FARMERS' CHOICES FOR SUSTAINABLE INTENSIFICATION TECHNOLOGIES IN KILOSA DISTRICT, TANZANIA

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A DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN AGRICULTURAL ECONOMICS OF SOKOINE UNIVERSITY OF AGRICULTURE, MOROGORO, TANZANIA

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ABSTRACT

The aim of this study was to assess farmers' choices to the adoption of sustainable agriculture practices (SAPs). It specifically aimed at determining the level of adoption, profit margin between SAPs adopters and non-adopters and the influence of socio-economic and institution factors to the adoption of sustainable agriculture practices. A cross-sectional research design was used involving 550 smallholders maize farmers. The secondary data collected was used to undertake and enrich the study. Descriptive statistics was used to examine the adoption rate of SAPs among smallholders' farmers in Kilosa District. Binary logistic regression analysis was used to analyze the socio-economic and institutional factors affecting the decision of a farmer to adopt SAPs. Findings indicated that there was a low rate of sustainable agriculture practices adoption (27%) among smallholder's farmers in Kilosa district despite the available policies to encourage the use of SAPs. Moreover, profit margin indicated that there was a significant difference between the adopters and non-adopters of SAPs with respect to maize production regarding the mean yield and revenue obtained from the field. Education, level of income of farmers, farm size, family size, and extension service were socio-economic and institutional factors that significantly ($p \leq 0.05$) affected farmers' choice to adopt SAPs. Generally, findings from the study suggested that policy makers at Kilosa District should address the factors that significantly influence the adoption of SAPs and to encourage the delivery of extension services by private agents. This might increase the adoption rate of SAPs among reluctant smallholder farmers for the consistent dissemination of SAPs as a way forward towards the sustainable improvement of food security and livelihoods of agriculture stakeholders.

DECLARATION

I, Joseph Jovin Mugula do hereby declare to the Senate of Sokoine University of Agriculture that this dissertation is my own original work done within the period of registration and that it has neither been submitted nor being concurrently submitted to any other institution.

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DEDICATION

This dissertation is dedicated to my wonderful and supportive family, especially my father, Prof Jovin K Mugula, my mother, Mrs. Scholastica-Elizabeth Mugula, and my lovely sister, Victoria Jovin Mugula, for their financial, spiritual support and encouragement throughout my education.

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LIST OF ABBREVIATION AND ACRONYMS

CA	Conservation Agriculture
CF	Conventional Farming
CI	Confidence Interval
DF	Degree of Freedom
Exp (B)	Expected Beta
FAO	Food and Agriculture Organization
Ha	Hectare
K	Kilograms
MAFC	Ministry of Agriculture Food Security and Cooperatives
SAPs	Sustainable Agriculture Practices
Sig	Significance level
SIP	Sustainable Intensification Practices
SNAL	Sokoine National Agriculture Library
SPSS	Statistical Package for Social Science
SUA	Sokoine University of Agriculture
TSH	Tanzania Shilling
URT	United Republic of Tanzania

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background Information

Sustainable Agricultural Practices (SAPs) that lead to an increase in productivity are central to the acceleration of economic growth and economic development: that might help alleviate poverty and overcome the recurrent food shortages that affect millions of households in Tanzania and Africa in general (Kassie, 2012). According to Pretty *et al.* (2011), despite the improvements made over the last four decades in the agricultural and industry sectors, a combination of declining soil fertility, population growth, low uptake of external inputs, and climate disruption have resulted in a dramatic fall in per capita food production in most of the African countries.

According to the Food and Agriculture Organization (FAO) (1989), sustainable agriculture consists of five major attributes: (i) it conserves resources, (ii) it is environmentally non-degrading, (iii) it is technically appropriate, (iv) it is economically and, (v) socially acceptable (Kassie *et al.*, 2012). Accordingly, these practices broadly defined may include conservation tillage, legume intercropping, legume crop rotations, improved crop varieties, the use of animal manure, the complementary use of inorganic fertilizers, soil and stone bunds for soil and water conservation (Lee 2005, Kassie *et al.*, 2010; Wollni *et al.*, 2010).

The importance of farmer's decision to adopt new agriculture practices and technologies has long been of interest to agricultural extension agents and economists. According to Oladele (2005), several parameters have been identified as crucial influential factors to the adoption behavior of farmers from qualitative and quantitative models. Researchers

investigating farmers adoption behavior have accumulated considerable evidence showing that awareness, attitude and profitability affect the adoption behavior of a farmer to adopt agriculture technologies (Oladele, 2005; Byakugila *et al.*, 2008). Moreover, farmer's decision to adopt a particular technology can be influenced by the available information from extension agents on that particular technology.

According to Mashingaidze and Mudhara (2005), smallholder farmers in Africa are accustomed to practicing conventional farming (CF), which involves disturbing the soil through ploughing, discing, harrowing and many other tilth conditioning operations. It is generally believed that conventional farming creates a favorable soil structure for seedbed preparation, controls proliferation of weeds, and increases mineralization of soil organic matter but inevitably compacts the soil, promotes sanitization, accelerates soil erosion and depletes the soil organic matter and nutrient content (FAO, 2001a; FAO, 2001b).

SAPs dissemination which was introduced in Africa in the midst of 90s and has been met with some resistance during the whole process of introducing and implementing adoption strategies (Chiputwa *et al.*, 2011). Where adoption has been observed, not all components of SAPs have been adopted due to bio-physical factors (soils, climate, and topography), socio-economic factors, institutional factors and technology characteristics (Baudron*et al.*, 2007) without forgetting inappropriate policies to support the technological dissemination to the intended set of farmers in targeted area.

Moreover, the current status of adoption and spread of SAPs globally is low, particularly in Africa. It has been reported that 47.6% of the total global area under SAPs is in South America, 34.1% in the United States and Canada, 14.7% in Australia and New Zealand and 3.5% in the rest of the world including Europe, Asia, and Africa (Kassama *et al.*,

2010). The latter is the developing continents in terms of SAPs adoption. Despite good and long-lasting research conducted in these continents showing positive results for SAPs systems, SAPs has experienced only small rates of adoption in Africa as indicated in Table 1.

Table 1: Global area under sustainable agriculture practices

Continent	Area ("000" hectare)	Percent of total
South America	55 630	47.6
North America	39 981	34.1
Australia & New Zealand	17 162	14.7
Asia	2 630	2.2
Europe	1 150	1.0
Africa	368	0.3
World total	**116 921**	**100**

Source: Kassama *et al.* (2010)

The purpose of this research was to improve our understanding of farmers' adoption decisions on SAPs in Kilosa district and to determine the profit margin between the adopters and non-adopters of SAPs. The information obtained would be crucial in providing the understanding on multiple agriculture technological adoption processes.

1.2 Problem Statement and Justification

Maize is one of the most produced crops in Tanzania; it is the most important staple food for the majority of Tanzanians. The net gain obtained from maize production differs depending on the type of technology adopted by a farmer for that particular cropping year (Lugandu, 2013). Moreover, maize growing zones in Tanzania are different since maize varieties requirements such as soil and climate differs with agro-ecological zones. Nevertheless, differences in the characteristics of ecologies in Tanzania have necessitated farmers to have appropriate knowledge on suitable agriculture practice for their maize

production in respective of the ecological zones for better and consistent perfomance interms yield and income generation.

These SAPs technologies are made and developed in different areas specialized in the sector such as the zonal research centers and thereafter disseminated to the farmers through extension services as one of the effective means. However, decision on how to integrate these sustainable agricultural practices into their individual farms depends on farmer's choice as well as the technology and its specific attributes. In addition to that Socio, economic, institutional factors and the profit that would have been obtained after adopting SAPs may have an influence on farmer's decisions to whether fully or partially adopt the principles of SAPs, or to not adopt the agricultural technologies at all.

Research on farmer's choices for sustainable intensification of technologies of one or two or through the combination of different sustainable agriculture practices has not been conducted in most of Tanzania areas and particularly in Kilosa District. Furthermore, many researchers have been conducted on the effects of sustainable intensification of technologies on maize production such as that of Monela (2014), Timu, (2014), and Tura (2010) who have focused on the use of conventional practices and other technologies which encourages the use of agro chemicals such as artificial fertilizers to maximize the output which is against the principles of sustainable agriculture practices. Nevertheless, conventional agriculture practices have been widely adopted by the majority of farmers due to its high return on the yield. However, few researches such as Temu (2013) have been conducted on farmer's choice to adopt sustainable agriculture practices in Morogoro whose results have demonstrated the need of SAPs to smallholders' farmers along with the required inputs for proper management of adoption strategies in their farms.

