THE INTERNATIONAL JOURNAL OF SCIENCE & TECHNOLEDGE

Effects of Adoption of Improved Seeds and Fertilizers on Household Welfare: The Case of Smallholder Maize and Pigeon Pea Farmers in Tanzania

Marco Bura Sanka
Department of Economics and Statistics, Moshi Co-operative University, Tanzania

Abstract:
The main objective of this study was to assess the economic effects of agricultural technologies practices on maize and pigeon pea productivity in Babati district, Tanzania. The study utilized cross section data collected from a random sample of 500 maize and pigeon pea farmer households in Babati district. The data were collected through face to face interviews using a semi-structured questionnaire. The study used descriptive statistics to analyse proportion of the smallholder farmer's uses four agricultural technology practices in the study area. In this study, an adopter of agricultural technology was defined as the farmer household using at least 50% of the technology package including at least one improved crop variety and one type of fertilizer. With respect to the individual technology practices/components, it had been found that improved maize seed and organic fertilizers were used by 98.90% and 69.90% respectively, followed by pigeon pea adopted at the level of 68.40%. Contrary to that adoption of agro-chemical had been found with low adoption by individual farmers. The results further revealed that the most common sources of technology packages are from local traders/organization reported by about86.64%. The study used a two-sample independent t-test to quantify the effects of adoption of agricultural technologies on farm productivity, farm income, household per capita expenditure and household food security as the indicators for household welfare. The results showed that adoption of improved agricultural technology can generate sizeable gains in maize and pigeon peas yields and increase household per capita consumption and food security status of adopting households in the study area. Moreover, results revealed that the average yield of maize and pigeon pea for adopters were 2,831.75kg/acres and 278.99kg/acres, respectively, compared to 1,906.28kg/acres and 151.76kg/acres for non-adopters in that order. This represents a yield gain of about 48.55% for maize and 83.83% for pigeon peas due to adoption of agricultural technologies. The household per capita expenditure was estimated at Tsh274, 134.04 for adopting households compared to Tsh184, 512.98 for non-adopting household; indicating 48.57% gain in purchasing power. Furthermore, the results show that mean calorie was higher among adopters (2,873.06 Kcal) compared to (2,387.08Kcal) for non-adopters; indicating 20.36% improved household food security of the adopting household. Findings from this study show that adoption of improved crop varieties and fertilizers can increase welfare of smallholder farmers in Tanzania. Efforts to promote adoption of agricultural technologies should focus on enhancement of farmer-awareness of the soil fertility management technologies; economic and other benefits such as livelihoods and living conditions. Similarly, the Government can increase access to improved agricultural technologies through subsidies on agricultural inputs.

Keywords: *Adoption, improved seeds, fertilizers*

1. Background Information

Majority of Sub-Saharan Africa's population lives in rural areas. They depend directly or indirectly on agriculture as their main stay of growth and development. Sub-Saharan African countries have achieved success in increasing exports by selling different crops. For example, fruit and vegetable exports from Kenya have increased fourfold in constant dollar terms since 1974, from Cote d'Ivoire grew at an annual rate of 4.4. Percent through the 1990s and in Zambia exports of fresh vegetables and cut flowers rose from $6 million in 1994 to more than $33 million in 2001, now accounting for almost 40% of total agricultural exports. These statistics have proved the contribution of agriculture sector in foreign exchange improvement (Karshenas, 2004). Agriculture accounts for more than 25% of the gross domestic product (GDP) of most African countries and is the main source of income and employment for at least 65% of Africa's population of 750 million. Thus, agricultural development is vital to Africa's economic growth, food security, and poverty alleviation. (Henao, J and C. Banaante, 2006). In Tanzania the sector employs the majority of the poor especially those in rural areas. For instance, in 2015, the sector contributed approximately 51 percent of foreign exchange, 65.5 percent of total employment and 29% percent of the Gross

Domestic Product (GDP) (Deloitte report, 2016). Smallholder farming dominates agricultural production, and a large proportion is for subsistence. Since poverty is predominantly a rural phenomenon, and agriculture is a major economic activity for rural population, it follows that success in poverty reduction depends critically on performance of the agriculture sector. Agricultural sector is very important in dealing with poverty because according to the ASDP, about 80 % of the poor people in Tanzania live in rural areas with agriculture accounting for 75% of rural household incomes. Thus, significant reductions in overall poverty levels, particularly rural poverty, in Tanzania will require raising agricultural incomes through adoption of modern agricultural practices (URT, 2010).

