 - 556
Child labor days on plot	10.9	22.84	0 - 262
Cost of seeds/seedlings used (Ug Shillings)	8,770.0	28,319.18	0 – 505,000
Cost on fertilizers, manure, pesticide, herbicides & fungicides used (Ug. Shillings per kg)	1,410.0	10,414.15	0 – 200,000
Amount of manure used (kg)	29.6	216.13	0 – 5,000
Extension Visits number (number)	0.2	1.26	0 - 24
Maize Production (Kg/acre)	392.2	781.45	45 – 10,000

4.2: Bivariate Analysis

To assess the effects of each of the categorical variables, Analysis of Variance (ANOVA) was performed on production for each of the crops (Banana & Maize). For continuous inputs and extension services provided, Simple Linear regression was performed.

4.2.1: Analysis of Variance of categorical variables on Banana (food-type) production

In order to assess the effects of each of the input and extension services on the production of banana (food-type), Analysis of Variance (ANOVA) was performed for categorical variables (Cropping system, Member participation in a NAADS training program, Change of practice with respect to agricultural technology in last 12 months, Sex of household head, Households ever been visited by an extension worker). Results of the average banana (food-type) production (kg/acre) and ANOVA are shown in Tables 4.5 and Table 4.6, respectively.

Table 4.5: Average Banana (food-type) Production within Categorical variables

Variable (Table 4.5)	Mean	Standard deviation
Cropping System		
Intercropping	750.2	1,135.37
Pure stand	774.9	1,002.48
HH member Participation in a NAADS Training		
No	404.3	329.58
Yes	1,875.1	1,705.92
Change of practice with respect to agric technology in the last 12 months		
No	420.5	357.29
Yes	1,517.6	1,645.08
Sex of Household Head		
Female	674.4	944.60
Male	787.2	1,127.86
HH ever been visited by extension wker in last 12months		
No	609.6	695.48
Yes	1,859.2	2222.23

Table 4.6: Analysis of Variance for categorical variables and banana (food-type) production

Source	**df**	**F-value**	**P-value**
Cropping system			
Between	1	0.23	0.634
Error	1865		
Total	**1866**		
HH member Participation in a NAADS Training			
Between	1	943.12	0.000
Error	1865		
Total	**1866**		
Change of practice with respect to agric technology in the last 12 months			
Between	1	519.30	0.000
Error	1865		
Total	**1866**		
Sex of Household Head			
Between	1	3.73	0.054
Error	1865		
Total	**1866**		
HH ever been visited by extension worker in last 12months			
Between	1	302.83	0.000
Error	1865		
Total	**1866**		

(i). Banana (food-type) Production and Cropping System

The average production of banana (food-type) for households that intercropped banana (750.2 Kgs/acre) was slightly lower than that of those that grew the crop in pure stand. However, the Analysis of Variance (ANOVA) results indicate that there was no statistically significant difference in the average banana (food-type) production between households that planted in pure stand and those that intercropped (p=0.634).

(ii). Banana (food-type) Production and Household member participation in a NAADS training program.

The average production for households that had a household member who had participated in a NAADS training program (1,875.1 Kgs/acre), was higher than those without a member who had participated (404.3 Kgs/acre) and these averages are significantly different (p=0.000).

(iii). Banana (food-type) Production and Change of practice with respect to agricultural technology in the last 12 months.

Agricultural households that changed practice with respect to agricultural technology had a much higher average banana (food-type) production (1,517.6 Kgs) than those that did not (420.5 Kgs) and these were significantly different (p=0.000).

(iv). Banana (food-type) Production and Sex of Household Head.

On average, the production of bananas in kilograms was more in Male headed households (787.2 Kgs) than their female counterparts. Analysis of variance (ANOVA) however revealed that, there was no significant difference in the average banana (food-type) production among male and female headed households (p=0.054).

(v). Banana (food-type) Production and Households ever been visited by extension worker in last 12months.

Households that had ever been visited by an extension worker in the last 12 months recorded a much higher average banana (food-type) production (1,859.2 kgs) than those that were not visited. The averages were statistically significantly different (p=0.000).

4.2.2: Simple linear regression of each continuous variable on Banana (food-type) production

To assess the effects of each of the continuous input/extension services (Area of plot-farmers estimate, Hired labour days, Cost on seeds/seedlings used, Cost of Fertilizers used, Cost of Pesticides, herbicides & fungicides used, Amount of manure used, Cost of manure used, Cost on use of draft Animals and Machines used, Extension visits to the household, Labour days on plot by Male household member, Labour days on plot by Female household member and Labour days on plot by a Child household member) on the production of banana (food-type) below as below, simple linear regression was performed. Details are shown in Table 4.7

Table 4.7: Simple linear regression of each continuous variable on Banana (food-type) production

Variable	Co-efficient	Std Error	P-value	95% Conf Int
Area Farmers estimate	19.24	5.653	0.001	8.152 – 30.328
Hired Labour (person days)	5.62	1.102	0.000	3.459 – 7.782
Cost of seeds/seedlings used	0.001	0.001	0.271	-0.001 – 0.003
Cost on Fertilizers, manure, Pesticide, herbicides & fungicides used	0.01	0.002	0.001	0.002 – 0.009
Amount of manure used (Kgs)	0.15	0.042	0.000	0.067 – 0.232
Extension visits	101.28	2.495	0.000	59.124 – 143.437
Labour days on plot by Male household member	5.56	1.320	0.000	2.973 – 8.151
Labour days on plot by Female household member	3.40	0.704	0.000	2.019 – 4.780
Labour days on plot by Child household member	2.77	1.346	0.040	0.132 – 5.412

(vi). Production of Banana (food-type) and Area of plot

Results indicated that households that increased their plot size by one acre, increased banana (food-type) production by approximately 19.2 percent. This shows that there is a significant relationship between area and banana (food-type) production (p=0.001).

(vii). Banana (food-type) Production and hired labour

Households that utilized hired labour by one extra Labour day, would increase household production of banana (food-type) by about 5.6 percent. The production of banana (food-type) is strongly related to hired labour (p=0.000).