Despite the demonstrated positive impacts of sustainable agriculture practices, SAPs dissemination has been met with some resistance during the whole process of adoption (Chiputwa *et al.*, 2011). Where adoption has been observed, not all components of SAPs have been adopted due to bio-physical factors (soils, climate, and topography), socio-economic factors, institutional factors and technology characteristics (Baudron *et al.*, 2007) without forgetting unavailability of appropriate policies to support the SAPs dissemination to the targeted population.

Currently little is known about SAPs in Kilosa in terms of adoption rate, profit margin and determinants, insufficient understanding of factors (socio economic and institutional) affecting adoption behavior of smallholders farmers to adopt SAPs in their farms, yet better knowledge of how these characteristics of individual farmers and their farming practices affect adoption would help policy makers and researchers in designing more effective technologies that will be tailored to the needs of the farmers.

In order to fully exploit the potential of promoting scaling up of sustainable agriculture practices the existing knowledge gaps have to be addressed. Information is scanty on the drivers that have made some areas in Tanzania succeed in scaling up sustainable agriculture practices, the constraints faced on making choices to adopt the technology and how to address them, lessons learnt and how to achieve impacts at a greater scale given the current and future demand and supply of maize to be produced under sustainable agriculture practices.

Results of this study will assist stakeholders such as policy makers and implementers to understand the influence of socio-economic, institutional factors on the adoption of sustainable agriculture practices such as intercropping, organic fertilizers, in view of

obliging them to design policies and or strategies that enhance adoption of SAPs and for advancing environmental and developmental goals.

1.3 Objectives

1.3.1 General objective

The overall objective of this study was assessement on farmers' choices for sustainable intensification technologies Kilosa district in order to boost adoption of SAPs among smallholder's farmers.

1.3.2 Specific objectives

The specific objectives of this study were to:

i. Determine the adoption level of sustainable agriculture practices among smallholder farmers in Kilosa District.

ii. Determine the profitability margin between SAPs Adopters and Non Adopters in Kilosa District.

iii. Determine household socio-economic and institutional factors that significantly affect the adoption of SAPs among smallholder farmers in Kilosa District.

1.4 Research Hypothesis

i. Socio-economic and institutional factors do not influence the adoption of SAPs among smallholder farmers in Kilosa District.

1.5 Conceptual Framework

The conceptual framework of this study is grounded by the assumption that farmers decision to adopt sustainable agriculture practice is influenced by socio-economic factors, institutional factors and profitability (Fig: 1). The socio-economic factors in the study include age, education, farm size, household size, household income and marital status. The institutional factors such as extension services and credit were included. Moreover, it was hypothesized that if a farmer chooses to adopt a full package of sustainable agriculture practices such as intercropping, manure, crop rotation, improved seeds, it was expected to significantly yield a positive result on agricultural output, food security, household income, standard living of people and the environment.

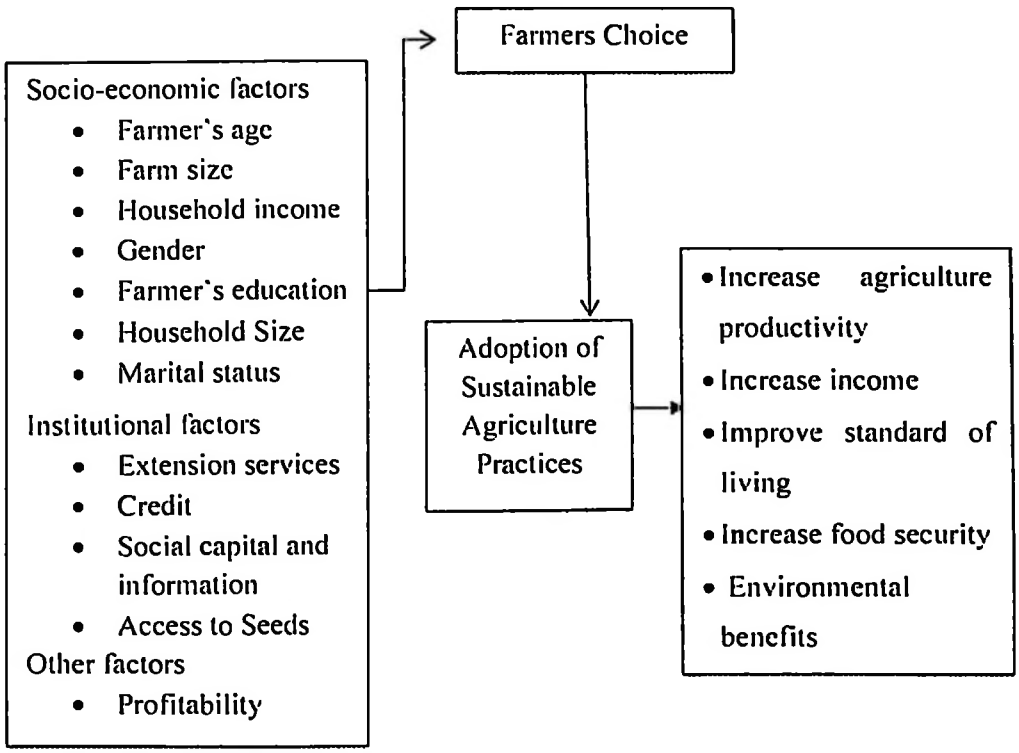

Figure 1: Conceptual Framework

1.6 Significance of the Study

This study will raise awareness among stakeholders especially policy makers and implementers on the factors necessary for the adoption of sustainable agriculture practices and be able to design policies or strategies that enhance adoption of sustainable agriculture practices in Kilosa District and Tanzania at large. Moreover, the study is expected to contribute positively to raise the awareness among farmers on the effects of socio-economic and institutional factors to the adoption of sustainable agriculture practices for the notable improvement of agricultural productivity and welfare gain.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Definition of Concept

Sustainable agriculture practices

Sustainable agriculture practices refer to the agriculture system that can indefinitely meet demands for food and fiber at socially acceptable economic and environmental costs. Furthermore, Caldwell (1994) broadened the definitions of sustainable agriculture as:

A more sustainable form of agriculture, in addition to the obvious environmental benefits, is likely to contribute to a larger farm population, increased employment, greater stability of the family farm, an increasing role for agriculture in local economic development, a more stable future for areas of marginal production, increasing protection from the uncertainty of world markets, less reliance on supply management and enhanced local marketing.

2.2 Adoption of Sustainable Agriculture Practices

Although sustainable agriculture does not refer to a normal standard set of agricultural practices, there are certain methods or practices that enhance sustainability (Horrigan *et al.*, 2002). Such methods are regarded as sustainable farming practices. There is a wide array of sustainable agriculture practices that are being employed by smallholder farmers in Tanzania. Some of the most commonly mentioned in the literature are: crop rotation, cover crops, no-till and low-till farming, soil conservation, diversity, nutrient management, integrated pest management and alternative marketing from which some of them are well practiced in Tanzania by smallholders farmers while others have yet to be known by smallholders as means toward a sustainable farming (SARE, 2003).

Despite the great promise of sustainable agriculture in helping to alleviate the problems originated from industrial agriculture, which has included the use of anticipated high chemicals to the farms. the adoption of sustainable practices remains low in many parts of the world especially in Africa. Pretty and Hine (2001) analyzed data from Africa, Asia, and Latin America and concluded that from the total agricultural land only a 3% is under some type of sustainable agriculture practice.

2.3 Diffusion of SAPs

Diffusion of SAPs in most of the African countries have been facing some resistance as some investigators blame agricultural policies that encourage production efficiency, specialization and heavy use of chemicals as obstacles that hinder the adoption of sustainable agricultural practices (Owenya *et al.*, 2012). There are other barriers that are embedded in the adoption of sustainable agriculture among smallholders' farmers including poor extension services in rural areas. Individual farmer attitudes and the general society are still skeptical and look upon these practices as outdated so as then they seem not to offer much compared to the conventional agriculture practices regarding yield and return. According to Bultena (1991) opponents of sustainable agriculture, smallholders, the conventional farmers, have to be targeted for educational programs, thus:

Diffusion of SAPs could be accelerated by placing increased priorities on outreach educational programs for reaching conventional smallholders farmers who work against the principles of SAPs on agronomic, environmental and social goals of the sustainable agriculture movement, smallholders farmers may feel trapped in conventional farming, due to being conservative to change, lack the management skills however if they are well

supported with the needed information, social, and financial resources then they might successfully engage in a new form of agricultural production.

2.4 A better Approach for Understanding the Non-adoption of SAPs

Compared to the large amount of research conducted to determine the factors influencing adoption of conventional agricultural technologies, adoption of sustainable agriculture practices, have less research examining socioeconomic factors that affect its adoption especially in African countries. (Arellanes and Lee, 2003). However, trying to find explanations for adoption of sustainable agriculture practices, as has been done in the past for adoption of conventional farming technologies, is somehow simplistic and one-dimensional (Cary *et al*. 2001). This way of approaching the issue implies that farmers need only to be persuaded to change in order to adopt sustainable agriculture practices and that these are available to them, which is not usually the case (Cary *et al*., 2001) in most of the African countries where farmers are lagging behind the means for transmitting new information to their farms.