The sector is now characterized by low productivity, which hampers, sustained economic growth. Productivity of the agricultural sector is estimated to grow at only 4.2 percent compared to the 5 percent growth as set by the government. Many challenges that resulted to the low productivity need to be overcome. These include poor technology, slow development of input and output markets and associated market services and slow progress in regional integration. Other challenges resulting to the low productivity are infrastructure constraints whereby country's road network is still poorly developed and inadequately maintained, with severe disruption during the rainy seasons. Dependence on rain fed agriculture has been a major constraint to sustainable increase in crop production. While there is an abundance of water in rivers and lakes, there is very limited application of irrigated agriculture. Institutional constraints include the policy shift of the 1980s which led to withdrawal of public institutions from production, development, processing and marketing of produce and input supply has not led to an efficient development of the agricultural sector. Poor soils and scarce use of modern technologies are some of the major causes of low yields. Furthermore, there is evidence of massive soil fertility depletion due to increasing population density. Several technologies for rejuvenating soil fertility exist in Tanzania. These range from inorganic fertilizers, organic fertilizers as well as integrated soil management practices. Inorganic fertilizers are however too costly to be afforded by the resource poor farmers, whilst organic resources are available in limited quantity (Amani, 2005)

The government of Tanzania has recently developed an Agricultural Sector Development Strategy (ASDS). The intention was to transform agriculture from subsistence to commercial targeting the poverty reduction of rural population. The transformation involves use and encouragement of improved crop varieties, in organic fertilizers and organic fertilizers among the small-holder farmers within the country. The transformation also involves private sectors that create environment for enhancing the productivity and profitability of agriculture (URT, 2010). The combined application of organic resources and mineral fertilizers is increasingly gaining recognition as a viable approach to address soil fertility decline in sub-Saharan Africa (SSA) including Tanzania (Chivenge et al. 2011). Intercropping of maize and legumes has also proven to increase maize yields over time. Intercropping maize and pigeon peas, enhanced maize yields over sole maize only when fertilized which indicated nutrient competition. Improved fallow (i.e. intercropping maize and pigeon peas in different fallows) with and without inorganic fertilizer both increased maize yield Kimaro et al, (2009). Integrated agricultural practices have registered positive economic benefits to farmers. For example, several promising integrated soil fertility management (ISFM) technologies including combination of inorganic fertilizers and organic nutrient sources such as farmyard manure, compost manure and legumes such as soya beans, groundnuts and pigeon peas were introduced in Tanzania. After implementation of this project the improvement of yield was evidenced among the small-scale peasants. ((Asfaw&Shiferaw. (2010); Asfaw et al. (2011); Amare et al. (2012); Kassie et al. (2012); Kassie et al. (2014)).

In Babati district, agriculture is the main income-generating activity for the improvement of livelihoods and the quality of life among the majority of the population. In recent years, the people of Babati district have relied on agriculture, especially small-scale farming. This type of practice has thus continued to be the potential food source and income generating activity of these people. Therefore, implementation of integrated soil fertility management is very crucial in improving production of maize and pigeon pea (Msuya, 2008). However, the literatures on contribution of the improved agricultural technology practices on agricultural performance (productivity of maize and pigeon peas in value terms), and its impacts on household food security are limited. The objectives of this paper are therefore to; (i)identify sources of improved agricultural technology practices in the study area (ii) to estimate the rate of adoption of individual technology packages (iii)estimate the effects of improved technology practices on farm productivity in value terms, household per capital expenditure and household food security

2. Methodology

2.1. Research Design and Sampling Strategy

The study was conducted using a quasi-experimental research design consisting of a cross-section survey of improved crop varieties and fertilizers adopters and non-adopter populations of selected smallholder farmers of maize and pigeon pea in the study area. The survey data was collected from famer households growing maize and pigeon pea to estimate the level of adoption of improved maize varieties, improved pigeon pea varieties, organic fertilizer and inorganic fertilizers using descriptive statistics, to determine and to estimate impact of adoption on farm productivity in value terms, household per capital expenditure and household food security. The study made the use of a multi-stage stage and random sampling procedure to ensure the representativeness of a sample subjects and wider generalizability of the results. Data analysis was carried out using descriptive statistics and inferential statistics.

2.2. Study Area

Data for this study were collected through a survey conducted in Babati district for 60 days between March and June, 2015. The study district was selected because it experiences low soil fertility, high poverty levels, higher agricultural potential area for maize and pigeon pea and different agricultural technologies including improved seeds, both inorganic and organic fertilizers were sensitized in district by different agricultural development project. Most of the study areas lie in the medium elevation of 950 meter above sea level to 2450 meter above sea level. The area receives annual rainfall ranging between 950 and 1,500 millimetres, which permit two growing seasons. Thus, most part of the District is considered to have good potential for agriculture. Farming is the main economic activity and is characterized by low external input-low output agriculture. The farming system incorporates crops and livestock.

2.3. Sources and Types of Data

Primary data were collected through face to face interviews in the period of 60 days on March and June 2015, with individual farmers who formed the core of this study. The village leader guided the enumerators who were trained before data collection to the respective farmers selected for the study. Farmers who could not be accessed at the time of interview were replaced by others based on the list provided by the village leaders. The survey used semi- structured questionnaires to collect primary data from selected households on background information, household characteristics, farm size, asset value, livestock value, knowledge on maize and pigeon pea varieties, agricultural training, use of organic and inorganic fertilizer, cost of fertilizers and improved crop varieties, area under maize and pigeon pea, productivity of maize and pigeon pea, food security and household expenditure, access to credit, extension services, distance to agricultural office and distance to the trading center among others. Furthermore, data on food consumption, expenditure on both food and non-food items were gathered using an indirect method. The quantities consumed, which were recorded in Kgs, were then converted into calorific value using content from selected food tables (Nathan, 1997) then summed up to get the total kilocalories available to households.