(viii). Banana (food-type) Production and Cost on Fertilizers, Manure, Pesticide, herbicides & fungicides used

Households that spent an extra shilling on "Fertilizers, Manure, Pesticide, herbicides & fungicides" used increased their banana (food-type) production by less than one percent. It however, there is a significant relationship between Cost of fertilizers used and banana (food-type) production (p=0.001).

(ix). Banana (food-type) Production and Amount of manure used (Kgs)

Agricultural households that used an additional kilogram of manure on the plot, increased their banana (food-type) production by 0.2 percent, and there was a significant relationship between Amount of manure used and household banana (food-type) production (p=0.000).

(x). Banana (food-type) Production and Cost of seeds/seedlings used

As households increased their Cost on "seeds/seedlings used" by an additional shilling, their banana (food-type) production increased by less than one percent (0.01%). However, the two have no significant relationship (p=0.271).

(xii). Banana (food-type) Production and Number of Extension visits

Agricultural households that received an extra Extension Visit increased their banana (food-type) production by almost 101.3 percent, and there is a significant relationship between number of visits by extension workers and the banana (food-type) production (p=0.000).

(xii). Banana (food-type) Production and Labour days on plot by Male household member

An extra labour day spent on the plot by Male household members increased the agricultural household banana (food-type) production by nearly 5.6 percent and there was a significant relationship between these two (p=0.000).

(xiii). Banana (food-type) Production and Labour days on plot by Female household members

An extra labour day spent on the plot by Female household members increased the agricultural household banana production by nearly 3.4 percent and, the two had a significant relationship (p=0.000).

(xiv). Banana (food-type) Production and Labour days on plot by Child household member

An increase in the Labour days on plot by a Child household member by one day, would increase household banana production by about 2.8 percent with significant relationship between the two (p-value = 0.040).

4.2.3: Analysis of Variance of categorical variables on Maize production

As in the case of Banana, to assess the effects of each of the input and extension services on the production of Maize, Analysis of Variance (ANOVA) was performed for categorical variables (Cropping system, Member participation in a NAADS training program, Change of practice with respect to agricultural technology in last 12 months, Sex of household head, Households ever been visited by an extension worker). Results of the average Maize production (kg/acre) and ANOVA are shown in Tables 4.8 and Table 4.9 respectively.

Table 4.8: Average Maize Production within Categorical variables

Variable	**Mean (kg/acre)**	**Standard deviation**
Cropping System		
Intercropping	203.9	175.96
Pure stand	810.8	1,283.13
HH member Participation in a NAADS Training		
No	221.3	217.14
Yes	1,141.1	1,547.52
Change of practice with respect to agric technology in the last 12 months		
No	243.6	438.59
Yes	760.6	1,207.66
Sex of Household Head		
Female	239.5	447.16
Male	435.8	848.27
HH ever been visited by extension wker in last 12months		
No	213.7	186.04
Yes	1,375.8	1,627.23

Table 4.9: Analysis of Variance for categorical variables and Maize production

Source	df	F-value	P-value
Cropping system			
Between	1	330.90	0.000
Error	2231		
Total	**2232**		
HH member Participation in a NAADS Training			
Between	1	592.15	0.000
Error	2231		
Total	**2232**		
Change of practice with respect to agric technology in the last 12 months			
Between	1	219.91	0.000
Error	2231		
Total	**2232**		
Sex of Household Head			
Between	1	24.61	0.000
Error	2231		
Total	**2232**		
HH ever been visited by extension wker in last 12months			
Between	1	900.85	0.000
Error	2231		
Total	**2232**		

(i). Maize Production and Cropping System

The average production of Maize for households that intercropped it (203.9 Kgs/acre) was much lower than that of those that grew the crop in pure stand. Analysis of variance (ANOVA) results indicate that there was a significant difference in the average Maize production between households that planted in pure stand and those that intercropped (p=0.000).

(ii). Maize Production and Household member participation in a NAADS training program.

The average maize production for households that had a member who had participated in a NAADS training program (1,141.1 Kgs/acre), was higher than those without a member who had participated (221.3 Kgs/acre) and these averages were significantly different (p=0.000).

(iii). Maize Production and Change of practice with respect to agric technology in the last 12 months.

Households that changed practice with respect to agricultural technology had a higher average maize production (760.6 Kgs/acre) than those that did not (243.6 Kgs/acre) and these were significantly different (p=0.000).

(iv). Maize Production and Sex of Household Head.

On average, the production of maize in kilograms was more in Male headed households (435.8 Kgs/acre) than their female counterparts. Analysis of variance (ANOVA) further revealed that, there is a significant difference in the average maize production among male and female headed households (p=0.000).

(v). Maize Production and Households ever been visited by extension worker in last 12months.

Households that had ever been visited by an extension worker in the last 12 months recorded a much higher average maize production (1,375.8 kgs/acre) than those that were not visited. The averages were significantly different (p=0.000).

4.2.4: Simple linear regression of each continuous variable on Maize production

Simple linear regression was again performed to assess the effects of each of the above continuous input/extension services on the production of maize. Details are shown in Table 4.10

Table 4.10: Simple linear of each continuous variable on Maize production

Variable	Co-efficient	Std Error	P-value	95% Conf Int
Area Farmers estimate (acres)	162.08	8.291	0.000	145.825 – 178.343
Hired labour (person days/season)	8.22	0.709	0.000	6.831 – 9.613
Cost of seeds/ seedlings used (Ug shs)	0.01	0.001	0.000	0.010 – 0.012
Cost on Fertilizers, manure, Pesticide, herbicides & fungicides used (Ug. shs)	0.02	0.002	0.000	0.018 – 0.024
Amount of manure used (Kgs)	0.70	0.765	0.360	-0.080 – 0.220
Extension visits	52.62	13.066	0.000	26.999 – 78.243
Labour days on plot by Male household member (person day)	5.95	0.948	0.000	4.094 – 7.811
Labour days on plot by Female household member	4.61	0.485	0.000	3.662 – 5.566
Labour days on plot by Child household member	4.16	0.719	0.000	2.754 – 5.574

(vi). Production of Maize and Area of plot:

Results indicate that households that increased their plot size by one acre, increased maize production by approximately 162.1 percent. It shows that there was a significant relationship between area and Maize production (p=0.000).