Some authors report that smallholders' farmers do not adopt sustainable agricultural practices even after they are aware of the adverse impact from conventional agriculture (Alonge and Martin, 1995). This suggests that awareness is necessary but not enough factor for adoption and that there might be factors outside of farmers' control affecting their decision to adopt SAPs to their farms.

2.5 Costs of Production in SAPs and Conventional Agricultural Practices

2.5.1 Costs associated with SAPs

The cost of production in SAPs is relatively low, this was caused by the little use of the highly mechanized implements like tractors and the use of small labor force in the

agricultural production activities. According to Hobbs and Gupta (2004), one of the major benefits of SAPs, which makes it popular with farmers, is that it costs less in terms of money and time. Inland preparation few labor are used since sustainable agriculture does not involve land cultivation which uses a large number of labor and high costs. Furthermore, sustainable agriculture reduces the number of weeding operations on the farm since the farm is covered with mulch and cover crops which in most cases reduce the weeding pressure in the farm and hence the reduce the costs associated with weeding. Along with the cost that could have been incurred for purchasing the chemical inputs such as fertilizer, under SAPs manure are preferred to fertilizers hence the cost of it are well set below the price attached to the artificial fertilizers.

2.5.2 Costs associated with conventional agricultural practices

Conventional farming practice is relatively expensive compared to the SAPs since the number of farming operations are many which lead to the rise in the cost of production. The farming operations involved in land preparation are like slashing and burning, a collection of the remaining after burning, ploughing, hallowing and use of fertilizers in their farms. All these operations involve costs along with labor expenses incurred over the season which leads to high costs of production. Also with conventional agriculture, farmers are required to have a number of weeding operations due to the high weeding pressure in the farm which leads to the increase in the costs of production in the farming operations. According to Hobbs (2006), conventional agriculture which involves intensive tillage costs a lot of money in the form of fuel for tractors, wear and tear on equipment along with the cost of the operator. If animal traction is used as the power source, the costs of feeding and caring for the animals over a full year are also high compared to the use of hand-hoe for farming activities.

2.6 Input Suppliers in Tanzania

Agricultural inputs are crucial and necessary for the insemination of SAPs technology among smallholders' farmers in the world and particularly in Tanzania, however, its availability hasn't been on point due to the usual delays on the delivery of inputs to the intended farmers especially in rural areas. Nevertheless, fluctuation of prices, untimely delivery of inputs has been the cause to the low adoption of SAPs in most of Tanzania areas.

According to ASDP report (2011), the adoption of improved seeds was influenced by a number of factors including socio-economic characteristics. Moreover, Input supply of such inputs such as fertilizers, seeds changes many hands before it finally gets to the end user (farmers). Actors in the supply chain of fertilizer distribution include: national importers, wholesalers, sub-wholesalers and retailers. Together with price fluctuations in the World Market, such long distribution chain does contribute to the rise in the price of fertilizers or seeds and that explains as to why fertilizers/seeds are more expensive in Tanzania and more often fails to reach farmers at the right time.

2.7 Extension Services in Tanzania for Small holders Farmers

Extension teachings and demonstrations have always been playing a significant role in improving the quality of produce and thus leading to the stable and sustainable agriculture. In Tanzania, agricultural extension services are provided mainly through the Ministry of Agriculture Food Security and Cooperatives (MAFC) (Mvuna, 2010). The ministry has also been providing rooms for private sectors to participate in improving the provision of agricultural services to farmers. In the meanwhile, the public sector has also been putting more emphasis on policy formulation, financial provision, and regulation of the supply of public goods and services (Mvuna, 2010).

However. the insemination of agriculture technologies to the smallholders farmers have been lagging behind due to the altitude and perceptions of farmers on the quality of services provided by extension agents to their farms. In this regard. farmers with a clear understanding of extension services are more likely to bring about successful use of the extension system in adopting agriculture technologies. which will adequetly address farmers' needs. As pointed out by Mattee (1994), an effective extension system should identify farmer needs and problems and determine the best solutions. According to the MAFC (2007). Tanzania is suffering from low agricultural productivity due to a number of factors including an inadequate extension system. poor linkage between extension and research, and climatic change.

2.8 Climate Change

According to Owenya (2011) on drought and famine in Dodoma District indicated that the presence of dry spells in critical periods for most crops contributed considerably to crop failure and famine. Given the over-dependence on rain-fed agriculture by the majority of farmers living in rural areas. climate change has been one of the major limiting factors in agriculture production thus resulting to food insecurity and low-income generation.

Furthermore. droughts and floods have repeatedly been a cause to crop and livestock failure and damage thus leading to chronic food shortages (Liwenga *et al.*. 2007; Kangalawe and Liwenga, 2005). The studies conducted by Rosen Zweig *et al.* (2002). revealed that changes in rainfall patterns and amounts have led to loss of crops and reduced livestock production. Increasing impacts of climate change in particular drought and floods on agriculture have been associated with various adaptation and coping mechanisms (Gwambene. 2007). which has not been useful in rural areas since

smallholders farmers from rural areas are not knowledgeable and are constrained to the board of information on the current coping and adaption mechanism due to unavailability of extension services and ignorance of a self farmer.

2.9 Theoretical Review

Research in the economic category is based on branches of economic theory. Despite slight variations in their assumptions, they are all built upon utility maximization theory and thus utility maximization theory was used to undertake the study. The theory explains that farmers choose the best production practices in order to achieve a utility with their limited resources. The theory is less restrictive than a profit maximization framework (Lynne *et al.*, 1988). Hence, profit may not be a total representation of utility. Furthermore, an emerging utility is a hybrid of movements, thinking, and action towards achieving income and environmental sustainability. Here, farmers are seen as rational, trying to optimize their particular utility out of their available resources. Economic research is, therefore, based on a decision algorithm for individual; smallholders farmers.

The branches of the theory can be grouped into three major paradigms: (1) the innovation-diffusion paradigm, (2) the economic constraint paradigm, and (3) the adopter perception paradigm.

2.9.1 Innovation-diffusion paradigm

The paradigm posits that access to its information is the key factor in determining adoptive decisions (Argawal, 1983). This paradigm is based on the concept of diffusion of innovation (DOI) (Rogers, 2003). It assumes that innovation is appropriate and profitable, leaving adoption as a function of communication of the relevant information to the potential adopters (Adesina and Zinnah, 2007). Rational farmers would want to adopt

them after being informed. The paradigm has worked well for profit-oriented innovations but less for SAPs this is because their orientation is different. As such, it is questionable whether the assumption of this paradigm has been met for SAPs.

This argument is supported by a consistent finding in a number of studies: the insignificant relationship between access to information and the adoption of SAPs (Warriner and Moul, 1992). This is the case even though farmers have had adequate access to information.

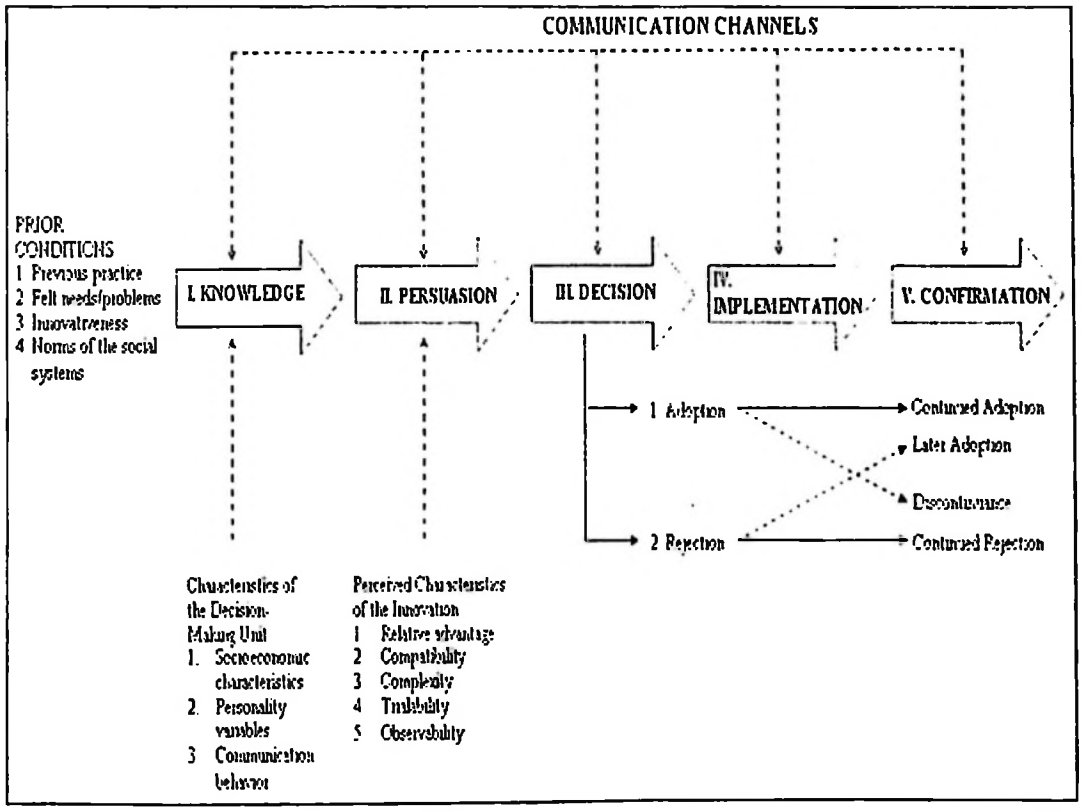

Figure 2: A model of five stages in the innovation-decision process
Source: Rogers (2003).

