Impact of Agricultural Modernization on the Socio-Economic Status of Smallholder Farmers in Luweero and Nakaseke Districts in Uganda

Gerald Wamala, Mohammed Bogere, Margaret Angucia

Abstract. *The aim of this paper was to study the impact of agricultural modernization on the socio-economic status of smallholder farmers in Luweero and Nakaseke Districts. The study adopted a cross sectional research design using a sample size of 350 respondents who were randomly selected from eight Sub-counties in the two districts. Primary data collection was done through the use of self-administered questionnaires, interview guides and focused group discussions. The data was analysed using the independent samples t-test. The findings revealed that low adopters of modern agricultural practices were significantly at a disadvantage when it comes to the acquisition of valuable assets compared to high adopters. Findings further indicated that food security, household income and expenditure were significantly higher among high adopters than low adopters. Promotion of awareness about the benefits inherent in agricultural modernization as a vehicle for improving smallholder farmers' socio economic status is recommended.*

Keywords: Agriculture, Poverty alleviation, Small holder farming.

Introduction

Given the rising population in many countries on one hand and the decline in the carrying capacity of its agricultural land, over the recent years, strategies have been initiated to increase farm output to feed the growing population and one of such mechanisms has been urging farmers to adopt modern agricultural practices. Accordingly, in realization of its contribution to the economy, the government of Uganda started Plan for Modernization of Agriculture (PMA) in 2001. This was in realization of the fact that although about 80 percent of the country's population live in the countryside and derive their livelihood from farming, they face enormous constraints to increased productivity such as soil infertility, limited access to agricultural inputs, pests and diseases, lack of skills and knowledge, lack of capital and access to credit, market problems, poor roads and transport networks, among others (MAAIF & MFPED, 2012).

In this paper, a modest attempt was made to study the impact of Agricultural Modernization (AM) on the Socio-Economic Status (SES) of smallholder farmers in Luweero and Nakaseke Districts. The topic was particularly chosen in light of the objectives for which the Plan for Modernization of Agriculture (PMA) was started as one of the major

tools for eradicating mass poverty through changing the dominant subsistence agriculture to business-oriented farming (Ssekandi and Chen, 2005). At that time, it was envisaged that modernization of the agricultural sector would result into the creation of more jobs especially in rural areas where 22 million Ugandans live and increase household income which would enable farmers improve their lifestyles, ensure food security among others (MAAIF, 2012).

According to Chuanqi (2012), agricultural modernization is an aspect of world modernization comprising of the transition from traditional agriculture (self-sufficient agriculture) to preliminary modern agriculture (marketized agriculture) as well as the transition from preliminary modern agriculture to advanced modern agriculture (knowledge agriculture). In the same vein, Ghosh et al. (2008) cited by Masoud and Asghar (2011) allude that agricultural modernization involves a process in which awareness is created, attitudes are changed and favourable conditions for adoption are provided. Among other things, the main characteristics of agricultural modernization are hybridization, mechanization, fertilizers and pesticides and large scale and intensive farms as Dibua (nd) indicates. Hybridization is the process of crossing two genetically different plants to result in a third crop variety with a different, often preferred, set of traits (Alemu and Tripp, 2010). Mechanization comes with higher capital intensity whereas chemicalization implies that farmers adopt practices that increase the efficiency in the use of fertilizer and chemicals required to produce a certain level of outputs (Otchia, 2014). In his submission, Villar (2000) explains that the process of transforming the agricultural sector into one that is dynamic, technologically advanced and competitive is reflected in the continuous increase of agricultural efficiency and farmer income, improvement in farmers' socio-economic status, assurance of agricultural product supply-demand balance and national food security.

Among the main reasons for agricultural modernization are the increase in labour productivity in order to increase profit; increase in food security, improving agricultural productivity, employment creation, the reduction of the unitary cost of production to beat the competition; and to enable the implementation of the agro-industrial complex in the country (Brum, 1988 cited by Caio, Ricardo and Marco, 2012). This can be achieved by developing and disseminating yield increasing practices and application of these practices by smallholder farmers. Thus, owing to its role in improving incomes for a vast

proportion of the population especially in countries of the developing world, agricultural growth is considered as the most effective means of addressing poverty. In these countries, nearly 75% of the poor people who live on less than a dollar a day work in the agricultural sector and projections suggest that more than 60% will remain rural until 2040 (Ravallion et al. 2007 quoted by Kalsey, 2013). For this reason, Gunnar (1968) quoted by Olawepo and Ibrahim (2013) succinctly stresses that it is in agriculture where the battle for long-term economic development will be won or lost.

Theoretically, the study was rooted in the diffusion of innovation theory developed by Everett Rogers in 1962. Described as the foundation of agriculture outreach methods by Garry (2003), the theory is based on the process by which an innovation is communicated through certain channels over time among the members of a social system. Specifically, the diffusion of innovation theory states that "an innovation (that is to say, an idea, new technique and new technology) diffuses or spreads throughout society in a predictable pattern". The theory predicts that an innovation will initially be adopted by a small group of innovative farmers as soon as these innovative farmers hear of it, while others will take longer to try something new and still others will take much longer. Over time, this innovation will spread to other farmers. For example, when introducing a new improved crop variety, extension workers introduce the variety to a particular area and progressively other farmers adopt innovation through the diffusion process (Siegfried and Mbugua, 1972). That is, an innovation is first adopted by only a few, others follow and more and more are converted through the multiplier effect. Once a certain section of a social unit (model farmers) has adopted an innovation, technology or agricultural practice, it spreads automatically, as long as the diffusion process is not interrupted by intervening factors. Special importance is attached to persons through whom an innovation finds entry into a social unit. The early adopters may seek attention for their innovative behaviour and may act as model farmers. In Uganda for example, the government through the NAADS supported model farmers with various inputs to catalyse transformation from subsistence to commercial agriculture. For this purpose, extension workers were recruited to offer quality advisory services to farmers with four staff being employed per sub-county to provide this support. Following the diffusion process, many farmers responded after learning from model farmers and from advisory

services given out in respect to transformation from subsistence to commercial farming.