2.4. Analytical Technics

Two main analytical techniques were employed to analyse the study objectives. Descriptive statistics and inferential statistics (two sample independent t-test) were used for the study. Descriptive statistics such as percentage, mean, standard deviation and standard error were used to describe the values of the of the selected technologies practices (improved maize varieties, improved pigeon pea varieties, organic fertilizer and inorganic fertilizers), sources of technologies practices in the study area, institutional variables such as access to extension services, access to credit and distance to the nearest market. Furthermore, independent sample T-tests were performed to test differences between the two categories of respondents (i.e. adopters sample and non-adopters sample) with respect to the economic indicators variables such as Asset values, labour endowments. Similarly, independent two sample t-test were performed to measure the effect of adoption on outcome variables such as farm productivity in kilogram per acres, household per capita expenditure and household food insecurity access scale and the size effect were also estimated. The results and findings were presented in forms of tables, graphs and narratives among others.

3. Results and Discussion

3.1. Farmers' Adoption of Agricultural Technologies Practices in Babati District

3.1.1. The Adoption Levels of Agricultural Technologies Components

This subsection reports the level of adoption of the four agricultural technologies practices among smallholder maize and pigeon pea farmers in Babati district. As it can be seen in Figure 1 about 49.40% of the households who were surveyed in Babati district adopted at least 50% technology packages in the study area. This level of adoption is comparable to those reported in recent studies in Tanzania for example, Asfaw et al. (2010) estimates the adoption of improved pigeon pea at the level of 33.00%; Amare et al. (2012) on the welfare impact of maize- pigeon pea intensification in Tanzania reports the adoption level of 43.00% and 34.00% of improved maize and pigeon pea respectively. Kassie et al. (2012) also revealed that the adoption level of improved maize varieties was 76.50%.

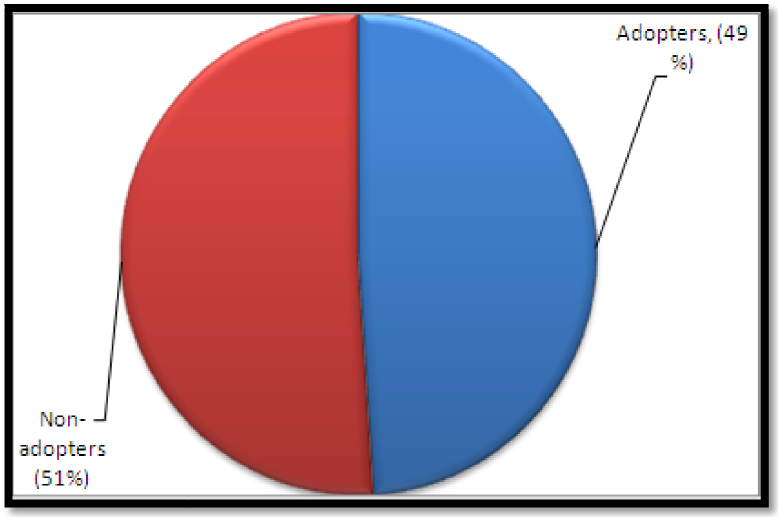

Figure 1: Proportion of Farmers Using ISFM
Source: Survey Data, 2015

With respect to the individual technology practices/components, it had been found that improved maize seed and organic fertilizers were used by 98.90% and 69.90% respectively, followed by pigeon pea adopted at the level of 68.40% (Table 3). Contrary to that adoption of agro-chemical had been found with low adoption by individual farmer. For example, it has been observed that, 13.40% of the surveyed farmers adopted pesticides, about 10.90% used inorganic fertilizers, and only 1.60% of the surveyed farmers used herbicides in their farms. The low adoption level of agro-chemical in Babati district may be probably due to poor access of agricultural inputs, lack of enough knowledge on the use of agro-chemical and lack of cash liquidity to buy such agricultural inputs.

Components of ISFM	Mean	Std. Deviation
Improved maize seed	0.99	0.18
Organic manure	0.69	0.39
Improved pigeon pea seed	0.68	0.47
Pesticides	0.13	0.34
Inorganic fertilizers	0.11	0.31
Herbicides	0.02	0.13

Table 1: Proportion of Adopters of the Various Components of Technology Packages in Babati, 2015
Source: Survey Data, 2015

Table 4 presents farmers' behaviors with respect to intercropping maize with pigeon peas, by means of comparing between adopters and non-adopters of agricultural technology packages. The intercropping of maize and pigeon pea in Tanzania is common practices in many places where pigeon pea is grown. Pigeon pea is intercropped with maize to maximize the land use, spreading economic risk and to improve soil fertility through nitrogen fixation. The results show that both adopters and non-adopters had good knowledge of intercropping. Indeed, more than three quarters of farmers in each category intercropped maize with pigeon peas at the average of 3.75years in the last four years. However, the average number were maize and pigeon pea were planted in the last four years was 3.77 years for adopters and 3.74 years for non-adopters.

Intercrop of Maize/Pigeon Pea	Adopters	Non-Adopters
Proportion of farmers intercrop maize/pigeon pea	99.60	97.60
Number of times were maize and pigeon pea were intercropped in the last four years	3.77	3.74

Table 2: Proportion of Farmers Intercropped Maize and Pigeon Pea
Source: Survey Data, 2015

3.1.2. Sources of Agricultural Inputs in the Study Area

Farmers obtained pigeon pea seed by buying from fellow farmers, and through farmer to farmer exchanges (33.47%) of adopter and 30.24% of the non-adopters.