2.9.2 Economic constraint paradigm

The paradigm contends that adoptive decisions are affected by the asymmetrical distribution of resource endowments among smallholders' farmers (Aikens *et al.*, 1975). Nevertheless, resource endowments does not only represent resources like credit access, farm size, and information but also describe inherent qualities such as education and farm location of the potential adopters of SAPs. Based on a utility maximization concept, farmers are assumed to be rational in decision-making while being constrained by resource endowments in their farming activities. The adoptive decision is a function of factors in socio-economy, agro-ecology, institution, and information. Adoption should happen when a farmer possesses better resource endowments with inconsistent effects across cases of SAPs (Schreinemachers *et al.*, 2009). Thus, smallholders' farmers will strive to maximize their utility such as profit with the use of limited resources that is available to them.

2.9.3 Adopter perception paradigm

The paradigm asserts that perceived attributes of an innovation are important explanatory factors to adoptive decisions of a farmer on agriculture technologies (Adesina and Zinnah, 2007). The assumption of this framework is an extension to the economic constraint paradigm by counting in subjective preferences, which derived from the concept of DOI (Rogers, 2003). Farmer decision-making and choices, therefore, is a function of factors in socio-economy, agro-ecology, institution, information, psycho-social, and perceived attributes. This seems to offer the best explanation for adoption, but one of its dimensions remains open to debate: the inclusion of attitude is lacking in theoretical support. Notwithstanding this, SAPs are likely to be adopted when the attributes are viewed favorably by the smallholders' farmers.

2.10 Empirical Review

2.10.1 Studies on the adoption level of sustainable agriculture practices

The adoptions level of different farming practices such as SAPs and conventional have never been on equal ratios. The difference in the level of adoption of these technologies has been highly contributed by numerous factors such as farmer's perception, the availability of arable land suitable for agriculture activities. However, the adoption of SAPs is particularly low compared to other technologies due to the number of reasons including the fact that most farmers' aims at maximizing profit thus pay less attention to the environment.

According to the study done by (Chipurta *et al.*, 2011) on the adoption of conservation agriculture technologies by smallholder's farmers in the Shamva district of Zimbabwe. The author tried to examine the awareness and use of CA technologies among sampled households. Introduction and awareness to these new technologies was coordinated through extension efforts by private or public organizations or simply by observing other farmers who have already used the technology. Therefore, the author decided to count adopters as farmers who were using the technology at the time of the survey, whilst dis-adopters were those farmers who after using a particular technology for a while they decided to abandon its use while non-adopters are those farmers that never used a particular technology.

A high proportion of farmers (90%, 84% and 78%) were aware of the principles or have adopted the conservation agriculture technologies which includes crop rotation, intercropping and zero-tillage, respectively and this is possibly due to extension support services from both government and NGOs (Langyintuo, 2005). Most farmers in the area practice rotation and intercropping whilst about 35% practice mulching and zero tillage.

Dis-adoption rate is relatively higher among zero-tillage farmers compared to other technologies. Clearly, Banner grass. tie ridging. stone terracing and strip cropping are amongst the least commonly adopted technologies.

2.10.2 Studies on determining the crop yields and production costs between SAPs and conventional technology

According to the study done by Mahenge (2014). the author aimed at establishing differences in profit margin between conservation and conventional technologies and determining productivity of inputs for conservation as compared to conventional agricultural practices. Purposive sampling was used to get three wards and two villages in each ward. Simple random sampling was used to get 200 farmers (100 from each group: conservation and conventional agriculture farmers). The mean gross margin per hectare for conservation and conventional agricultural practices were TZS 526 800 and TZS 200 360 respectively. This implies that that the returns for conservation agriculture are higher than that of conventional agricultural practice. The marginal productivity of land for conservation agriculture farmers was 366 kg/ha while that of conventional agriculture farmers was 248 kg/ha. Marginal productivity of labour for conservation agriculture famers was 90 kg/man day while that of conventional agriculture farmers was 46 kg/man day. This shows that the marginal productivity of inputs for conservation agriculture farmers was higher than conventional agriculture farmers. Generally the study suggested that Conservation agricultural practices have potential to improve the income and livelihood of farmers in the study area if properly managed.

2.10.3 Studies on factors influencing the adoption of sustainable agriculture practices

According to study conducted by (Temu, 2013) on the adoption of sustainable land management technologies: revisiting impact to community livelihood in west Usambara Mountains, Tanzania. The binary logistic regression model indicated that total number of household members; farm total size and average income per year had a significant positive impact on the adoption of sustainable land management. Furthermore, multiple linear regression models indicated that household head age, farmland ownership and household income had a significant positive impact on improving community livelihood while sustainable land management non-adopters deteriorate it. The computed independent T-test for the mean income difference was statistically highly significance between adopters and non-adopters, suggesting that adopters were in better-off position to improve their livelihood.

2.11 Review of the Analytical Tools

i) Binary Logistic regressions

The same as in linear regression (LR), the objective is to estimate the regression coefficients in a model, given a sample of (X, Y) pairs. However, the crucial limitation of linear regression is that it cannot deal with dichotomous or categorical variables (Menard, 2002). With logistic regression, the X's can be numerical usually coded as dummy variable that is 0 for those who do not have the event or 1 for those who have the event (Summer, 2012).

Logistic regression determines the impact of multiple independent variables presented simultaneously to predict membership of one or other of the two dependent categories (Menard, 2002). According to Summer (2012), the simple logistic model is based on a

linear relationship between the natural logarithm (ln) of the odds of an event and anumerical independent variable as follows:

$$L=\ln(0)=\ln\left(\frac{p}{1-p}\right)=\beta_0+\beta_1 X+\mu \quad \ldots\ldots(1)$$

Whereby:

L = is binary and represent the event of interest (response), coded as 0/1 for failure/success.

P = is the proportion of successes.

O = is the odds of the events

X = is the independent variables,

β_0 ,β_1 and X are the coefficients and the slope, respectively

μ = is the random error.

ii) Gross margin analysis

The good way to comprehend the economic performance of the agricultural technologies is to make the comparison of their gross margins. This arises due to the fact that most often new technologies and practices in smallholder agriculture aim at increasing the farm productivity and profit to say at large. One of the immediate goals of farmers is to increase income, moreover, (Mutayoba, 2005) stated that the cost which is involved in production might be one of the hindrances in adopting expensive but more rewarding technologies.

The most often variable costs in SAPs and conventional agricultural production are the cost of factors of production such as seeds, fertilizer, pesticides, hired labor and herbicides. The Gross margin is the difference between gross incomes accrues and the variable costs incurred. Gross margin has some limitations which include its inability to

CHAPTER THREE

3.0 METHODOLOGY

3.1 Description of the Study Area

This study was conducted in Kilosa Districts in Morogoro Region, Tanzania. The location was selected because it's among the potential district in producing maize in Morogoro region. Morogoro is the third largest region in Tanzania, occupying a total land area of about 72 939, which is approximately 8.2% of the total area of Tanzania mainland and has a population of 1 759 809 people (URT, 2013). The region lies between latitude 5° 58"and 10° 0" to the south of the equator and longitude 35° 25" and 35° 30" to the east (URT, 2013). It has a wide climatic variation with the temperature ranging from 18 to 28°C and the annual average rainfall ranges from 500 to 1800 mm (Daninga, 2011). It is bordered to the North by Arusha and Tanga Region, to the east by the Coast Region, to the south by the Ruvuma and to the west by Iringa and Dodoma Region.