In Uganda, agriculture plays a pivotal role in the economic and social development of the country since the sector contributes about 43 percent to the country's Gross Domestic Product (MAAIF and MFPED 2012). The sector also accounts for 85 percent of foreign exchange earnings and provides employment to 80 percent of the population. However, in many parts of country, including the districts of Luweero and Nakaseke, a major characteristic of the agricultural sector is that agricultural output mainly comes from about 3 million smallholder farmers who constitute three quarters of the total and the hand- hoe is the predominant technology being used for cultivation (FAO Corporate document repository, nd). Although factors cited in the literature for the low farm output are enormous, one of the major factors is that a considerable proportion (99.4%) of smallholder farmers in Uganda use traditional, rudimentary and obsolete practices and methodologies (Masinde, 2013). In most parts of the country, farm power in agriculture to a great extent has continued to rely on human muscle power, based on operations that depend on the hoe and other hand tools. Such tools have implicit limitations in terms of energy and output. In this paper, it was envisaged that establishing the impact and outcome of a broad intervention across a sector like agriculture on poverty and food security over the long term is important in order to make rational conclusions as to whether agricultural modernization has contributed significantly towards improving smallholder farmers' socio-economic status.

Statement of the Problem

Smallholder farmers' socio-economic status cannot meaningfully improve if crop yields remain markedly low. In recognition of the importance of agricultural modernization in accounting for the remarkable improvement in farm productivity, various efforts have been made by the government of Uganda to develop strategies and policies aimed at increasing the adoption and uptake of modern farming by smallholder farmers. One of such strategies was the Plan for Modernization of Agriculture (PMA) which was started in 2001 as one of the major tools for eradicating mass poverty by enabling farmers adopt new methods of production thereby changing the dominant subsistence agriculture to business-oriented farming. The uniqueness of

this study stems from the fact that since its inauguration in 2001, nobody, to the knowledge of the researcher has carried out an impact assessment of the role of PMA in the Districts of Luweero and Nakaseke with an aim of understanding the impact and helping to redress the policy failures experienced (if any) with modern agricultural farming in the two Districts. In fact, some anecdotal evidence points to no significant improvement in agricultural production, food security and income levels in terms of a genuine change from predominantly subsistence agriculture to an economy with a commercial agricultural sector (Egwel, 2012). In view of the above submission, the intent of this paper was to add to the scholarly body of knowledge by carrying out an empirical study on the impact of agricultural modernization on the socio-economic status of smallholder farmers in Luweero and Nakaseke Districts.

Purpose

The study sought to establish the impact of agricultural modernization on the socio-economic status of smallholder farmers in Luweero and Nakaseke Districts.

Objectives

1. To establish the extent to which the level of AM impacts on asset ownership among smallholder farmers
2. To find out whether the level of AM affects Food security among smallholder farmers
3. To establish whether the level of AM influences smallholder farmers income
4. To determine whether the level of AM impacts smallholder farmers' expenditure

Hypothesis

1. The level of AM impacts on asset ownership among smallholder farmers
2. The level of AM affects Food security among smallholder farmers
3. The level of AM influences smallholder farmers income
4. The level of AM impacts smallholder farmers' expenditure

Scope

The geographical scope of the study was restricted to two districts in Luweero triangle that include Nakaseke and Luweero Districts. In terms of content scope, the research was undertaken to determine the impact of agricultural modernization on smallholder farmers' socio-economic status in terms of asset ownership, food security, income level and total expenditure on agricultural inputs and non-agricultural expenses such as school fees, medical care, clothing, foot wear, soap, recreation and expenditures on saving schemes. In terms of time scope, the study considered a period of 14 years starting from 2001 when PMA was launched to the year 2014.

Related Literature

It is a general fact that modernization of the agricultural sector plays an important role in agricultural development and can contribute to an increase in agricultural yields and improvement in the welfare of farmers including other people living in rural areas. This section provides a review of the related literature regarding the hypothesized effect of smallholder farmers' participation in agricultural modernization on their socio-economic status based on what previous empirical studies have revealed.

Starting off things in Nigeria, Merga and Urgessa (2014) analysed the factors affecting modern agricultural technology adoption by farmers and the impact of technology adoption decision on the welfare of households in the study area. The result of the propensity score matching estimation showed that the average income and consumption expenditure of adopters are greater than that of non-adopters. Sofoluwe, Tijani and Ogundari (2013) evaluated the potential impact of indigenous agricultural technology adoption on poverty of farm households. Through an empirical investigation of the relationship between adoption of indigenous innovation of the crop protection type, and wellbeing of farm households in Nigeria, the result revealed a positive and significant effect of adoption on adopter's income suggesting that there is a large scope for enhancing the role of indigenous agricultural innovation in 'directly' contributing to poverty alleviation. In Malawi, Simtowe, et al (2012) investigated the welfare effects of agricultural technology adoption between adopters and non- adopters. In the analysis the study found positive and significant impacts of improved groundnut variety adoption on per capita consumption expenditure and

on poverty reduction. Using the comprehensive data set collected from 238 rice producers during 2011, Akhter, Olaf and Bahadur (2014) found out that adopter households have a higher income compared to non-adopting households. In Nigeria, a study by Awotide, et al (2012) examined the impact of improved rice varieties adoption on rice productivity and farming households' welfare. Among the key findings of their analysis, there was a significant positive impact of Agricultural Technology Adoption on rice productivity and total households' expenditure. This suggests that adoption of improved rice varieties significantly generates an improvement in farming household living standard.