(vii). Maize Production and hired labour:

Agricultural households that utilized hired labour by one Labour day, increased household production of Maize by nearly 8.2 percent. The production of maize was independent of hired labour (p=0.000).

(viii). Maize Production and Cost on fertilizers, manure, pesticide, herbicides & fungicides used:

Households that spent an extra shilling on "fertilizers, manure, pesticide, herbicides & fungicides" used, increased their maize production by less than one percent. It also showed that there was a significant relationship between Cost of this extra unit and maize production (p=0.000).

(ix). Maize Production and Amount of manure used (Kgs):

Agricultural households that used an additional kilogram of manure on the plot, increased their maize production by 0.7 percent, and there is no significant relationship between amount of manure used and household maize production (p=0.360).

(x). Maize Production and Cost of seeds/seedlings used:

As households increased their Cost on "seeds/seedlings used" by an additional shilling, their Maize production increased by less than a percent point and there is a significant relationship between the two variables (p=0.000).

(xi). Maize Production and Number of Extension visits:

Households that received an extra Extension Visit increased their Maize production by almost 52.6 percent, and there is a significant relationship between number of visits by extension workers and the Maize production (p=0.000).

(xii). Maize Production and Labour days on plot by Male household member:

An extra labour day spent on the plot by Male household members increased the agricultural household Maize production by approximately 6.0 percent and there was a significant relationship between these two (p=0.000).

(xiii). Maize Production and Labour days on plot by Female household members:

An extra labour day spent on the plot by Female household members increased the agricultural household Maize production by about 4.6 percent and, the two have a significant relationship (p=0.000).

(xiv). Maize Production and Labour days on plot by Child household member:

An increase in the Labour days on plot by a Child household member by one day, would increase household Maize production by 4.2 percent with a significant relationship between the two variables (p-value = 0.000).

4.3: Multivariate Analysis

With multivariate analysis, to assess the effect of inputs and extension services on household production of Banana and Maize, a transformed linear model was used for each of the crops. The dependent variable (production of Maize and Banana) and the independent variables which are continuous (Area of plot-farmers estimate, Hired labour days, Cost on seeds/seedlings used, Cost of Fertilizers used, Cost of Pesticides, herbicides & fungicides used, Amount of manure used, Cost of manure used, Extension visits to the household, Labour days on plot by Male household member, Labour days on plot by Female household member and Labour days on plot by a Child household member) were not normally distributed and so, they were transformed by taking their natural logarithm (Ln).

Multiple Linear Regression and discussion of results

4.3.1: Inputs and extension services and Banana (food-type) production

In order to determine the effect of inputs and extension services on the production of banana (food-type), log-log linear model was fitted. The results are shown in Tables 4.11 and they are followed by discussions

Table 4.11: Multiple regression output of inputs/extension services on Banana (food-type) Production. Adj R-squared = 0.5858

Variables (categorical)	**Exp (Coef.)**	**Std Error**	**P-value**	**95% Conf Int**
Cropping System				
Pure	1.005	0.038	0.888	0.934 – 1.082
*Intercropping				
HH member Participation in a NAADS Training				
Yes	2.261	0.109	0.000	2.057 – 2.486
*No				
Change of practice with respect to agric technology in the last 12 months				
Yes	1.483	0.066	0.000	1.359 – 1.618
*No				
Sex of Household Head				
Male	0.996	.0460	0.933	0.910 – 1.091
*Female				
HH ever been visited by extension wker in last 12months				
Yes	1.394	0.104	0.000	1.204 – 1.614
*No				
Variable (continuous)	**Coefficient**	**Std Error**	**P-value**	**95% Conf Int**
Area Farmers estimate	0.070	0.018	0.000	0.035 - 0.105
Hired Labour (person days)	-0.012	0.016	0.460	-0.044 - 0.020
Cost of seeds/ seedlings used	0.158	0.005	0.000	0.147 - 0.168
Cost on Fertilizers, manure, Pesticide, herbicides & fungicides used	-0.148	0.016	0.000	-0.179 - -0.117
Amount of manure used (Kgs)	0.136	0.018	0.000	0.101 - 0.171
Extension visits	-0.119	0.074	0.109	-0.265 - 0.026
Labour days on plot by Male household member	0.014	0.007	0.048	0.000 - 0.028
Labour days on plot by Female household member	0.052	0.016	0.001	0.022 - 0.083
Labour days on plot by Child household member	0.029	0.014	0.045	0.001 - 0.057

* Base category

(i). Banana (food-type) Production and Household member participation in a NAADS training program.

In this study, agricultural households which had received NAADS training had a higher yield than those that did not. Agricultural households that had a member who had participated in a NAADS training program realized a banana (food-type) production of 2.261 times than that of those who never had member participation. These findings were attributed to NAADS training; on soil and water management practices that increase soil fertility and reduces reliance on natural rainfall which has become unpredictable, provision of knowledge on agronomic practices, feeding regimes and post harvest handling.

One of the studies by IFPRI (IFPRI, 2004), revealed that higher per capita income arising from increased yields of major crops like Banana (food-type) was realized in sub-counties in which NAADS was operating, unlike in the non-NAADS sub-counties. The crop productivity income analysis predicted a 41% higher per capita income in NAADS sub-counties. This was attributed to adoption of improved planting materials, access to information on best agronomic practices, post-harvest skills and marketing opportunities. The limited technologies being developed and demonstrated have raised farmer awareness and interest in these productivity-enhancing skills.

(ii). Banana (food-type) Production and Change of practice with respect to agriculture technology in the last 12 months.