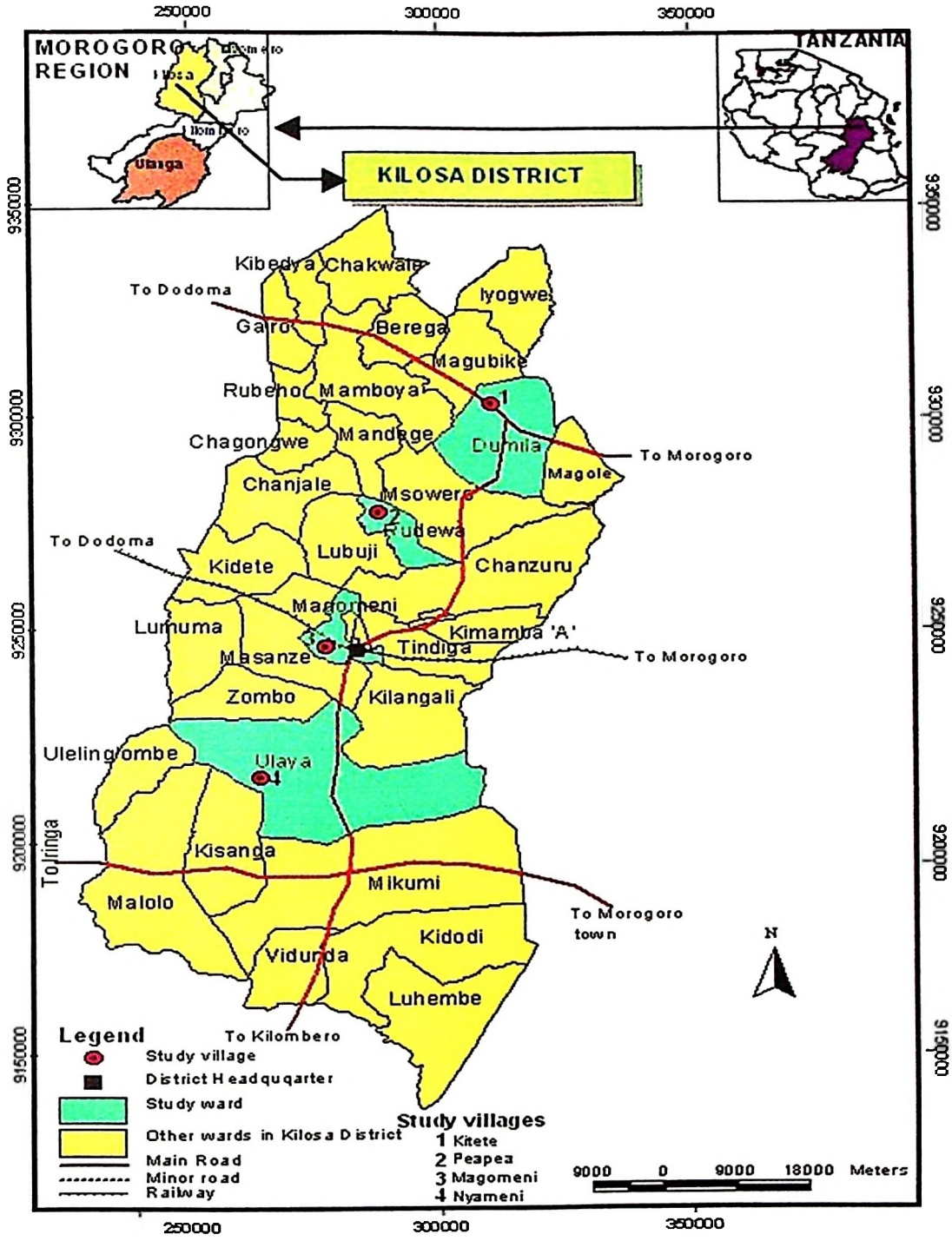

Figure 3: Kilosa District Map

Source: Adopted from the GIS and remote sensing laboratory SUA

3.2 Economic Activities

The major economic activities in Kilosa District are agricultural crop production, fishing and livestock keeping. The main food crops and cash crops grown in the district include banana, rain fed upland rice, fruits, sugar cane, beans, spices, vegetables, maize, cassava, sorghum,. The lowland areas have fertile soil deposited from highlands by floods during heavy rainfall and the area is suitable for maize production. Other land uses include livestock keeping, including pigs, goat, cattle, ducks and chicken and fishing; wildlife conservation and forest reserves. The majority of Kilosa district economic activities are based on agricultural crop production and pastoralist livestock keeping in the southern part. More than 85% of the population engaged in agriculture produce maize, beans, cassava, sorghum, rice, fruits, coffee, and cotton. The animal husbandry includes cattle, goat, sheep, pigs, chicken and ducks

3.3 Research Design

This study used a cross-sectional approach by collecting data at one episode of time. Cross-sectional design is useful because it is cost-effective, less time consuming and much information is obtained in a relatively short period of time and allows data to be collected at one point in time from different individuals or groups of respondents (Bailey, 1998).

3.4 Sampling

This was a follow up project to trace farmers who were given SAPs therefore 550 smallholder maize farmers from the village household register were chosen after a random sampling. For the sampled household, the head or his representative was interviewed.

3.5 Data Type and Sources

Secondary data

Adoption pathway project under CIMMYT was used as the main secondary data long with other data from Sokoine National Agricultural Library (SNAL) especially various research reports from publications including agricultural economics journal, articles and reports. This is due to the fact that additional information from different perspectives was needed to enrich the study.

3.6 Data Analysis

Secondary data was organized, coded, processed and analyzed using qualitative and quantitative methods. Statistical Package for Social Sciences (SPSS) version 16. Descriptive statistics such as means, frequencies and percentages were derived using SPSS. The analyses were carried out to achieve the study objectives as described below. The level of adoption of SAPs was ranked low if a farmer implements only 1 principle, moderate if the farmers implements a combination of 2 principles and high adoption if farmer implements all the principles.

3.7 Quantitative Analysis

3.7.1 Specific objective one

Analysis of the level of adoption and the socio-economic profiles of adopters and non-adopters of SAPs was carried out using descriptive statistics including frequencies, mean, and standard deviation.

To determine the intensity level of adoption of sustainable agriculture practices in smallholder maize production the following model was used:

$$\text{Adoption level} = \frac{\text{Areas cultivated with SAPs}}{\text{Total Areas cultivated}} \text{ X } 100 \quad \ldots\ldots(1)$$

3.7.2 Specific objective two

Analysis of the profitability of farm operations for adopters and non-adopters was carried by calculating the mean revenues and costs for maize crop farm operations using SPSS. Maize was chosen since it is the main crop promoted for food security in Kilosa District.

(i) The Gross Margin was used to compute the production costs and returns per Hectare (Gross margins) of Full package of SAPs and other technologies that is for Adopters and Non adopters.

$$GM = TR - TVC \quad \ldots\ldots(2)$$

$$PQ - TVC = PQ - TVC \quad \ldots\ldots(3)$$

GM = Gross Margin

TR = Total revenue

TVC = Total Variable Cost

P = Price of Output

Q = Quantity of Output

3.7.3 Specific objective three

Model specification

Binary Logistic regression model was useful in determining socio-economic and institutional factors influencing the adoption of sustainable agriculture practices to their

maize production. Logit regression model applies to the data taken on a dependent variable Y and a set of explanatory variables X_1, X_2...Xk with i sets of data. In matrix form, the formula is presented in Equation 4 as follows:

Model:

$$P_r(Y_i = 1) = F(\chi_i \beta) = \frac{\exp(\chi_i \beta)}{1 + \exp(\chi_i \beta)} + \mu \quad \text{.....(4)}$$

Where: Y_i = Adoption of technology

{1 if adopted the three principles of SAPs, 0 if did not adopt the three principles of SAPs}

β_0 = Intercept

χ_i = Independent variables

μ= Error term

$$Y = \beta_1\chi_1 + \beta_2\chi_2 + \beta_3\chi_3 + \beta_4\chi_4 + \beta_5\chi_5 + \beta_6\chi_6 + \beta_7\chi_7 + \beta_8\chi_8 + \mu \quad \text{.....(5)}$$

Table 2: Explanatory Variables

Description	Expected Sign
Income of the respondent (X_1)	+
Age of head of household (years): = (X_2)	+
Family size = X_3	+
Gender of head of household (1=Male 0=Female) = X_4	+
Education of head of household (1=No formal, 2=Primary, 3=Secondary, 4= (Beyond Secondary) = X_5	+/_
Extension service on SAPs (1=Yes0=No) = X_6	+
Credit received for agriculture (1=Yes received, 0=Not received) = X_7	+
Land size of household (Ha) = X_8	+
Access to improved seeds: (1=Yes, 0=No) =X_9	+/_

3.8 Definition of Variables

Education: It was given by years spent in school. It was hypothesized that educated farmers are more likely to adopt SAPs because they can use information relevant for adoption unlike uneducated ones.

Farm size: This was referred to the total size of a farm owned by the farmer. It was hypothesized that a farmer with larger farm size he/she is more likely to adopt SAPs than farmers with small size.