On their part, Caio, Ricardo and Marco (2012) analysed the impacts and externalities of agricultural modernization in Brazilian states. The Spearman correlation test was used to verify the relationship and in the analysis, there was a significant and positive correlation between the agricultural modernization and per capita GDP and trade balance per capita. This means that agricultural modernization contributes to increased production, exports and the levels of socio-economic development of the states. Mariapia's (2007) study analysed the potential impact of agricultural technology adoption on poverty alleviation strategies through an empirical investigation of the relationship between technological change, of the Green Revolution type, and well-being of smallholder farm households in two rural Bangladeshi regions. The outcomes of his analysis revealed a robust and positive effect of agricultural technology adoption on farm household well-being. In Uganda, Kijima et al. (2008) studied the impact of NERICA varieties and found that NERICA adoption reduces poverty without deteriorating the income distribution. More recently, Dontsop, Diagne, Okoruwa and Ojehomon (2011) also examined the impact of NERICA adoption on farmers' welfare in Nigeria. The result of the study shows that adoption of NERICA varieties has a positive and significant impact on farm household income and welfare measured by the per capita expenditure and poverty reduction in rural Nigeria.

In contrast, Babatunde (2009) estimated the effects of new agricultural technology on poverty reduction. The study noted that participation in agricultural technology does not automatically lead to the reduction in poverty headcount levels and does not disproportionately improve the income of the poorest adopters in comparison with the non-adopters. The study thus concluded that although new agricultural practices have a potential to lead to poverty reduction and increase food security, this

does not mean that poor African countries should invest more in such technologies without consolidating the technical improvement of farmers where necessary, and for that reason, the new agricultural technology would not expressly lead to poverty reduction in poor countries. Another contrasting finding was reported by Hossain et.al. (2003 cited by Awotide, et al 2012) in Bangladesh where adoption of improved varieties of rice only had a positive impact on the richer households but this effect was negative to the poor. Furthermore, in another study, Bourdillon et al. (2002 cited by Awotide, et al 2012) revealed that the adoption of improved varieties of maize leads to a moderate increase in income of the adopters.

From the review, it can be seen that a number of studies have been conducted to analyse impact of adoption of agricultural technologies on farmers' socio-economic status. However, some have reported positive while others found negative impacts. In short, the results have been mixed and in other situations, the results have been weak in terms of statistical significance across the different methods, model specifications, and outcomes analysed, making it difficult to draw definitive and generalizable conclusions. This has resulted to scepticism regarding the validity and reliability of the results due to some contradictory and exaggerated results. Besides, most of the empirical studies that have tried to explore the issue of agricultural modernization and socio-economic status have been conducted outside Uganda. Within this mixed history of hopes, doubts, exaggerations and contradictions, this paper sought to assess whether agricultural modernization has brought the intended results among people in the war ravaged region of Luweero district.

Methodology

The study adopted a cross sectional research design since data was collected at a defined time. According to Dillman (2000), cross-sectional survey collects information from a sample that has been drawn from a pre-determined population at just one point in time. The study population comprised of smallholder farmers in the districts of Luweero and Nakaseke and the sample constituted a representative total of 350 respondents who were randomly selected from a total of eight Sub-counties in the two districts. Data collection was done by contacting the

respondents for first-hand information through the use of self-administered questionnaires, interview guides and focused group discussions. Statistical Analysis involved the use of the Statistical Package for Social Science (SPSS) programs and the main statistical test used was the independent samples t-test with an aim of comparing whether significant differences exist between low and high adopters of modern agricultural practices with regard to food security, asset ownership, income level and total expenditure

Findings and Discussion

This part of the paper presents and discusses the major findings of the study. It begins with some key background information of the respondents followed by the results of the statistical analysis and discussion under each objective of the study.

Background Information about the Respondents

Regarding gender distribution, males were represented by nearly 55 percent while females were represented by 45 percent. In, more than three quarters (77.1%) of the sampled homes were headed by males and nearly two thirds of the respondents were married while a sixth (16%) of the though not legally married, were living together as husband and wife. In relation to academic attainment, 57 percent had primary level as their highest academic attainment while 32 percent of the respondents had secondary education. The proportion of individuals with no education was almost nine percent (8.9%) while 1.7% was the proportion that had attained higher education. The results generally reflect low education levels among the sampled households and this perhaps explains why most of them chose to join farming. The average age was 46±13 while the modal age was 45 years indicating that a typical smallholder farmer was economically active. When it comes to farming experience, the study found out that on average, respondents had practiced farming for 23±15.1 years.

Turning to household size, the mean size of a household was 7±3.8 and out of this, the average number of children (below 6 years) was 2±1.6 which means that on average, the dependency ratio was generally low. The average number of children aged 6-17 years was 3±2.4 while that of adults in the age bracket of 18-59 years was 2±1.6. Children aged 6-17 and adults aged 18-59 years were considered to be the ones in the

productive age. This means that a typical household in the two study areas on average had five members providing farm labour (i.e. 2.9+2.4=5.3). In relation to land ownership, the number of acres included all the land on which the household had full ownership and the acres she/he was renting, borrowed or was under lease.