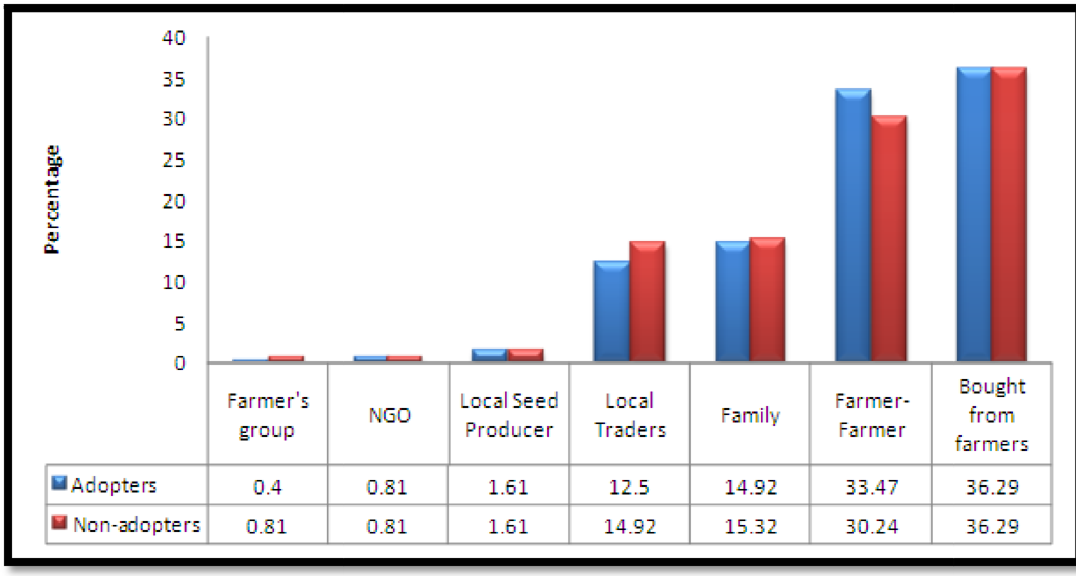

Figure 2: Sources of Pigeon Pea Seed

Most farmers bought maize seed from local traders/organization. About 86.64% of adopters bought improved maize varieties from local traders/organization; that is 2.39% more than non-adopters. Further, the results revealed that 0.39% of non-adopters bought from local seed producer and there were no adopters who bought from local seed produce, it may be due to absence of local seed producer in the study area.

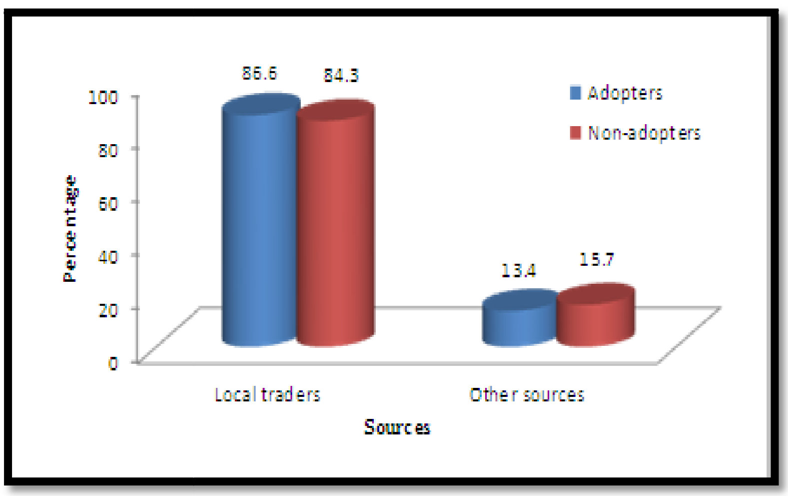

Figure 3: Sources of Improved Maize Varieties

3.1.3. Household Access to Extension and Financial Services

The summary statistics also show that adopters have better access to extension and financial services than non-adopters (Table 3). For example, about 89.80% of adopters received some form of training in the past twelve months compared to only 32.80% of the non-adopters (p<5%). This is probably because agricultural training imparts farmers with necessary knowledge and skills on application of technology packages in the study area. The results corroborate the findings from the earlier studies on adoption of agricultural technologies in developing countries; for example (Doss et al., 2003; Sserunkuuma. 2005; Matata et al., 2010; Amare et al., 2012) also reported that participation in agricultural training positively influences adoption of agricultural technologies.

Similarly, about 19.40% of adopters interacted with an extension agent in the past twelve months compared 9.80% of their non-adopting counterparts (P< 5%). This is the case because extension service is the sources of information, knowledge and advice to smallholder farmers in the study area. The results corroborate the findings from the earlier studies on adoption of agricultural technologies in developing countries; for example (Namwata et al., 2010; Tura et al. 2010; Amare et al., 2012; Kassie et al., 2012; Wiredu et al., 2014) also reported that extension services increase adoption of agricultural technologies in developing countries.

With regard to farming credit, about 26.30% of the adopters indicated that they had access to credit compare to only 4.70% of non-adopting household p< 1%).