Income: Income of the farmer was hypothesized to be positively related to the adoption of SAPs. A farmer with higher income was expected to adopt SAPs more easily than the farmer with lower income.

Household labor/family size: Referred to the number of people who were able to work in a family. It was expected that, the household would choose to adopt a technology (SAPs) if there are enough household labors to work in the farms.

Age of the respondents: It was measured in years of respondents from birth to the time of interview. It was hypothesized that age of the farmer can influence or affect farmer's decision to adopt SAPs. Older farmers were expected to adopt SAPs quickly compared to the younger ones.

Gender: If a respondent is a male or female. It was hypothesized that gender of the farmer can affect adoption of SAPs. Male tend to adopt new innovation faster than female since females are constrained by the cultural attributes such as division of labor and other family responsibilities.

Extension service: If extension officer visits the farmer. It was expected that Visits from extension staff are positively related to adoption by exposing farmers to new information unlike to those farmers with a shorter number of visits from the extension agents.

Access to improved seeds: It was hypothesized that, if a farmer has an access to improved seed he/she is more likely to adopt SAPs to the farms than farmers who had no access to the improved seeds.

Access to credit: If a respondent has received credit for agriculture activities. It was hypothesized that a farmer who had access to credit was more likely to adopt SAPs compared to those who had no access to credit.

3.9 Limitation of the Study

i) There were very few reports related to this study specifically on sustainable agriculture practices that have been carried out in Kilosa District. Thus, it was difficult to access relevant materials directly related to the theme of this study.

ii. This research investigated only farmer's choice on the adoption of sustainable agriculture practices on maize production due to time and budget constraints. Therefore conclusion drawn from the study cannot be generalized to the whole set of adoption to the sustainable agriculture practices found in the country in general.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 Socio-Economic Characteristics of the Respondents

The socio-economic characteristics presented under this section include: age of the respondents, gender, marital status of respondent, educational level of respondent, land size, household size, and household income. Most of these characteristics have a direct relationship with whether a respondent has adopted a full package of SAPs or not.

4.1.1 Age of the respondents

The survey results for the adopters of SAPs respondents indicate that, there is small number of people engaged in farming activities at the age above 61 years (Table 3). This can be explained by the fact that inadequacy in physical strengths to perform agricultural activities and other farm managements, thus they tend to entrust them to other family member of younger age. According to Basnayake and Gunaratne (2002), the age of a person is usually a factor that can explain the level of production, efficiency and adoption of SAPs.

Findings show that the majority of respondents lie between the ages of 41-50 for the SAPs adopter's farmers. According to the study conducted by Nyanga (2012), stipulated that frequently cited reason behind the numbers is due to the migration of young people from rural to urban areas searching for the jobs and other off-farm activities such migration is also under the influence of the limited land in the rural areas. Nevertheless, results indicate that few people engaged in farming activities at the age between 21-30 and 31-40 for adopters as the majority of them were students or employed to other off farming activities.

Table 3: Distribution of respondents by age

Age	Percentages SAPs farmers
21-30 (N=38)	7
31-40 (N=159)	29
41-50 (N=255)	46
51-60 (N=93)	17
61-70 (N=5)	1
Total	**100**

4.1.2 Gender status of the respondents

Findings indicate that majority of the respondents were males, who represents 48% and 52% for female and male respondents respectively (Table 4). Moreover, this implies that many smallholders family are male headed households. The low representation of women could be attributed to cultural barriers (Norman, 2005) where women are considered household heads only when they are widowed, divorced or separated or single. Furthermore, the involvement of women in farming activities is normally constrained by their cultural division of labor, responsibilities and the control and use of income which have widespread implications in agricultural production in adopting the SAPs in the study area.

Table 4: Proportion of respondents by Gender

Sex	Percentages SAPs farmers
Males (N=286)	52
Females (N=264)	48
Total	**100**

4.1.3 Marital status of the respondents

The majority of respondents were married (50%) (Table 5) the results can be explained by the fact that, most of the respondents in rural area are married at very young age as

the tradition and customs are there to support such commitments and these marriages are mostly done when people have reached grade 7 classes thus unmarried young men and women are generally at low compared to the married ones. Hence the availability of labour was assured to undertake the adoption of SAPs in the study area.

Table 5: Distribution of respondents by marital status

Marital status	Percentages SAPs farmers
Single (N=126)	23
Married (N=275)	50
Widow (N=28)	5
Separated (N=121)	22
Total	**100**

4.1.4 Education level of the respondents

From the results in (Table 6), 78% of SAPs adopters had primary school education, 14% had secondary school education, 3% had a university school education and 6% did not attend to school. Furthermore, based on these findings, one could infer that farmers with high level of education marginally had more knowledge and information on good SAPs practices, coping and adaptation strategies and, those farmers with tertiary education were able to synthesize information much better than those who had no formal education or illiterate.

Table 6: Education level of the respondents

Education Level	Percentages SAPs farmers
No formal Education (N=33)	6
Primary school (N=429)	78
Secondary school (N=77)	14
Beyond Secondary (N=11)	2
Total	**100**

4.1.5 Main occupation of the respondents

From (Table 7) the result shows that farming was found to be the main occupation for the majority of respondents by 90%. Results further reveal that 4%, 2%, and 4% represents petty business, carpentry, and employment respectively as the main occupation of SAPs respondents. Most of the respondents were found to be self-employed because most of them have reached only just a low level of education hence become unable to get a sufficient job opportunity to invest more on activities concerning the adoption of SAPs in the study area.

Table 7: Distribution of respondents by their main occupation

Occupation	Percentages SAPs farmers
Self-Employment (N=523)	95
Petty business (N=11)	2
Carpentry (N=5)	1
Employed (N=11)	2
Total	**100**

4.1.6 Household size of the respondents

The average household size had higher percentage of 5-7 members. Results from this study indicated that number of members in the family had an influence in assisting the whole need process of the adopting SAPs technologies especially if members fully participate in farming activities (Lugandu, 2013). Nevertheless, these findings implies that, households with large family size were more likely to engage in adopting the SAPs, take advantage of high production in agriculture and are more likely to adapt to new agricultural technologies.

4.2 Adoption Level of Sustainable Agriculture Practices among Small Holders Farmers

The adoption levels of sustainable agriculture practices were different among smallholders' farmers in Kilosa District.

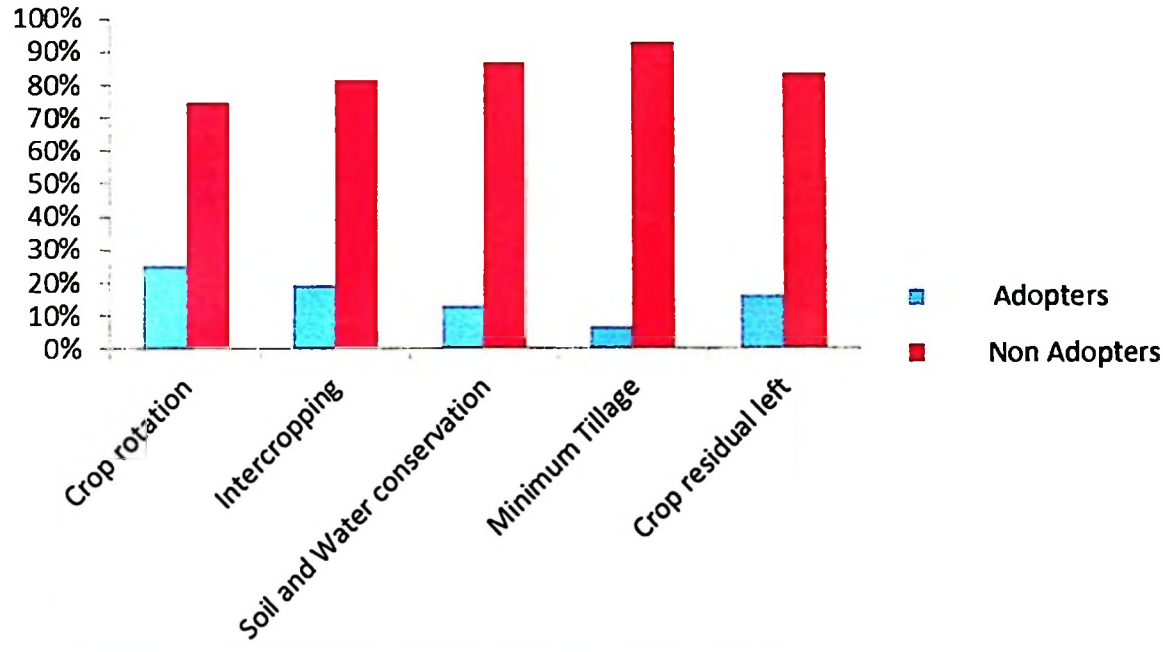

Figure 4: Adoption level of sustainable agriculture practices

(i) Crop rotation:

Smallholders' maize farmers had a different combination of crops that were rotated once the main season was over including common beans and pigeon peas. However the adoption level was particularly low as only (25%) of the respondents were able to adopt compared to non-adopters (75%). The reason for the low adoption is contributed by the effect of climate change on the farming activities, under such circumstances some of the crops may not be able to cope with the changes that come along with the climate change such as inadequate rainfalls or drought.