Agricultural households that changed practice with respect to agricultural technology (crop protection, farm management, improved produce quality, on-farm storage and improved individual/group marketing) in the last 12 months prior to the survey produced banana output of 1.483 times that of their counterparts who did not. This could be accredited to agricultural households' appreciation of methods of crop protection, knowledge of good farm management, adoption of quality produce and improvement of on-farm storage facilities not forgetting access to transportation of banana as it is perishable. Also farmers could have well adopted issues of spacing requirements of banana plants, which reduces competition for nutrients thus increasing the yield. Impact studies conducted by the International Food Policy Research Institute (IFPRI) on the benefits of the agricultural technologies generated and disseminated, and advisory services provided by the NARO and other institutions both public and private involved in agriculture (especially growing of main crops like Banana), are already yielding dividends in to the end-users including Banana growers. Providing specific interventions that promote adoption and sustained use of improved technologies can greatly increase these benefits.

(iii). Banana (food-type) Production and Households ever been visited by extension worker in last 12months.

Results indicate that there was a higher banana (food-type) production for holdings/ agricultural households that had ever been visited by an extension worker in last 12months than that of those that were not visited in the same period. Households that were visited had a banana (food-type) output of 1.394 times that of their colleagues that were not visited. This could have been attributed to the different advice given to banana farmers by the extension staff at different stages of the crop cycle such as planting, weeding, pruning and harvesting. These include advice on; use of improved variety, spacing of the sucker, intervals of weeding and pruning were it is due.

Extension workers with a view of increasing yield of major crops focus on imparting key messages to farmers on each visit, with the complexity of these messages being increased in subsequent visits. Initial messages aim at improving basic production techniques, with attention being focused on land preparation, the timeliness of operations, crop spacing, plant population sizes, the use of better seed varieties and on weeding. After the simple messages, attention shifts to more complex messages such as those relating to fertilizer use and pest control measures. Implementation of the latter set of messages typically requires higher investment expenditure in purchased inputs by farmers (Evenson et. al, 1998).

(iv). Production of Banana (food-type) and Area of plot

There was realization of a 0.07 percent increase in banana (food-type) production for agricultural households that had an extra one percent of acreage under banana (food-type) holding other factors constant. This is attributed to opening up of new land that has been under fallow and gained some nutrients that increase soil fertility.

A Study on Sustainable Agricultural Enterprises in two districts in Uganda revealed that the average yield of banana were; 3 bunches per week for quarter an acre, 5-6 bunches for half an acre. In terms of bunch weight 20-30kg, the yield was 3 tons per year for quarter an acre, giving 30 tons per 2.5 acres per year (Nkuba et. al, 2001).

(v). Banana (food-type) Production and Cost on fertilizers, manure, pesticide, herbicides & fungicides used:

There was a decline in the banana (food-type) yield for agricultural households that used purchased fertilizers, pesticides, herbicides and fungicides. Households that spent an extra 10 shillings on the fertilizers and pesticides used, reduced their banana (food-type) yield by an average of 1.48 percent compared to those that did not. This could have risen from purchase of substandard fertilizers/cides from the shops/markets and these instead degenerate proper growth of the crop due to poor mixtures/manufacture which can not fight banana (food-type) diseases and strong weeds.

Nate Ryan et al 2006, pointed out that although this crop (banana) is relatively easy to grow, there are major constraints to its yields, i.e., pests, diseases, and soil fertility loss. The banana weevil and parasitic nematodes make up the major pests to this crop and if poor/ineffective and especially purchased Fertilizers, Manure, Pesticide, herbicides & fungicides are used, this hampers yield. In fact, if a plantain were to be infected by both of these pests, yield losses could reach as high as 85 percent for major diseases that infect plantains include the Black Sigatoka leaf spot disease, Fungal leaf spot, Fusarium wilt (Panama disease), Banana streak virus, Banana dieback virus, and the Cucumber mosaic virus. Plants infected with the Banana streak virus can cause yield reductions up to 60%.

(vi). Banana (food-type) Production and Amount of manure used (Kgs):

It was also revealed that agricultural households which used extra kilograms of manure (inorganic or organic) or compost had a higher yield than those that did not. Households that used an extra 10 percent of kilograms of manure had their banana (food-type) production increased by about 1.36 percent compared to those that did not. This to some extent agrees with theory and could be due to increased soil nutrient and hence fertility, which enhances good growth of the crop and high yield.

Besides factors that naturally affect land conditions and productivity, such as soil type (erodibility and vulnerability), relief and climate, the development pathway pursued in a given location may have a big impact on land management and productivity. Production of perennials (coffee and banana) and storable annuals (maize and beans) is increasing in the lakeshore region. Intensification with respect to banana production only refers to the use of fertilizers/manure (inorganic or organic) or compost since there were no improved varieties to talk about in some agricultural households. In the study on Land Management Problems and Potentials in the Lakeshore Intensive Banana-Coffee Farming System, 67.7 percent of the households grew cooking bananas (matooke) in 2000, and about one fourth of these (18.9 percent in first season and 15.5 percent in second season) applied manure, and a lower proportion applied compost (nearly 7%). On average, 417 kgs of manure and 50.71 kgs of compost per household were applied to bananas in 2000 (Sserunkuuma et. al., 2001).

Uganda was the world's largest producer and consumer of bananas (FAO, 1995a). Per capita banana consumption was estimated to be 220-460 kg per year (Hartman, 1989) where it was used as a dessert fruit, cooked as a staple starch or brewed as beverage (Stover and Simmonds, 1987). A down ward trend arose from nutrient depletion of banana-based small holdings. Approximately 2000 metric tonnes of fertilizer was consumed during 1994, all of which was imported (FAO, 1995b). Per capita fertilizer use was less than 0.1 kg per year (calculated from FAO, 1995a, 1995b). One manifestation of nutrient depletion was matoke/banana decline, where banana yields declined to less than 10 kg per bunch or 0.5 ton/ ha per year (Zake et al., 1994). Farmers who wish to re-establish banana in nutrient depleted soil without access to fertilizers must rely on external organic inputs. Bekunda and Woomer (1996) reported that two such inputs available to farmers are livestock manure and napier grass (Pennisetum purpureum).