Agricultural Modernization

In this paper, smallholder farmers constituted farmers with small farms of less than one hectare of land supporting a single family with a mixture of cash crops and subsistence farming and are mainly dependent on family labour. These farmers were categorized as either low or high adopters of modern agricultural practices. In measuring the level of adoption, eleven questions were formulated and respondents were asked to indicate whether they have practiced each or any of the 11 practices and the responses were based on No and Yes responses. The responses for these questions had binary responses where the former was given a code of zero (0) while the latter was assigned a code of one (1). A sum of scores on these questions was obtained and these ranged from 0-11 with higher score signifying higher level of adoption and vice versa. For comparative purposes, respondents whose score was between zero and five were considered to be low adopters while high adopters were those whose scores on the index of adoption was between six to eleven. The lead question was: in the last two years, have you practiced/used any of the following on your farm? Figure 1 presents a summary of the responses.

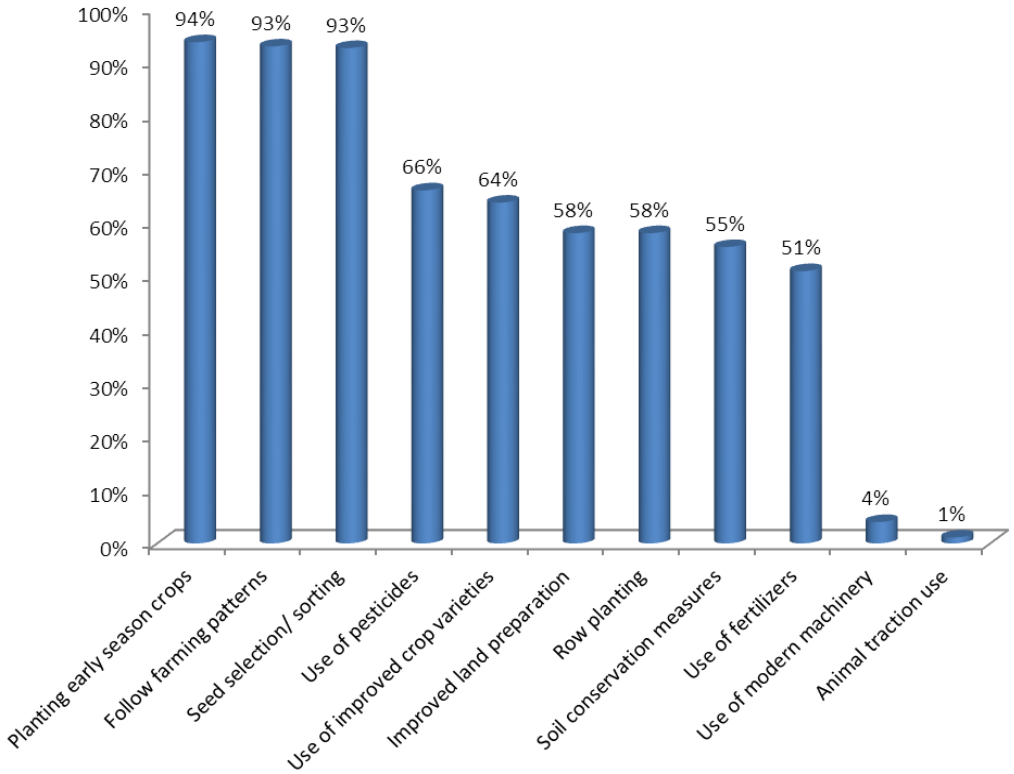

Figure 1: Farming Practices Adopted by Smallholder Farmers in the Last Two Years

Source: primary data (2015)

In Figure 1, the major farming practices adopted by smallholder farmers include planting early season crops, following farming patterns and seed selection/ sorting. Indeed, these three practices are aimed at ensuring food security in the home, avoiding losses due to failure to follow appropriate farming patterns and guaranteeing high quality output at the time of harvest respectively. Use of pesticides and use of improved crop varieties also emerged among the farming practices with outstanding percentages. The use of pesticides on the farm is aimed at reducing the incidence of diseases while the use of improved crop varieties is that as opposed to traditional varieties, the former has the advantage of being less vulnerable to diseases, heat, drought, and other stresses. Practices such as improved land preparation like levelling of plot before planting, row planting, use of soil conservation measures and use of fertilizers were moderately practiced. While emphasizing its importance, Klein and Zaid (2015) mention that land preparation is

important in the provision of the necessary soil conditions which will enhance the successful establishment of the young offshoots or the tissue culture plants received from the nursery. On the other hand, row planting enables the plant to have sufficient light, walking space within the garden and sufficient space for root development. The study established that use of modern machinery such as tractors in tilling the land and animal traction use is extremely low. According to the findings, the rate of use for modern machinery stands at 4 percent while animal traction is the least with 1 percent.

In the process of constructing the index for agricultural modernization, the response category was collapsed to create dichotomous variables on the basis of whether or not an individual adopted any/each of the practices summarized in Figure 1 above. Consequently, it was established that out of a total sample of 350 respondents, 112 (32%) were low adopters while 238(68%) were regarded as high level adopters of modern agricultural practices which implies that using the 11 indicators, the intensity of agricultural modernization stands at 68 percent in the two study areas. The two groups were then compared against the four dependent variables to determine whether the level of adoption significantly impact on their SES as measured by: household wealth, food security, household income and household expenditure on things such as agricultural inputs, school fees, medical care, clothing, foot wear, soap, recreation and expenditures on saving schemes.