Furthermore, according to Wollni (2010) poor soil and environmental management have been said to be cause for the low adoption as many farmers opted to leave the farms un farmed for a while so as to preserve the needed fertility for the next season.

(ii) **Intercropping**: Is one of the sustainable agriculture practices technologies which are used by the majority of smallholders farmers to preserve the environment and increase the yield. It's one of the possible techniques to avoid the risk of climate change such as drought for the majority of farmers who depends on rain-fed agriculture.

However, the adoption level is significant low (19.2%) among the smallholders' farmers compared to (81.8%) who did not adopt the technology. According to the interviewed extension agent, the reason for the low adoption is due to different soil characteristics in their farms which do not allow other crops to be grown in such area hence become a limiting factor to the farmers. Nevertheless, Lack of extension services in rural areas has played a significant role for the SAPs not to be fully adopted as farmers became unaware of the ongoing changes in techniques and information.

(iii) **Soil and Water Conservation**

Soil and water conservation methods have not been well known among smallholders' farmers in the rural areas. Most of the farmers weren't aware of the soil and water conservation methods as the adoption level was low to (13%) while the remaining (87%) did not adopt the technology. According to the study done by Persevearance (2012) the reason for the low adoption is due to lack of provision of extension services to smallholder's farmers. Farmers became unaware of the methods since the extension agents are far from delivering the information and advice along with demonstration to their fields due to the distance from the office to the farms.

Furthermore, Nyanga (2012) argued that, farmers who rented land paid no attention to the soil and water conservation techniques during the period of farming as most of them were encouraged to use more chemicals to maximize the yield thus destroying the natural fertility of the land.

(iv) Minimum Tillage

As opposed to conventional practices that include intensive tillage technique which changes the cover and structures the soil but, under minimum tillage the soil cover is not disturbed thus the effect is so minimum and enough for the successful production to take place.

The adoption rate is very low among small holders farmers as (6.7%) of the respondents were the ones who adopted the technology while (93.3%) respondent did not adopt the technology. Kshirsagar (2002) reported that, the reason for the low adoption is due to its inability to cooperate well the soil with agrochemicals/inputs to produce sustainable yields unlike intensive technique once the chemicals or seeds are applied they tend to corporate well with the soil and hence gives the higher possibility of achieving the intended return. Nevertheless, lack of extension services in the study area played a role to the low adoption rate as 93.3% respondents did not receive training, advice and information from the extension agents.

(v) Crop residual leftovers

Crop residual refers to what is left on the field when the harvest in done, the remains of the harvested plant. This is one of conservation methods which used to conserve soil from being destructed by natural and manmade causes.

Nevertheless, adoption of the technology among smallholder's farmers is low (16%), and the majority (84%) of the farmers did not adopt the technology. The study done by Lugandu (2013) defined the reason for the low adoption due to the presence of conventional agriculture inputs such as chemicals, fertilizers which compensate the use crop residuals in other activities apart from conserving the environment. Many respondents didn't apply the technology because, crop residuals had multiple uses, one of them was being used as a source of income once it was sold nevertheless it was also used to feed the livestock such as large and medium size livestock.

Table 8: The adoption level of sustainable agriculture practices

Sustainable Agriculture Practices	Adopters (%)	Non Adopters (%)
Crop rotation	25	75
Intercropping	19.2	81.8
Soil and water conservation	13	87
Minimum tillage	6.7	93.3
Crop residues	16	84.0

4.2.1 Adoption Level of SAPs package in Kilosa District

It was observed that 22% of the interviewed households in Kilosa districts are practicing conventional or other farming practices, which imply that they don't abide to any of the three SAPs principles. This means farmers mostly practice monoculture, do not grow soil cover crops, and use conventional tillage practices in their fields. Conventional farming practices such as intensive tillage and burning or removing crop residue often lead to declining agricultural productivity and increasing rural poverty (Shetto *et al.*, 2007). About (78 %) of the farmers implement one or a combination of two principles.

The reason for the low level of adoption of SAPs in the study district could be as report by Norman (2005) that most farmers have not been exposed to farming practice and support services that could promote uptake of the technology. Adoption levels and percentage of implementing households in Kilosa district are as presented in Figure 5.

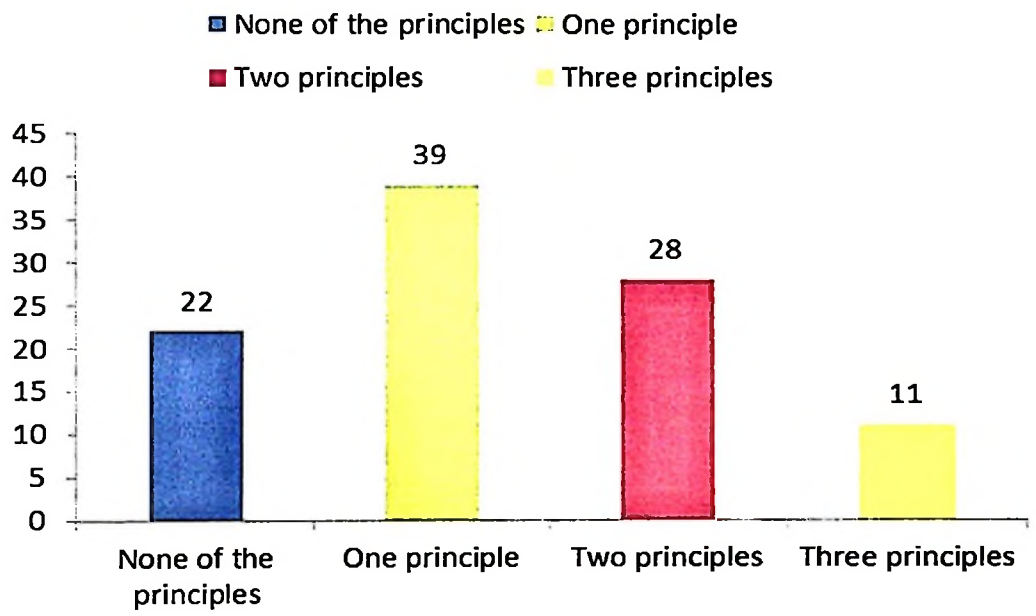

Figure 5: Adoption Level of SAPs package in Kilosa District

4.2.2 Adoption intensity of sustainable agriculture practices

The adoption intensity of the SAPs differs significantly as the proportionate area used for the adoption was very small compared to the area used by non-adopters, this is due to the poor climate conditions, limited land for the production and poor policies to facilitate and encourage the adoption of sustainable agriculture practices in the study area. Thus farmers were left with no option other than adopting the most profitable practices available so as to compensate for the cost incurred during the whole period of production and for the welfare gain.

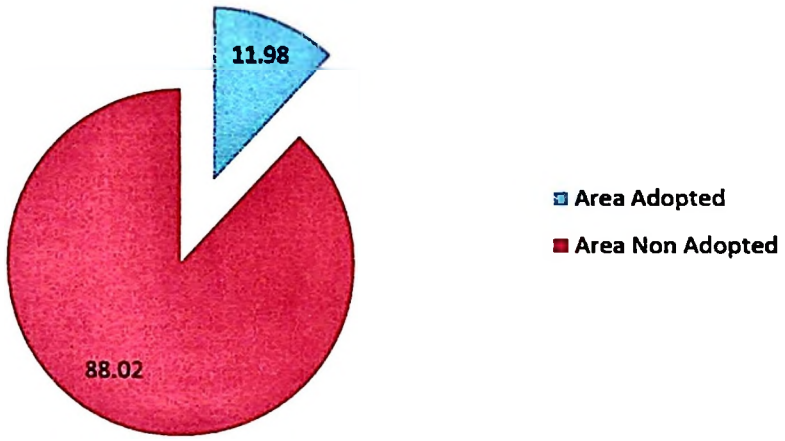

Figure 6: The adoption intensity of the SAP over the Land use

4.3 Profitability Analysis of the Sustainable Agriculture Practices

The result from Table 9 shows that smallholder farmers who were non adopters of the sustainable agriculture practices in Kilosa recorded a gross margin of 563 675 Tshs per hectare. This result implies that smallholder farmers operated under loss from maize production perspective as the yield obtained were far less incomparison to the adopters of three principles of SAPs.