This is probably because smallholder farmers rarely have sufficient mean to buy agricultural inputs. Therefore, farmers who have access to credit can minimize their financial constraints and buy agricultural inputs more readily. The results corroborate the findings from earlier studies; for instance (Doss et al. 2003; Shiferaw et al., 2005; Akinola et al., 2010; Namwata et al., 2010; Tura et al., 2010; Amare et al., 2012; Shiferaw et al., 2014), reported that access to agricultural credit drives adoption of agricultural technologies in developing countries.

Variables	All Households (n=500)	Adopters (n=247)	Non-Adopters (n=253)	T-Value	P-Value
	Mean	Mean	Mean		
Extension contact (1=yes, 0 otherwise)	0.15 (0.35)	0.19 (0.39)	0.09 (0.29)	-2.13	0.03
Distance in km to the agricultural extension office	3.95 (3.09)	3.92 (3.12)	3.99 (3.08)	2.26	0.06
Agricultural training attended in the last 12 months (1=yes, 0 otherwise)	0.61 (0.98)	0.89 (0.30)	0.33 (1.28)	-3.49	0.00
Access to credit (1=yes, 0 otherwise)	0.15 (0.36)	0.26 (0.44)	0.05 (0.21)	-3.99	0.00
Access to bank account (1=yes, 0 otherwise)	0.02 (0.15)	0.03 (0.17)	0.02 (0.14)	-1.27	0.20
Distance in km to the nearest village market	2.23 (1.43)	2.22 (1.38)	2.24 (1.60)	-0.90	0.37
Distance in km to the main market	26.31 (13.89)	27.70 (14.58)	24.95 (13.02)	-1.12	0.10

Table 3: Household Access to Extension and Financial Services in Babati District, 2015
Note: Standard Deviation in Parentheses
Source: Survey Data, 2015

3.1.4. Economic Indicators of the Household in the Study Area

Table 4 presents the variables and economic indicators of the surveyed households. The results show that the adopting household are more endowed with financial, physical and human capital than non- adopters. For example, the value of assets reported by adopters was Tshs733, 155.60 compared to Tshs485, 602.90 for the non-adopters (p< 1%). Similarly, adopters allocated large acreage of land (of 3.25 acres) to maize and pigeon peas production than the 2.53 acres allocated by non- adopters (p< 1%). The average value of livestock sold in the past 3 months was about Tshs250, 862.75 for the adopters compared to Tshs130, 823.30 reported by non- adopters (p<1%). Similarly, findings show that adopting household were more endowed with family labor contributing to farming activities (3.78) compared to the counterpart's non-adopters who had an average of 2.90 family labor contributing to farming activities (p <1%).

Variables	All Households (n=500)	Adopters (n=247)	Non-adopters(n=253)	T-value	P-value
	Mean	Mean	Mean		
Value of Assets					
Total value (Tshs) other of household assets	607,894.00 (475,763.70)	733,155.60 (473,818.90	485,602.90 (445,711.20)	-6.02	0.00
Total land owned (acres)	2.89 (1.50)	3.25 (1.61)	2.53 (1.31)	-5.46	0.00
Total value of livestock sold (Tshs)	190,770.79 (29,027.39)	250,862.75 (30,703.41)	130,823.30 (26,006.12)	-4.74	0.00
Labour endowment					
Total family labor contribution to farming	3.34 (1.43)	3.78 (1.46)	2.90 (1.25)	-7.24	0.00
Hire labor far farming activities	6.06 (0.28)	6.08 (0.28)	6.03 (0.28)	0.42	0.68

Table 4: Economic Situation of the Surveyed Households in Babati District, 2015

Table 5, present results on the household expenditure per year in the study area. The summary statistics indicate higher per capita consumption expenditure among adopting households than the non-adopters (Table 7). For example, total per capita expenditure was about Tshs1, 390,400.00 per year among adopting households compared to Tshs926, 336.10 per year reported by the non-adopters (p<1%). This is probably because adopter have produce more output translating into more marketable surplus, hence more expenditure. This result is supported by the findings of (Asfaw et al., 2010; Amare et al., 2012). Conversely food expenditure was higher among non-adopting households (about Tshs58, 997.63) compared to the (Tshs51, 819.84) reported by the adopters. With regards to expenditure on fertilizers and improved seed on average adopting households reports Tshs182, 232.60, compared to Tshs103, 427.70 reported by a non-adopting household (Table 5). With regard to household food, the results show that the mean calorie available to adopting households is 2,873.06 Kcal while that to non-adopters is 2,387.08 Kcal. The mean test results indicate that they are significantly different (p< 1%). This is probably because adopting household has produce more farm output for household consumption compared to non-adopting household. This finding is supported by the findings of (Jayne et al., 2010; Kassie et al. 2012; Kassie et al. 2014), reported that adoption of agricultural technologies improves food security status of the farming households and the probability of being poor, chronic and transitory food insecurity declines with the intensity of adoption.