Agricultural Modernization and Socio-economic Status

Drawing from previous studies (such as Irz et al., 2001; Msuya, 2010; Mariapia, 2007; Merga and Urgessa, 2014 Seidu, 2011; Awotide, Diagnen and Omonona, 2012) that established that adoption of modern agricultural practices influences the poor by raising their economic wellbeing, the contention of the researcher was that when farmers take advantage of modern agricultural practices, asset ownership, household income, food security and household consumption expenditure would all increase. This assumption is based on Kusz's (2014) statement that modernisation of the agricultural sector is supposed to ensure productivity growth, reduction in poverty by increasing profitability of farms among rural households as well as ensuring food security. In order to ensure that the better socio-economic status of high adopters compared to low-adopters is caused by the level of technology

adoption, four indicators were used and these included asset ownership, income from different activities, food security and consumption expenditure (such as school fees, medical care, clothing, foot wear, soap, recreation and expenditures on saving schemes).

Following studies that have also assessed the impact of different agricultural programs on farmers' welfare, the current study also uses proxies to measure household welfare outcome. For example, Simtowe et al (2012) used annual income (from crop) and household annual consumption expenditure as proxies in measuring household welfare. In this regard, Mariapia (2007) maintains that as long as technology adoption is random, we can compare income of similar households in different technological status, and in this context, high or low levels of technology adoption. Accordingly, in his study, Mariapia (2007) used the level of gross income consisting of a combination of income from land and non-land assets and off-farm income. The other indicator used in estimating households' welfare was food security access scale derived from Terri, Coates, Swindale & Bilinsky, (2011). Food security was measured with nine-question USDA Household Food Security Scale Module adapted for developing countries. A full description of each of the four proxies is described in the following subsections.

Agricultural Modernisation and Asset Ownership

Household's endowment is usually used as a measure of SES and can reveal a lot about the living condition of farmers (Awotide, et al 2012). Economic improvement was measured in terms of household possession of assets that included possession of: radio, television, mobile phone, personal computers, sofa chairs, sewing machine, bicycle, motorcycle and vehicle. It was hypothesized that other factors remaining constant, adoption of modern agricultural practices leads to production of high farm output which is sold off. The income from this output increases their purchasing power which makes them well-endowed with the above-mentioned assets. A comparison of household assets was therefore made between low and high-adopters of modern methods of farming with an aim of determining if the level of adoption has an impact on households' assets. Table 1 presents the descriptive statistics for both low and high adopters' including the weights attached to the different assets possessed by households.

Table 1: Level of adoption by household endowments

Household Endowments	Weight attached	Low adopters (n=112)	High adopters (n=238)	Pooled data (n=350)
Ownership of a mobile phone	03	85.70%	91.20%	89.40%
Ownership of a radio	07	88.40%	93.30%	91.70%
Ownership of a TV	15	12.50%	13.40%	13.10%
Ownership of a personal computer	20	0%	0.80%	0.80%
Ownership of a sewing machine	17	7.10%	5.50%	6.00%
Ownership of a bicycle	20	75.00%	81.50%	79.40%
Ownership of a motorcycle	50	24.10%	29.40%	27.70%
Ownership of a motor vehicle	80	0.90%	2.10%	1.70%

In Table 1, a significant proportion of low and high adopters own mobile telephones and radios. Although high adopters appeared to be relatively more endowed with these two assets, the differences appeared to be small. In the pooled data, 89% and 91.7% own mobile phones and radios respectively an indication that access to information via these two ICTs is not a major constraint to most farmers. In terms of TV ownership, only 12.5% and 13.4% of the low and high adopters respectively had access to televisions. This means that access to information via television is a constraint militating against accessing agricultural information for the two groups. On the other hand, ownership of a sewing machine was slightly skewed in favour of low adopters. In the analysis, although 6 percent was the overall proportion of respondents who owned a sewing machine, the percentage of low adopters was 7.1% whereas that of high adopters was less at 5.5 percent. Regarding ownership of the means of transport, more than three quarters (79.4%) mentioned that they own bicycles. Among the low-adopters, only 75 % owned bicycles while the percentage of their counterparts was higher by 6.5% more which means that in measuring households economic being using this proxy variable, high adopters are better off than the low adopters. However, few respondents owned motorcycles and motor vehicles. Among the low adopters and high adopters, the proportion of households that owned motorcycles was 24 and 29 percent respectively. Regarding vehicle ownership, the trend was not very different among the two groups as indicated by 0.9% and 2.1% of the low and high adopters respectively. Overall ownership of motorcycle and vehicles stood at 27.7% and 1.7% as indicated by the

percentages in the pooled data column. This shows that regarding the ownership of the means of transport, most of the smallholder farmers (79.4%) depend on the bicycle to transport agricultural inputs and merchandise or as a means of transport to reach centres where extension services are provided.

In order to determine whether higher adoption level has a significant impact on socio-economic status of smallholder farmers, a wealth index was calculated for each respondent and an overall score obtained. The weight attached to the different assets is also indicated in Table 1. For example; a score of 3, 7, 20, and 80 was given to a respondent who owned a mobile phone, radio, computer, motor vehicle respectively. Accordingly, the highest possible score was 227 while the lowest was zero which implies that such a household did not own any of the assets mentioned in the Table. A household was considered to have higher socio-economic status if his/her wealth index was higher and vice versa. A t-test for independent samples was subsequently used to determine whether the level of adoption significantly influenced the economic improvement of the respondents. The results are summarized in Table 2.