(vii). Banana (food-type) Production and Cost of seeds/seedlings used:

There was a very small percent increase (0.158%) in banana (food-type) production for Households that spent an extra one percent shilling on purchase of seedlings used, as compared to those that did not. This could be because most of the farmers normally use un-purchased seedlings from their gardens and if they are to buy them, they go in for purchase of improved seedlings from Agricultural Research and Development Centres (ARDCs-NARO) which are high yielding.

(viii). Banana (food-type) Production and Labour days on plot by Male, Female and Child household member:

During the survey and keeping other factors constant, households that had a 10 percent increase in the labour (in form of labour days) on the banana (food-type) plot by Male, Female and Child household members had their average banana production increased by about 0.14, 0.52 and 0.29 percent, respectively. These increments though very small, agree with the expectation. However, what comes out clearly is that labour days by female household members had a higher increment compared to the other two. This could be due to full time availability of women on the farm, limited availability of Male and Children on the holding as a result of other male employment off the holding and Child school commitments respectively.

Where credit services are unavailable, farmers must rely on their own savings as a source of investment capital. Also income from off-farm sources can serve to generate funds for agricultural investments where credit availability is low (Reardon et. al., 1996). However, off-farm employment opportunities may compete for labor with agricultural activities, and thus tend to reduce the adoption of labor-intensive technologies. Lack of a well-developed labor market makes labor scarce and costly in some places, which may undermine farmers' ability to invest in soil fertility conservation and other practices that are labor intensive. Imperfections in labor markets mean that household endowment of labor has a direct effect on the level of agricultural production and use of other inputs (Deininger and Okidi, 1999). That is, imperfect labor markets force farm households to rely entirely on family labor to carry out all farm activities including soil conservation, thus, limited availability of family labor could undermine farmers' ability to intensify.

4.3.2: Inputs and extension services and Maize production

In order to determine the effect of inputs and extension services on the production of Maize, the same transformed linear model was fitted on transformed maize yield. Results are shown in Tables 4.12.

Table 4.12: Multiple regression of inputs and extension services and Maize Production.

Adj R-squared = 0.4974

Variable	Exp (Coef.)	Std Error	P-value	95% Conf Int
Cropping System				
Pure	1.392	0.051	0.000	1.294 - 1.496
*Intercropping				
HH member Participation in a NAADS Training				
Yes	1.482	0.069	0.000	1.353 - 1.623
*No				
Change of practice with respect to agric technology in the last 12 months				
Yes	1.382	0.053	0.000	1.282 - 1.489
*No				
Sex of Household Head				
Male	1.123	0.045	0.004	1.039 - 1.215
*Female				
HH ever been visited by extension wker in last 12months				
Yes	1.788	0.115	0.000	1.576 - 2.028
*No				
Variable	**Coefficient**	**Std Error**	**P-value**	**95% Conf Int**
Area Farmers estimate	0.085	0.019	0.000	0.049 - 0.122
Hired Labour (person days)	-0.008	0.015	0.581	-0.037 - 0.021
Cost of seeds/ seedlings used	0.014	0.004	0.000	0.006 - 0.022
Cost on Fertilizers, manure, Pesticide, herbicides & fungicides used	0.077	0.008	0.000	0.062 - 0.092

Table 4.12 ctn. Variable	Coefficient	Std Error	P-value	95% Conf Int
Amount of manure used (Kgs)	0.029	0.012	0.014	0.006 - 0.052
Extension visits	-0.300	0.063	0.000	-0.424 -0.177
Labour days on plot by Male household member	0.066	0.019	0.000	0.030 - 0.102
Labour days on plot by Female household member	0.062	0.016	0.000	0.030 - 0.093
Labour days on plot by Child household member	0.054	0.012	0.000	0.031 - 0.078

(i). Maize Production, Cropping System and Area of plot (Farmers' Estimate)

Households that grew maize in pure stand had a production of 1.392 times that of their counterparts that intercropped the crop.

Likewise, those that increased their maize plot area by one percent, increased their maize production by an average of 0.85 percent as compared to their counterparts who did not.

The two variables (Cropping system and Area of maize plot) are discussed together because normally, holders that get interested in increasing their maize production tend to plant the crop in pure stand to increase the area under the crop as opposed to the intercropping/mixed cropping where several crops are grown together on the same plot (which normally reduces the area of the crop). Though the intercropping is claimed to have a good impact on the soil fertility, this is valid when the other crops for example leguminous crops, add nutrients like nitrogen to soil for example legumes.

Maize is the most important cereal crop in Uganda providing over 40% of the calories consumed in both rural and urban areas. The crop has increasingly become a staple food in many parts of the country due to changes in peoples eating habits. However, the yields are low, fluctuating between 0.8-1.5 t/ha. Small scale farmers who constitute the bulk of the rural poor, also account for the largest share of maize production. A needs assessment study carried out in Eastern Uganda (Bugiri, Tororo, Kapchorwa districts) showed that to have good yield within the reach of small scale farmers, simple and relatively inexpensive methods need to be developed that are tailored to the diversity of cropping systems in this region where over 70% of the farmers grow maize intercropped with other crops, and these include increasing area and growing under pure stand (*NARO, 2002*).

(ii). Maize Production and Household member participation in a NAADS training program.

The study also reveals that maize growing households which had a member who had participated in a NAADS training progam had a higher yield than those that did not. Households with a member who had participated in a NAADS training program increased had a maize production of 1.482 times that of those that did not have. This finding could be attributed to NAADS training; on land preparation, planting time, method, and spacing.

There are recommendations that; Land preparation should start early enough so that planting can be done on time, Tillage should be done appropriately, as it allows free movement of water and air, which are vital for maize plant growth, and minimizes weed infestation at the early stages of maize growth. It is further recommended that in light sandy soils maize should be planted on ridges to conserve moisture and prevent soil erosion. Ridges can be prepared by hand hoe, oxen, or tractor. Heavy soils can be cultivated on the flat.