Variables	All household (N=500)	Adopters (N=247)	Non-adopters (N=253	T-value	P-value
Expenditure in Tsh on improved seed and fertilizer	142,812.70 (238,485.20)	182,232.60 (315,323.00)	104,327.70 (112,029.30)	-3.69	0.00
Food expenditure (Tsh)	55,451.80 (4,793.64)	51,819.84 (2,920.14)	58,997.63 (9,038.65)	0.75	0.45
Expenditure in Tsh on other non-food items	834,722.00 (274,439.00)	1,015,111.00 (471,013.00)	658,610.70 (120,182.00)	-3.16	0.00
Expenditure in Ths on contributions	114,528.50 (115,838.20)	133,448.20 (114,051.10)	95,984.00 (114,791.50)	-3.69	0.00
Total household expenditure per year	1,156,043.00 (146,402.00)	1,390,400.00 (162,437.00)	926336.10 (155,488.00)	-3.65	0.00
Per capita expenditure	124,0430.40 (287,047.30)	274,134.00 (312,753.60)	207,526.10 (255,873.40)	-2.61	0.01
Household food security (Kcals)	2,630.07 (248.14)	2,873.06 (268.90)	2,387.08 (258.40)	-2.83	0.00

Table 5: Household Expenditure and Household Food Security ((Tshs))
Source: Survey Data, 2015

Table 6 presents summary statistics of the surveyed household farm income and farm productivity. Descriptive statistics show that adopters have released higher farm income on average in both maize and pigeon pea compared to their counterpart's non-adopters. Average farm income of both maize and pigeon pea for adopters was reported at Tsh 1,872,541.00 compared to Tsh 667,748.00 reported by non-adopters (p< 1%). A possible explanation is that improved technology practices has bigger role in improving farm productivity. This result is in line with earlier studies; for instance (Asfaw&Shiferaw. 2010; Kassie et al. 2010; Amare et al., 2012; Mathenge et al., 2013) reported that use of improved agricultural technologies increased crop income. The summary statistics, further showed that, adopters have released higher average yield of maize and pigeon pea (p< 1%). For example, the average yields of adopters were 2831.75 kg/acres and 278.99 kg/acres for maize and pigeon pea respectively compared to 1036.10 kg/acres and 157.77 kg/acres respectively reported by non-adopters. This result is as expected because ISFM is the yield enhancing technology. This result is in line with findings from past studies; for example (Sauer et al., 2007; Wanyama. 2010; Kato et al., 2011; Fungo et al., 2013; Teklewold et al., 2013), reported that adoption of agricultural technologies has a significant effect on agricultural productivity.

Variables	All Household(N=500)	Adopters (N=247)	Non-Adopters (N=253)	T-Value	P-Value
Pigeon pea only	476,736.00 (104,748.00)	667,715.80 (137,762.00)	29,0285.40 (49,937.50)	-4.09	0.00
Maize only	786,179.60 (113,886.60)	1,204,825.00 (223,179.90)	377,462.60 (44,099.48)	-3.68	0.00
Both pigeon pea and maize	1,262,916.00 (993,186.00)	1,872,541.00 (471,188.00)	667,748.00 (616,910.80)	-3.68	0.00
Yield of pigeon pea(kg/acres)	217.66 (17.51)	278.99 (28.99)	157.77 (19.25)	-3.49	0.00
Yield of maize (kg/acres)	1,923.15 (266.79)	2,831.75 (463.55)	1,036.10 (259.66)	-3.40	0.00

Table 6: Household Farm Income (TSH) and Farm Productivity
Source: Survey Data, 2015

3.1.5 Effect Size for Outcome Variables (Household per Capital Expenditure, Productivity, Farm Income and Household Food Insecurity Access Scale

Effect size statistics provide an indication of the magnitude of the differences between the two groups (not just whether the difference could have occurred by chance). There are a number of different effect size statistics, the most commonly used being eta squared. Eta squared can range from 0 to 1 and represents the proportion of variance in the dependent variable that is explained by the independent (group) variable. Unfortunately, SPSS does not provide this calculation; therefore, effect size was estimated using the following statistical formula proposed by (Cohen, 1988);

$$\text{Eta squared} = \frac{t^2}{t^2 \quad + (N1 + N2 - 2)}$$

The summary statistics in (Table 7), presents the effects size of outcome variables such as household per capita expenditure in Tsh, crop value in Tsh, yield of Pigeon pea, yield of maize both measured in terms of Kilogram per acres and household food security measured by mean kilocalorie consumed by the household. The results on effect size revealed that crop value had effect size of 2.65%, followed by yield of pigeon 2.39%. Moreover, the maize yield had effect size of 2.27%, household food security had effect size of 1.58% and the effect size for house per capita expenditure was estimated at 1.35%.

Variable Name	Effect Size (%)
Household per capita expenditure	1.35
Crop value	2.65
Yield of pigeon pea	2.39
Yield of maize	2.27
Household food security	1.58

Table 7: Effect Size for Outcome Variables
Sources: Survey Data, 2015

The results in table 7 indicates that adoption of improve crop varieties and use of organic and inorganic fertilizers has significant effect in improving the household welfare of the farming household in the study area

4. Policy Implication

The main objective of this study was to explore empirically the impact of adoption of improved maize and pigeon pea varieties, organic and inorganic fertilizers on household welfare measured by indicator variables such farm productivity, crop value, household per capita expenditure and household food security (measured by kilocalorie consumed by the household) in Tanzania.