Table 2: Analysis of the impact of Level of adoption on household wealth index

Level of adoption	N	Mean	Std. Deviation	Mean difference	t	p-value
High (6-11)	238	48.58	30.01	6.58	1.868	0.063
Low (0-5)	112	42.00	32.29			

For high adopters, the mean score was 48.58±30.01 while that of low adopters was 42±32.9. The finding suggests that as the level of adoption increases, households' wealth also follows suit. The mean difference between households in the two cohorts was 6.58 and this difference was statistically significant at 10 percent level (.063<0.1). The results are therefore in line with the researcher's postulation that adoption status has a significant bearing on household wealth. As earlier noted, as farm productivity increases, part of the output is sold off which boosts income levels. As income level goes up, purchasing power parity also goes up and consequently, an individual would be in position to acquire a wide range of assets. Overall, the outcome of this analysis has demonstrated that low adopters are at a disadvantage when it comes to the acquisition of valuable assets compared to their counterparts who adopted a wide range of modern farming practices.

Agricultural Modernisation and Food Security

Food security is generally defined as the condition to which all people at all times have enough food for a healthy and productive life (Msuya, 2010). Hunger is one of the major threats to many people particularly in Sub-Saharan Africa. For the case of Uganda, a 2013 expenditure review for 2012 in the Directorate of Social Protection in the Ministry of Gender, Labour and Social Development (quoted by Anguyo, 2013) cited drought, floods and economic shocks such as high prices for goods and inputs and low prices of farm produce as the most reported risks to poverty and subsequently food insecurity. Several measures have been put in place to address the problem of food insecurity among households. Examples of such measures include increasing agricultural production through technology improvement, provision of credit to farmers and diversification to farm enterprises (Msuya, 2010). This section determines the extent to which agricultural modernization has impacted on food security of low and high adopters of modern agricultural practices.

Food security status was measured using a standard metric scale for household hunger developed in 2006 with an aim of providing a valid tool for use in a developing country context that would be capable of measuring food insecurity in a comparable way (Terri, Coates, Swindale and Bilinsky 2007). The Household Food Insecurity Access Scale (HFIAS) tool consists of nine occurrence questions and nine frequency-of-occurrence questions. The occurrence questions ask whether or not a specific condition associated with the experience of food insecurity ever occurred in a household in the last one month. These indicators provide specific, disaggregated information about the behaviours and perceptions of the surveyed households. Descriptive statistics were used to provide summary statistics of households' responses on the nine questions.

Table 3: Responses on Food security by adoption status (%)

		Level of adoption of agricultural modernization	
		Low (n=112)	High (n=238)
Did you or any household member have to eat a limited variety of foods?	No	59.8	60.9
	Yes	40.2	39.1
How often did this happen?	Rarely	29.5	69
	Sometimes	40.9	25.9
	Often	29.5	5.2
Did you or any household member have to eat some foods that you really did not want to eat?	No	55.4	58.8
	Yes	44.6	41.2
How often did this happen?	Rarely	27.7	54.8
	Sometimes	27.7	33.9
	Often	44.7	11.3
Did you or any household member have to eat a smaller meal than you felt you needed?	No	71.4	82.4
	Yes	28.6	17.6
How often did this happen?	Rarely	61.3	64.9
	Sometimes	22.6	35.1
	Often	16.1	
Did you or any other household member have to eat fewer meals in a day?	No	70.5	81.9
	Yes	29.5	18.1
How often did this happen?	Rarely	48.3	67.9
	Sometimes	31.0	28.6
	Often	20.7	3.6
Was there ever no food to eat of any kind in your household?	No	88.4	79
	Yes	11.6	21
How often did this happen?	Rarely	55.6	60
	Sometimes	11.1	26.7
	Often	33.3	13.3
Did you or any household member go to sleep at night hungry because there was not enough food?	No	88.4	93.3
	Yes	11.6	6.7
How often did this happen?	Rarely	50	80
	Sometimes	40	20
	Often	10	
Did you or any household member go a whole day and night without eating anything because there was not enough food?	No	88.4	99.2
	Yes	11.6	.8
How often did this happen?	Rarely	50	
	Sometimes	40	100
	Often	10	

Households were categorized as being increasingly food insecure if they responded affirmatively to more severe conditions and/or experienced those conditions more frequently. On the other hand, households who

were food secure experienced none of the food insecurity conditions, or just worried, but rarely. In the analysis, the percentages in the table show that respondents with low levels of adoption were more likely to choose affirmative responses to the different conditions and were also more likely to experience such conditions more frequently compared to households whose level of adoption was high. For example, compared to the low adopters, households with high adoption levels were less likely to worry about not having enough food sometimes or often, and/or unable to eat preferred foods, and/or eat a more monotonous diet than desired and/or some foods considered undesirable. The findings further show that a severely food insecure household had at some point resorted to for instance cutting back on meal size or number of meals often, and/or experience any of the three most severe conditions (running out of food, going to bed hungry, or going a whole day and night without eating). According to Terri, et al (2011), any household that experienced one of these three conditions even once in the last one month is considered severely food insecure and as seen in the descriptive statistics, this probability increased among low adopters.