Time of planting is a complex issue in the Lake Zone, where rainfall patterns and distribution vary. Farmers are advised to plant maize so that flowering and seed setting coincide with the months of reliable rainfall. The planting date for a given area is chosen depending on the rainfall pattern in the area and the number of days that a given variety or hybrid requires to reach tasselling. In areas where there are two rainfall peaks with a dry spell in between, when rainfall is unreliable, maize should be planted during and up to the end of the first peak so that vegetative growth occurs during the drier months and flowering occurs at the beginning of the second rainfall peak so that good yields can be achieved *(Mafuru et.al, 1999)*

In a study carried out on 40 farmer groups in 2003 on changes in Produce Quality as a result of NAADS among other areas of study revealed that the 26 out of 40 farmers groups reported that, the quality of produce had improved in a number of crops such as; bananas (increase in the size of butches), Cereals (well dried and sorted and good looking). The means through which the quality of produce improved included: harvesting at proper time, better drying practices (11 out of 40), better Storage practices (9 out of 40), cleaning and sorting (8 out of 40), improved Varieties (11 out of 40).

(iii). Maize Production and Change of practice with respect to agricultural technology in the last 12 months.

Households that changed practice with respect to agricultural technology (crop protection, farm management, improved produce quality, on-farm storage and improved individual/group marketing) had a production of 1.382 times that of those that did not change their practice. This arose from adoption of; crop protection methods like mulching, bunding and practice of terracing which reduces soil erosion and also increase soil fertility; improvement of on-farm storage facilities like modern silos that protect the maize crop from rotting and being eaten by rodents like rats.

However, from their study on Food Security, Agricultural Technology and Policy with a Case study of Maize in Sub-Saharan Africa, Göran Djurfeldt and Rolf Larsson (2004) discovered that; use of crop rotation, intercropping and fallowing have a negative correlation, significant at 5% level, with production of maize per consumption unit. This can be taken to mean that farmers using these methods tend to be less food secure. Regarding crop rotation, intercropping and fallowing, it is evident that in many parts of sub-Saharan Africa, these traditional methods are not sufficient on their own to ensure food security, even in a good year. Fallow periods are getting progressively shortened as population pressure increases and, for various reasons, the scarcity of land goes up. Too short a period of fallowing is not enough to restore the fertility of the soil, which thus deteriorates. While crop rotation as well as intercropping including nitrogen fixing crops could be a remedy to the exhaustion of the soil, their results indicated that on their own these measures are not adequate (Göran et. al, 2004).

Harvesting may begin as soon as maize grain is physiologically mature. This occurs when the grain contains 30–40% moisture, depending on the variety. The bulk of the crop may be harvested at 25–35% moisture. Large harvest losses from storage pests occur when harvesting is done at a moisture level below 18–20%. When seed has dried to about 12–14% moisture content, it should be stored in a cool, dry place free from rodents and storage pests. One 90–100 kg bag of well-dried maize should be stored with 90–100 g of Actellic Super dust (*Mafuru et.al, 1999).*

(iv). Maize Production and Sex of Household Head.

The results pointed out that, male headed households had a higher maize production than their female counterparts. Holdings/ agricultural households that were male headed had a Maize production of 1.123 times that of their female counterparts. This could be due to the issue that Males heads; have a bigger bargaining power for household agricultural labour, they easily adopt to new agricultural production technologies including those that are labour intensive, which their female colleagues could find difficult.

Gender differentials in the adoption of improved maize production technologies were studied with two dependent variables that constitute the main components of the improved maize production technology were used. Results indicated that the adoption of improved maize seed and fertiliser is biased by gender, where female-headed households adopt the technologies less. Sixty-two and fifty-seven per cent of male- and female-headed households, respectively, planted maize at the recommended time. Eighty-four and sixty two per cent of male-and female-headed households had adopted improved maize varieties, respectively. The recommended weeding was widely adopted, with all farmers weeding their plots at least once. Sixty-five per cent of male-headed and fifty-seven per cent of female-headed households weeded twice.

Maize technologies and gender have a significant association in the case of improved maize seed and fertiliser. Male-headed households had adopted improved maize seed at significantly higher levels than female-headed households (R2=6.2, 0<0.01). Kumar (1994:2) found similar results for the adoption of hybrid maize in Zambia. The adoption of inorganic fertiliser was also significantly higher for male-headed households than for female-headed households (R2=3.5, p<0.01). All these recommendations are less practiced by women headed households yet they are vital in maize yield increase (Mwangi et.al, 1999).

(v). Maize Production, Households ever been visited by extension worker in last 12 months.

Examination of the extension services revealed that, there was about one percent (0.788%) increase in maize production for holding that had ever been visited by an extension worker in the last 2 months as compared to those that had not been visited in the same period.

Extension workers in Uganda's case include graduate agricultural officers who through government restructuring have been posted to almost every sub-county. These provide farmers with extension on;

proper use of fertilizers and herbicides, and use of new techniques taught as part of the extension program. These could have been vital in the increase of household maize production.

John Masereka Kyakora, a 44-year-old farmer with 10 children, nine of whom were in school, was chosen as a demonstration farmer for maize trials. He had grown maize in the past and reported that typical yields were around 300 kilograms per acre. By using the new techniques taught as part of the extension program, his maize yield increased to 800 kgs per acre, with a corresponding increase in income. He stated that the program had changed his way of farming tremendously in that he had learned about improved seeds leading to improved yields; line planting and proper spacing increase plant population, and, most importantly, that timely planting reduces costs and improves yields and income. Kyakora further stated that his increased income made it much easier to pay school fees and provide for his family. He was also quite proud of the fact that many of his neighbors started asking him for farming advice.

Peredasi Kabukobi a 40-year-old mother of four children, all of whom were in school. A primary school teacher, earning $60 per month, and was also largely responsible for the family farm as her husband is partially disabled. The Kabukobi family had grown maize before. The demonstration plot farmed yielded 850 kgs per acre as opposed to the normal 300 kgs per acre previously produced. Kabukobi stated that the proper use of fertilizers and herbicides had not only greatly increased yields and profits, but that time saved allows for other activities, such as working with her children on their schooling and attending seminars and meetings of the cooperative union society (USAID, 2003).