The quantitative results revealed that the mean Kcalorie availability for adopters was 2,873.06 Kcal and non-adopters 2,387.08Kcal and that mean difference were statistically significant; indicating an improvement 20.36% household food security of the adopting household. Furthermore, the quantitative results revealed that the average yield of maize and pigeon pea for adopters were 2,831.75kg/acres and 278.99kg/acres, respectively, compared to 1,906.28kg/acres and 151.76kg/acres for non-adopters in that order. This represents a yield gain of about 48.55% for maize and 83.83% for pigeon peas due to adoption of agricultural technologies. The household per capita expenditure was estimated at Tsh274, 134.04 for adopting households compared to Tsh184, 512.98 for non-adopting household; indicating 48.57% gain in purchasing power.

Findings from this study further shows that adoption of improved crop varieties and fertilizers can increase welfare of smallholder farmers in Tanzania. The study drew attention to information that can guide policy towards influencing adoption of agricultural technologies which can have a potential benefit to soil fertility conditions, increased productivity, farm income, improved household food security and environmental sustainability. Efforts to promote Agricultural technologies such as improved crop varieties, inorganic fertilizers and organic fertilizers should focus on enhancement of farmer-awareness of the soil fertility management to improve farm productivity, economic and other benefits such as livelihoods and living conditions.

Provision of training and technical advice on agricultural technologies practices such improved seeds and application of both organic and in organic fertilizers through agricultural extension services and developing information networks among farmers is vital. This strategy will require both the government and NGOs concerned with agricultural production to hire more staff members and equip them with the necessary facilities to execute this role. In addition, there is need to organize for seminars and workshops regularly where farmers are invited and educated on the importance of improved crop varieties and fertilizers as well as the technicalities involved in application of the technologies.

Improving farmer access to credit facilities needs to be enhanced. This will help to eliminate liquidity constraints experienced in the purchase of improved seeds, in organic fertilizers and organic fertilizers for those household whose do not have livestock. Similarly, the Government can increase access to improved agricultural technologies through subsidies on agricultural inputs.

5. References

i. Akinola, A. A., Alene, A. D., Adeyemo, R., Sanogo, D., Olanrewaju, A. S., Nwoke, C., &Nziguheba, G. (2010). Determinants of adoption and intensity of use of balance nutrient management systems technologies in the northern Guinea savanna of Nigeria. Quarterly Journal of International Agriculture, 49(1), 25.
ii. Amani, H. K. R. (2005). Making agriculture impact on Poverty in Tanzania: The case on non-traditional Export crops. A Policy Dialogue for Accelerating Growth and Poverty Reduction in Tanzania, ESRF, Dar es Salaam.
iii. Amare, M., Asfaw, S., &Shiferaw, B. (2012). Welfare impacts of maize–pigeonpea intensification in Tanzania. Agricultural Economics, 43(1), 27-43.
iv. Asfaw, S., & Shiferaw, B. (2010). Agricultural technology adoption and rural poverty: Application of an endogenous switching regression for selected East African Countries. Poster Presented at the Joint 3rd African Association of Agricultural Economists (AAAE), 19-23.
v. Asfaw, S., Kassie, M., Simtowe, F., & Lipper, L. (2011). Poverty reduction effects of agricultural technology: A micro-evidence from Tanzania. Food and Agricultural Organization of the United Nations, Agricultural Development Economics Division, working paper.
vi. Chivenge, P., Vanlauwe, B., & Six, J. (2011). Does the combined application of organic and mineral nutrient sources influence maize productivity? A meta-analysis. Plant and Soil, 342(1-2), 1-30.
vii. Doss, C. R., Mwangi, W. M., Verkuijl, H., & De Groote, H. (2003). Adoption of maize and wheat technologies in Eastern Africa: A synthesis of the findings of 22 case studies.
viii. Fungo, B., Kabanyoro, R., Mugisa, I., &Kabiri, S. (2013). Narrowing yield-gap of rice through soil fertility management in the Lake Victoria Crescent agro-ecological zone, Uganda. African Journal of Agricultural, 8(23), 2988-2999.
ix. Henao, J., &Baanante, C. (2006). Agricultural production and soil nutrient mining in Africa: implications for resource conservation and policy development. IFDC-An International Center for Soil Fertility and Agricultural Development.
x. Jayne, T.S., Mason, N., Myers, R., Ferris, J., Mather, D., Beaver, M., Lenski, N., Chapoto, A. &Boughton, D. (2010). Patterns and Trends in Food Staples Markets in Eastern and Southern Africa: Toward the Identification of Priority Investments and Strategies for Developing Markets and Promoting Smallholder Productivity Growth. MSU International Development Working Paper No. 104. East Lansing: Michigan State University.
xi. Kato, E., Nkonya, E., & Place, F. M. (2011). Heterogeneous treatment effects of integrated soil fertility management on crop productivity: evidence from Nigeria (No. 1089). International Food Policy Research Institute (IFPRI).
xii. Kassie, M., Shiferaw, B., & Muricho, G. (2010). Adoption and impact of improved groundnut varieties on rural poverty: Evidence from rural Uganda (No. dp-10-11-efd).
xiii. Kassie, M., Jaleta, M., Shiferaw, B. A., Mmbando, F., & De Groote, H. (2012, July). Improved Maize Technologies and Welfare Outcomes In Smallholder Systems: Evidence From Application of Parametric and Non-Parametric Approaches. In 2012 Conference, August 18-24, 2012, Foz do Iguacu, Brazil (No. 128004). International Association of Agricultural Economists.
xiv. Kassie, M., Jaleta, M., Shiferaw, B., Mmbando, F., &Mekuria, M. (2013). Adoption of interrelated sustainable agricultural practices in smallholder systems: Evidence from rural Tanzania. Technological forecasting and social change, 80(3), 525-540.
xv. Kassie, M., Jaleta, M., &Mattei, A. (2014). Evaluating the impact of improved maize varieties on food security in Rural Tanzania: Evidence from a continuous treatment approach. Food Security, 6(2), 217-230.
xvi. Kijima, Y., Otsuka, K., &Sserunkuuma, D. (2008). Assessing the impact of NERICA on income and poverty in central and western Uganda. Agricultural Economics, 38(3), 327-337.
xvii. Kimaro A, A., Timmer V. R., Chamshama, S., Ngaga, Y, N.&Kimaro, D, A. (2009). Competition between Maize and Pigeon-Pea in Semi-arid Tanzania: Effect on Yields and Nutrition of Crops. AgricEcosyst Environ, 134:115–125.
xviii. Namwata, B. M., Lwelamira, J., &Mzirai, O. B. (2010). Adoption of improved agricultural technologies for Irish potatoes (Solanum tuberosum) among farmers in Mbeya Rural district, Tanzania: A case of Ilungu ward. Journal of Animal & Plant Sciences, 8(1), 927-935.
xix. Nathan, M.C. 1997. Human Nutrition in the Developing World, FAO
xx. Odendo, M., Obare, G., & Salasya, B. (2009). Factors responsible for differences in uptake of integrated soil fertility management practices amongst smallholders in western Kenya. African Journal of Agricultural Research, 4(11), 1303-1311.
xxi. Okalebo, J.R., Othieno, C. O., Woomer, P. L., Karanja, N. K., Semoka, J, M. R., Bekunda, M. A., Mugendi, D. N., Muasya, R. M., Batiano A. &Mukhwana, E. J. (2007). Available Technologies to Replenish Soil Fertility in East Africa.
xxii. Omilola, B. (2009). Estimating the impact agricultural technology on poverty reduction in rural Nigeria(Vol. 901). Intl Food Policy Res Inst.
xxiii. Otunge, D., Muchiri, N., Wachoro, G., &Kullaya, A. (2010). Mitigating the impact of drought in Tanzania: The WEMA intervention. Policy Brief.
xxiv. Sauer, J., Tchale, H., & Wobst, P. (2007). Alternative soil fertility management options in Malawi: an economic analysis. Journal of Sustainable Agriculture, 29(3), 29-53.
xxv. Shiferaw B, Silim S, Muricho G, Audi P,Mligo J, Lyimo S, You L & Christiansen J.L. (2005).