To compute the level of food insecurity, a HFIAS score variable was calculated for each respondent by summing the codes for each frequency-of-occurrence question. Prior to adding the codes, all cases where the answer to the corresponding occurrence question was "no" were given a code of zero (that is, if i_1a=0, then i_1b=0, if i_2a=0, then i_2b=0 and so on). In case a households response to all nine frequency-of-occurrence questions was "often", coded with response code of 3, the maximum score for a such a household was therefore 27 while the minimum score was 0 (in case the household responded "no" to all occurrence questions). Accordingly, the higher the score, the more food insecurity (access) the household experienced. The lower the score, the less food insecurity a household experienced (Terri, Coates, Swindale and Bilinsky 2011). Table 4 gives a summary of the t-test results for Households Food security score in relation to the level of adoption of modern agricultural practices.

Table 4: Impact of the level of adoption on Households Food security score

Level of adoption	N	Mean	Std. Deviation	Mean difference	t-value	p-value
Low (0-5)	112	4.38	6.04	2.4	4.775	.000
High (6-11)	238	2.01	3.26			

The analysis shows that on average, low adopters (households which adopted 0-5 practices) were food insecure compared to high adopters as indicated by an average of 4.38 and 2.01 respectively with a mean difference between the two groups being 2.4. In specific terms, high adopters were significantly (0.000<0.01) more food secure than households whose level of adoption was low, an indication that the modernisation process was the driving force behind food security among high adopters. It is however worth pointing out that considering the fact that the maximum level of food insecurity was 27, a key point to note is that, the level of food insecurity was generally low among the two households bearing in mind that 4.38 and 2.01 were the average level of food security for low and high adopters respectively.

The observed significant difference in the means render support to much of the previous studies conducted in different countries under different conditions to determine the impact of technology adoption on household food security. In the first place, the findings are in corroboration with Setotaw et al. (2003) who found adoption of improved agricultural technologies (improved varieties and agronomic practices) to have a positive and significant impact on food security of households in Ethiopia. In the same vein, the t-test result conform the analysis of Kassie *et al.* (2012) regarding the impact of the intensity of improved maize varieties adoption on food security and poverty in rural Tanzania. Similar to the results of the current study, increase in food security was found to be positively and significantly correlated with households' adoption of maize technology. Furthermore, the results match with the findings of Msuya (2010) regarding the contribution of Special Program for Food Security (SPFS) introduced by Food and Agricultural Organization (FAO) from 1996 and launched in Tanzania 1998. The study found changes in food security before and after the program and this was attributed to the project.

Agricultural Modernisation, Income and Expenditure

In 2007, Mariapia (2007) reported that globally, 75 percent of the people living on less than a dollar per day live and work in rural areas. It was further estimated that over 60% will continue to do so in 2025. The 2013 expenditure review for Uganda 2012 quoted by Anguyo (2013) revealed that about 67% of Ugandans are either poor or highly vulnerable to poverty, spending below the poverty line of $ 1.20 per day. With a current population of 34.6 million people (UBOS, 2016), this means that

about 23.2 million people are prone to poverty. Therefore, the need to increase household income by encouraging smallholder farmers to increase the uptake of modern agricultural innovations is seen as a plausible avenue for increasing agricultural production. As to whether the level of uptake for modern methods of farming contributes to poverty reduction is the empirical question this paper sought to address.

This section focuses on the impact of households' level of adoption of modern agricultural practices on estimated annual income (farm, livestock and off farm income) and expenditure on food and non-food items. The expenditure pattern of people has been used to measure the poverty status of households. In other words, the things on which people spend their incomes can be used to ascertain whether progress is being made in the fight against poverty. These proxies of household welfare have also been used in the estimation of poverty levels by researchers such as Simtowe et al (2012) and Mariapia (2007). Thus, in terms of the impact of adoption levels on economic improvement, a comparison was made between high adopters and low adopters for both household income and expenditure. *An independent samples t*-test was used to test for differences in income and expenditure between high adopters and low adopters. Table 5 presents the analysis of the level of adoption on annual income and total agricultural and non-agricultural expenditure for the two types of households.

Table 5: Impact of Level of adoption on average household income and expenditure (Shs) 1USD=3240.646UGX

Variable	Pooled data (n=350)	High (n=238)	Low (n=112)	Mean Difference
Household income				
Farm Income	2,485,118.3	2,912,327.3	1,577,299.1	1,335,028.2***
Livestock income	543,605.7	612,831.9	396,500.0	216,331.9**
Off farm income	1,046,471.4	1,026,218.5	1,089,508.9	-63,290.4
Total income	4,098,616.1	4,570,581.9	3,090,905.4	1,479,676.5**
Expenditure				
Agricultural expenditure	298,542.9	367,521.0	151,964.3	215,556.7**
Non-agricultural expenditure	2,637,908.6	2,787,399.2	2,320,241.1	467,158.1
Total expenditure	2,936,451.4	3,154,920.2	2,472,205.4	682,714.8*

**** Significant at p<0.01, ** significant at p<0.05 and * significant at p<0.1*

In the analysis, high adopters differ from low adopters in all characteristics related to income and expenditure. In particular, the analysis shows that the average annual farm income of high adopters

was shillings 2,912,327.3 whereas shillings 1,577,299 was the average income for low adopters with a statistically significant ($p<0.01$) mean difference of shillings 1,335,028.2. The table also shows that farmers who were involved in livestock rearing in total had an average income of 543,605.7/=. From this total, high adopters contributed 612,831.9/= while the average income obtained by low adopters from livestock was 396,500/= and the mean differences in the two groups were statistically significant at the 5 percent level. Therefore, these findings are indicative of the significance of livestock rearing on household economic improvement. Regarding off farm income, low adopters were better-off (mean=1,089,508.9) than the high-adopters (mean=1,026,218.5) but not to a statistically significant extent. This is quite understandable given that a significant proportion of low adopters depended on off farm income (such as formal employment, casual labour, business etc.) for a livelihood.