(vi). Maize Production and Cost on Fertilizers, Manure, Pesticide, herbicides & fungicides used:

The study also revealed that, households that spent an extra one percent of shillings on purchase of Fertilizers, Manure, Pesticide, herbicides, fungicides used, increased their maize output by 0.77 percent compared to those that did not spent. This could have come from additional nutrients from these purchased inputs. The cides (Pesticide, herbicides, fungicides) could have also played a big role in control of the maize diseases and pests thus improving on the production.

Commercial fertilizers represent net imports of nutrients into agricultural systems – whereas the other techniques mostly represent a rearrangement and concentration of nutrients already present. Their high nutrient concentrations also largely overcome the labor requirements of traditional inputs, which have low nutrient concentration and thus high mass and volume. However, they usually require cash for purchase, and relatively few farmers in the region have previous experience with them, so few know much about their use or potential impacts on output. At the time of the survey, there were also relatively few shops or vendors selling fertilizers, though they were available in some rural locations. Most farmers say they are aware of the benefits of fertilizers, having at least seen some of the demonstration plots that the Ministry of Agriculture and the Investment in Developing Export Agriculture (IDEA) Project have scattered through the districts, mostly for maize. Some farmers who have not used fertilizers are also reluctant to begin because they have heard that once one starts using fertilizers, one cannot stop using them. (This belief is common in many areas where there is little or no use of fertilizers. Agricultural officials believe, it reflects the inability to maintain higher yields without fertilizer use.) However, the main constraint to use of fertilizers cited by farmers is cost (Goldman et, al, 2003).

(vii). Maize Production and Amount of manure used (Kgs):

Manure use and Maize production had a positive correlation. This was revealed by the positive elasticity of the Maize production (0.029) with respect to the amount of manure used. In particular, a one percent increase in amount of manure (compost, farmyard or any other) used on plot by the holding increased Maize production by 0.029 percent.

Manure like fertilizers also improves on the soil nutrients when properly applied and this increases the production of a crop. This could have been very fundamental in the upward tendency of maize production.

Using farm -yard manure presupposes the ownership of livestock, or the availability of manure in the market. Poor farmers are likely to have limited access to both. Also, applying compost and green manure often represent labour-intensive methods of increasing production. On this score too, many farmers are handicapped.

The AIDS pandemic contributes to increasing the labour crisis in African agriculture and thus it limits the scope of labour intensive methods of intensification.

However, farmers who use these techniques (hence easily apply manure) are much more likely to be food secure (and surplus producers too) than colleagues who do not. Ownership of oxen moreover gives easier access to manure and thus indirectly promotes food security (Göran et. al, 2004).

(viii). Maize Production and Cost of seeds/seedlings used:

There was a 0.14 percent increase in maize production for households that spent an extra 10 percent shilling on purchase of seeds/seedlings used, as compared to those that did not. As in the case of other crops, it is believed that most farmers spend their money on mostly purchase of only improved/hybrid seed as these are expected to be high yielding. When they are to plant local seeds, they get reserves from previous harvest.

In their study on Gender and Soil Fertility Management in Mbale District,Southeastern Uganda, Goldman et. al, 2003, indicated that; Hybrid maize varieties, developed and adapted to local conditions by Ugandan and Kenyan agricultural research stations, can potentially increase yields, particularly in combination with fertilizer use. Some hybrid varieties also mature more rapidly than local varieties, which may reduce drought and/or pest losses. However, new hybrid seed must be purchased each year by farmers, unlike traditional varieties or other open-pollinated improved varieties for which farmers can plant saved seed from the previous season. Hybrid maize use has been widespread in many areas of Kenya, including areas bordering Mbale for a long period, but hybrid maize adoption is more recent and less prevalent in Uganda.

(ix). Maize Production and Number of Extension visits:

As far as number of extension visits is concerned, households that increased their extension visits by 10 percent reduced their maize production by 3 percent. This contradicts with the usual thinking of increased visits positively related to increase in production but could have been caused by other factors like improper adoption of information/advice as by the different extension visits. Doss et al. (2002) attempted to analyze the different adoption studies. Extension is clearly the variable that is most highly correlated with the use of improved technologies. There continues to be an important role for extension services to disseminate information on new varieties and how to manage them. It is not always clear, however, what the extension variable is actually capturing. It may be related to the provision of both inputs and information. The extent of extension services may also be picking up infrastructure issues: farmers in more accessible, less remote areas may receive more frequent extension visits.

Market access was also found extremely important for maize adoption in Ethiopian context. Although often variables that are available are not ideal, they can be used but care needs to be taken (Hugo et.al, 2002)

(x). Maize Production and Labour days on plot by Male, Female and Child household member:

Results as well showed that labour elasticities of maize yield are positive for gender differentials among household members. A one (1) percent increase in the household member labour (in terms of labour days) on plot for male, female and children improves maize yields by about 0.07, 0.06 and 0.05 percent per acre, respectively. These increments which were not far different, agree with the expectation. The increments could have risen from the issue that men, women and children almost allocate the same time and devotion to the maize plot as their maturity period is too short to the extent that the these three groups of people are always available from the garden clearing, planting, weeding and or harvesting.

The study on Gender Differentials in Farm Productivity Implications for Household Efficiency and Agricultural Policy however revealed that;

Labor inputs by household members who are men and children and by non-household members are higher on plots controlled by men; female labor is more intensively used on plots controlled by women. Plots controlled by women have significantly lower yields than other plots within the household planted to the same crop in the same year, but controlled by men. Moreover, the effect was very large. On average, yields were about 18 percent lower on women's plots than on similar men's plots simultaneously planted to the same crop within the same household as seen in Table 4.13.

Table 4.13: Mean yield and labor inputs per plot, by gender of cultivator (n = 4,655)

	Crop Output	Male labor	Female labor	Child labor
Men's plots	79.9	593	248	104
Women's plots	105.4	128	859	53

The finding that there are large gender differences in yield, therefore, does not imply that women are less efficient cultivators than men. The yield differences might reflect differences in the intensity with which inputs are applied on men's and women's plots. Recognizing the source of the yield difference is a necessary step in the determination of an appropriate policy intervention (Harold Alderman et. al., 1995).