xxvi. Assessment of the adoption and impact of improved pigeon pea varieties in Tanzania. Journal of SAT Agricultural Research 3(1)
xxvii. Shiferaw, B., Kassie, M., Jaleta, M., &Yirga, C. (2014). Adoption of improved wheat varieties and impacts on household food security in Ethiopia. Food Policy, 44, 272-284.
xxviii. Simtowe, F., Kassie, M., Asfaw, S., Shiferaw, B., Monyo, E., &Siambi, M. (2012, August). Welfare Effects of Agricultural Technology adoption: the case of improved groundnut varieties in rural Malawi. In Selected Paper prepared for presentation at the International Association of Agricultural Economists (IAAE) Triennial Conference, Foz do Iguaçu, Brazil 18-24.
xxix. Sserunkuuma, D. (2005). The adoption and impact of improved maize and land management technologies in Uganda. Electronic Journal of Agricultural and Development Economics, 2(1), 67-84.
xxx. Teklewold, H., Kassie, M., &Shiferaw, B. (2013). Adoption of multiple sustainable agricultural practices in rural Ethiopia. Journal of agricultural economics, 64(3), 597-623.
xxxi. Tura, M., Aredo, D., Tsegaye, W., Rovere, R. L., Tesfahun, G., Mwangi, W., &Mwabu, G. (2010). Adoption and continued use of improved maize seeds: Case study of Central Ethiopia. African Journal of Agricultural Research, 5(17), 2350-2358.
xxxii. URT, (2008). Agricultural Sector Reforms in Tanzania: Perspectives from Within. Dar es Salaam, Tanzania.
xxxiii. URT, (2010). The Comprehensive Africa Agriculture Development Programme (CAADP). Post Compact Roadmap for Tanzania July 2010.
xxxiv. URT, (2012). National Agriculture Policy. Ministry of Agriculture Food Security and Cooperative. Dar es Salaam, Tanzania.
xxxv. Wanyama, J. M., Nyambati, E. M., Mose, L. O., Mutoko, C. M., Wanyonyi, W. M., Wanjekeche, E., &Rono, S. C. (2010). Assessing impact of soil management technologies on smallholder farmers' livelihoods in North Western Kenya. African Journal of Agricultural Research, 5(21), 2899-2908.
xxxvi. Wiredu, A.,Martey, E.&Fosu,M.(2014). Describing Adoption of Integrated Soil Fertility Management Practices in Northern Ghana.