The index for total household income was obtained by summing up the cash obtained from all income sources and according to the results given in Table 5, there was a significant difference in the total income between high and low adopters, with the former having an average of 4,570,581.9/= while low adopters' average was 3,090,905.4/= with a mean difference in the income equal to shillings 1,479,676.5 and significant at the 5 percent level. This implies that the welfare of high adopters was better than that of low-adopters which perhaps explains why they were able to spend significantly ($p<0.1$) more (mean= 682,714.8/=) than the low- adopters whose annual expenditure value was shillings 2,472,205.4.

In this study, annual expenditure was considered to be a reflection of the effective consumption of households on agricultural, non-agricultural and total expenditure on these two activities. Accordingly, high adopters had a significantly higher expenditure ($p<.05$) on agricultural expenses than low adopters with a mean difference of shillings 215,556.7, significant at 5 percent level. This was expected because most of the low adopters depended mainly on off farm activities and as a result, their expenses on farm implements and other agricultural inputs could not match that of their counterparts whose major source of livelihood was farming. Also in the analysis, although high adopters' average on non-agricultural expenditure was higher than low adopters as indicated by the mean difference of 46,158.1/=, the findings show that the former seem not be better-off than the latter if economic improvement is measured in terms of non-agricultural

expenditure for a household. This is because of the insignificant value of the t-statistic at all levels. It therefore means that if we were to exclusively use non-agricultural expenditure as the indicator of households' economic improvement, the level of economic improvement for the two categories of households would be the same. The things that comprised non-agricultural expenditure included: school fees, medical care, basic needs (such as food, clothing, foot wear, soap etc.), recreation and expenditures on saving schemes.

Regarding overall expenditure, the table shows that the estimated annual household expenditure is 2,936,451.4/= for low and high adopters. Annual consumption expenditure of the high adopters was Shs 3,154,920.2 while that of low adopters was Shs 2,472,205.4 with a significant ($p<0.1$) mean difference of Shs 682,714.8 indicating that high adopters had more annual consumption expenditure than low adopters. The implication of this finding is that high adopters had a better welfare than low adopters

Lending support to the findings, Merga and Urgessa's (2014) results of the propensity score matching estimation showed that the average income and consumption expenditure of adopters are greater than that of non-adopters of Modern Agricultural Technology. According to their findings, most of this difference was a result of adoption of modern agricultural practices. The results of Afolami, et al (2015) also revealed that adoption of improved cassava varieties increases the annual income and the annual consumption expenditure of producing households' thus increasing welfare in South West Nigeria. In a study by Seidu, (2011) irrigation was used as a proxy for agricultural modernization. Among the major findings, irrigation farming was found to have a positive effect on the socio-economic conditions of the beneficiaries by way of improvement in their income levels, food security and education of their children.

Additionally, the analysis validates Awotide, et al (2012) results which showed a significant positive impact of adoption of improved rice varieties on not only rice productivity but also total households' expenditure. The results are further supported by the findings of Tesfaye, et al (2016) which analysed the impact of improved wheat technology adoption on the productivity and income in Ethiopia. In their analysis, the average income of adopters was greater than the non-adopters. In the same vein, Mignouna, Rusike, Mutabazi and Senkondo (nd) also showed that adoption of imazapyr-resistant maize (IRM) raises farm household income. The findings are also in tandem with Mariapia

(2006) who found a robust and positive effect of agricultural technology adoption on farm household improvement. Moreover, Kijima *et al*. (2008) found that NERICA adoption reduces poverty in central and western Uganda. Other empirical studies done elsewhere whose findings are worth mentioning include Mendola (2006) who found technology adoption to reduce poverty, Wu et al. (2010) found that adoption of agricultural technologies had a positive impact on farmers' well-being thereby improving household income.

Conclusions

All in all, a straightforward comparison between asset ownership, food security, income and expenditure of high and low adopters of AM shows that the level of uptake of modern farming practices impact significantly on smallholder farmers' status. The findings have shown that for all the four measures of SES (household wealth, food security, income and expenditure), high adopters' SES is much better than that of low adopters. Accordingly, a combination of the findings from this study and empirical studies conducted done elsewhere emphasize the notion that modern agricultural practices are important in improving the socio-economic status of smallholder farmers. This leads to the conclusion that in order to achieve the much desired reduction in poverty through the current Operation Wealth Creation; government should intensify efforts by ensuring that farmers have access to modern agricultural practices at the right time and place. This will be one of the practical ways of achieving Uganda's target of becoming a middle income country by the year 2020.

Recommendations

Since high level of adoption of agricultural modernization was a key factor in increasing smallholder farmers' SES, the study recommends that one of the ways to increase food security, income and wealth among smallholder farmers, all necessary efforts should be intensified with an aim of creating smallholder farmers' awareness about the benefits inherent in agricultural modernization. This could be through increased extension contacts with the farmers coupled with in-depth practical training on the use and importance of the innovation and other modern agricultural practices. This is most likely to make smallholder

farmers change their attitude and begin to look at farming as a profession and make them develop a business attitude.

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