CHAPTER FIVE:
SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.1. Summary of findings

The main objective of this study was to establish the effect of agricultural inputs and extension services on household crop production in Uganda. For the relationship of each of the input/extension service on production of banana and maize, the probability of the t-distribution was used based on a Multiple linear regression model (Meta production function) at 5 percent level of significance. The dependent variable and the all the continuous independent variables were found not to be normally distributed. So, they were transformed by taking the natural logarithm.

5.2. Conclusions

This study examined the effect of agricultural inputs and extension services on household crop production in Uganda, other factors such as education of farmers, proxy by agro-ecological conditions controlled. The findings of the study include:

Household crop production highly gains from farmers' application of both agricultural inputs and extension services.

Banana (food-type) production boost is achieved from plots where farmers have used agricultural inputs and have received extension services in relation to the plot. However, there could also be some unobserved factors that play a vital combination role in achieving the increment.

Hired labour (in terms of labour days) on the plots reduces household crop production. It is however, worthwhile to note that this reduction is not significant. The reduction could be due to limited commitment and skills by the hired labourers who in most cases quickly and un-satisfactorily weed, prune, mulch or apply inputs to get quick money.

Household agricultural investment in terms of purchases of inputs such as seeds, fertilizers, manure and pesticides on plots increase household crop production. This is so because most times when farmers opt to purchase inputs, they purchase high yielding inputs like seed and also high quality fertilizers, pesticides and fungicides, which highly contribute to high crop yields.

Although NAADS training is focused on farmer groups rather than individuals, households which have members that are part of the groups and participate in the training, increase their crop production significantly. This is because NAADS training provide directly effective technology transfer mechanism that expose farmers to improved technologies and practices through demonstration centres of farmers.

Agricultural households that increase their labour days on plot by child household members increase their crop production significantly. This is an important discovery as it has a big impact on the education policy in Uganda through the Universal Primary Education (UPE). Whereas the children play a big role in crop production, the education policy with seemingly compulsory education requires them to be at school and this can cause distribution of time between education and farm work extremely difficult.

Generally, male-headed agricultural households realize boosts in crop production than those of their female counterparts. This could be partly due to the fact that there are more male than female headed households. It could also be due to the issue that males easily assess loan than female and can use them as agricultural loan, which boost crop production in their households. The tradition is currently changing due to change in traditional perception of only male heads and also due to the AIDS pandemic, which has claimed more male/husbands and leave wives or senior daughters as household heads (Ministry of Health, 2004).

5.3. Recommendations

Technical improvement characteristics and external persuasion seriously affect the adoption of improved crop practices. Field pests limit crop production, and flexible integrated management packages that combine drought tolerant varieties with improved cultural practices could be adopted as they increase crop yields. Low-cost technologies for controlling crop pests and diseases using cultural practices or environmentally friendly industrial chemicals should also be developed.

The majority of improved varieties are responsive to fertilizer, and farmers usually obtain economic yields with fertilizer or manure. But the use of fertilizer/manure is most times constrained by its high price and farmers' lack of knowledge of fertilizer. An efficient agricultural inputs (fertilizer/manure) awareness system would benefit farmers by teaching them the nitty-gritty of the inputs and reducing the cost of fertilizer/manure. Such a system cannot be established without policy support from the government. Studies of the economics of fertilizer use should be undertaken, especially now that input and output markets have been liberalized.

Extension should be reinforced to increase the flow of information to farmers. Supplementary effort should be directed towards fertilizer technologies, as the bulk of farmers use inefficient practices. More knowledge on use of organic manure to supplement chemical fertilizer should be given or imparted into farmers. Furthermore, extension efforts should be directed towards promoting the adoption of improved varieties, weeding, and management practices for controlling diseases and field and storage pests. Farmers who intend to store their harvested crops should be advised to treat their stored crops against insect infestation.

The National Agricultural Advisory Services (NAADS) should be guided and supported by the government to; open-up to all districts and sub-counties in Uganda since they currently operate in about 44 out of over 80 districts; make sure that the NAADS demonstration gardens are in easily accessible places for all beneficiaries; open-up to all farmers instead of groups of farmers as this leads to wide spread of knowledge.

There is limited accessibility of Credit to most farmers through formal channels, even though the accessibility of credit becomes increasingly important as input prices rise. The government of Uganda has introduced a Micro-Finance Programme called "*Prosperity for all*" or "*Bona-bagagawale*" within MFPED, and it is responsible for alleviation of poverty through credit accessibility with focus on households (greatest composition are peasant farmers, Census 2002). So in cooperation with the government and other stakeholders, the formal credit system needs to tackle the credit problems faced by small-scale farmers, especially their lack of knowledge (information) about formal credit and the bureaucratic procedures that often impede access to credit. Farmers should also be encouraged to form credit groups, because lending to groups tends to reduce transaction costs and ensures a high rate of loan recovery. All this can boost access of purchased inputs to farmers for production enhancement.

Since hired labour does seem to increase household crop production, there is need to think of other types for labour to supplement household member labour on the plot. This could be in form of government revisiting the old system where tractors and ploughs were availed to almost all sub-counties and would be used by farmers at very low cost because of subsidies from government.

Government without necessarily tampering with household crop production, should lay down measures that will reduce if not completely eliminate participation of child household members in farming during schooling period. This will imply more school hours for children in households and also promote propel government education strategy of UPE and Universal Secondary Education (USE).

Government though Ministry of Gender, Labour and Social Developments (MGLSD) should continue to strengthen women emancipation strategies especially for women farmers to support them in areas like acquisition of low interest agricultural loans to enhance their household crop production. This will help increase production for female headed agricultural households in the country.

5.4. Suggestions for further research

The results presented in this dissertation are very not conclusive and should be treated as being preliminary. Further analysis of the survey data (plot and household) needs to be done to validate these findings and provide greater confidence in explaining the changes in livelihood activities in the household crop production.

A study should be carried to establish how the introduction and promotion of Micro Finance Office within MFPED has affected credit accessibility by farmers and the overall effect to use of agricultural inputs/extension services not forgetting household crop production.

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