Table 9: Profitability analysis for Adopters and Non-adopters

		Maize Value Tshs/Ha	Costs incurred (Tshs)/Ha	Net profit (Tshs/Ha)
Non adopter	Mean	693 489	129 814	563 675
	Std. Deviation	573 916	94 045	
	Minimum	75 000	41 000	
	Maximum	2 900 000	491 653	
	N	450	450	
Adopter	Mean	782 500	148 300	634 200
	Std. Deviation	517 644	136 838	
	Minimum	85 000	63 000	
	Maximum	1 850 000	390 000	
	N	100	100	
	Mean	660 088	101 480	
	Std. Deviation	565 093	97 274	
Total (All)				
	Minimum	75 000	41 000	
	Maximum	2 900 000	491 653	
	N	550	550	

The technology average yields recorded 1680 kg and 2640 kg per Hectare for the non-adopters and adopters of fully packaged principles, respectively, which was equivalent to 14 and 22 bags of 120 kg, respectively. The result revealed that, adopters were better off in terms of yield and revenue as compared to the non-adopters of sustainable agriculture practices in Kilosa District.

This indicated that once SAPs is applied along with other supporting factors such as extension agents, it could have contributed positively to the household income, farm yield, and food security to the smallholder farmers who operated under subsistence or commercial farming.

However, despite not being widely adopted among stallholders, SAPs adopters seemed to operate on profit since the yield and revenue obtained from the farm activities were relatively higher compared to those of non-adopters.

Non-adopters of SAPs recorded a less gross margin per hectare of 563 675 Tshs as compared to adopters 634 200 Tshs. The price of maize per kg during the season of year 2013/2014 was used to calculate the revenue against the costs that were incurred over the season. However, the inadequacy of inputs and high prices attached to the inputs such as fertilizers and agro chemicals contributed to the low adoption level of SAPs among smallholders maize farmers.

It was found that 75% of households interviewed were engaged in maize cultivation. Previous studies on SAPs technology suggested that crop yields increased when SAP was applied (Mazvimavi, 2011), which is in line to the findings of this study. The possible explanation for the higher net benefit for adopter farmers could be that the smallholders farmers had fully embraced the SAP practices, and/or soils had regained their fertility.

4.4 Socio-Economic and Institutional Factors Influencing the Adoption of SAP

The results of the Logit regression model estimating social economic factors and farm characteristics influencing adoption of different agricultural innovation in maize are presented in Table 10. The fit of the model was statistically significant at ($P \leq 0.005$). These results show that the specified explanatory variables were able to explain adoption SAPs in the study area. The variables that were found to be significant are to be explained below.

Table 10: The Binary Logit regression results of socio-economic and institutional factors influencing adoption of SAPs in maize production

Explanatory Variables	B	Wald	Sig.
Family Size	0.733	3.924	0.041**
Farm total size	0.886	5.128	0.038**
Household Income	0.230	16.111	0.006***
Contact with Extensions	0.982	1.743	0.030**
Age of the household head	0.357	1.190	0.011**
Sex of the household head	0.421	0.091	0.046**
Education Status	0.487	0.012	0.030**
Years of Farming	0.198	0.175	0.276
Marital Status	-1.281	0.301	0.613
Improved Seed	2.214	0.726	0.312
Access to credit	-9.486	0.400	0.290
Constant	10.577	0.000	1.000

Note: ***, **, significant at 1%, 5% and levels of significance respectively

-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
111.134	.674	.723

4.4.1 Farmer's age

Table 10 results show that, farmers age is positively related and statistically significant at ($P \leq 0.05$) to the adoption of SAPs. Implies that a unit increase (age) of the respondent increases the probability of adopting SAPs increases by 0.357. This implied that old farmers were likely to take up new technology than young farmers. The findings of the study are in line with the findings from the study conducted by Mazimavi and Twomlow (2009) who argued that there was a positive correlation between age and adoption of conservation practices in Zimbabwe. However, these observations contradicted those reported by wollin (2010) who argued that older people had more experience, thus their receptivity to new ideas and technologies typically decreases with age. Moreover, Rukuni *et al.* (2006) claimed that being older creates a conservative feeling among farmers and hence resistance to change.

Furthermore, an increase in the adoption of new technology with age has been facing some challenges because youths have a little appreciation of the importance of agricultural activities in most rural set ups and will take marginal effort to expand these activities.

4.4.2 Farm size

Table 10 results indicated that farm size was positively related and statistically significant at ($\rho \leq 0.05$) to the adoption of SAPs in Kilosa District. A unit increase in amount of land (acre) increased the probability of adopting of SAPs by 0.866 holding other factors constant.

The finding implies that, farm size could influence farmer's participation in adopting the SAPs; thus inadequate farm size can affect farmer's decision of adopting SAPs (Wollni, 2010). Farmers with large arable land have the opportunity to spare some sections to try out new practices at less risk. Large land size also implies that farmers can diversify into other crops and reduce the inherent risk in agricultural production (Perseverance *et al.*, 2012). The results are in line with the study by Gabre Madhin and Haggblade (2001) who found that, large commercial farmers adopted new high yielding maize varieties more rapidly than smallholders in Kenya. Large farm size also gives a farmer the capacity to use land intensive conservation practices (elements) such as improved fallow and crop rotation.

4.4.3 Household size /labor

Table 10 results shows that household labor was positively related and statistically significant at 5% ($\rho \leq 0.05$) to the adoption of SAPs. This implies a unit increase in the number of labour available increased the probability of adopting SAPs by 0.733 holding other factors constant.

These observations are in line with number of studies which suggest that, household size has been linked to the availability of own/family farm labor in adoption studies (Amsalu and De Jan, 2007). The argument is that larger households have an importance in the determinant of the availability labor required during the introduction of new technologies (Kassie, 2011). It is expected that a larger household size will influence the decision of acceptance because of the availability of labor required to undertake adoption process.

4.4.4 Education

Table 10 findings show that, level of education was positively related and statistically significant at ($\rho \leq 0.05$) to the adoption of SAPs. The finding of the study implies that, a unit increase in the amount of years spent in school increased the probability of adopting SAPs by 0.487. Nevertheless the finding of the study are in line with the study conducted by Asfaw and Admassie (2004) who argued that, the level of education had an influence adoption of agricultural Innovation, if that education is necessary for understanding and utilization of agricultural Innovation. Through education Norman (2005) claims that farmers may know the rationale for managing land through better farming practices and other social economic factors. The farmer's education background is an important factor that determining the readiness to accept and properly apply technologies (Marenya, 2007). In Tanzania most farmers have low formal education and they mostly use traditional farming practices, the more complex the technology to be utilized the more likely it is the education will play the major role especially in adopting new agriculture technologies such as SAPs to their farms.

4.4.5 Household income

Table 10 findings. show that household income was positively related and statistically significant at ($\rho \leq 0.05$) to the adoption of SAPs. Implies that, a unit increase in the amount of income (Shillings) increased the probability of adopting the SAPs by 0.230 holding other factors constant. High income has a positive influence on the adoption of SAPs as the wealth allows the farmer to invest a relative small proportion if their income into an uncertain enterprise (FAO, 2003). Wealthier farmers may be the first to try new technology especially if it involves the purchase of necessary inputs for the adoption.

The findings of the study are in line with the study conducted by Serman and Filson (1999) who argued that high income improves the capacity to adopt agricultural technologies as it assists to have the necessary capital to purchase the needed inputs to start the innovation. The influence of off-farm income in the adoption of new technologies is derived from the fact that income earned can be used to finance the uptake of new technological adoption.

4.4.6 Gender

Table 10 results show that, gender of household head was positively related and statistically significant at ($\rho \leq 0.05$) to the adoption of SAPs. This implies that probability of male household head to adopt SAPs is higher by 0.208 compared to female household head in the study area. These observations are similar to the findings reported by of (Pretty *et al.*, 2011) who further argued that though most technologies are considered gender neutral, they are often gender-biased during their introduction and use by societies hence to the insemination and practice.

Gender was hypothesized to have an influence on the adoption of SAPs. It is often that women are forgotten when it comes to the insemination of SAPs technology. This is reinforced by the cultural system which requires women to remain at home while husbands attend seminars, and yet do not always teach the women what they have learnt in the extension meetings (Morris *et al.*, 1991). Women also do not have accessibility to the key productive resources of land, labor and capital, as well as being under privileged in education and knowledge (Morris, 1991; Mazvimavi *et al.*, 2009).

4.4.7 Extension Services

Table 10 results show that access to extension service was positively related and statistically significant at ($\rho \leq 0.05$) to the adoption of SAPs in Kilosa District. Implies a unit increase in the number of visits from extension agents increased the probability of adopting SAPs by 0.982 holding other factors constant.

The findings are similarly related to that of Ouma *et al.* (2006), who found that extension services were positively influenced the utilization of improved technology by farmers in farming. Nevertheless, the same source also claimed that found that adoption rate of farmers who are having contact with extension agents working on agroforestry technologies was higher compared to farmers who have never contact any extension agent.

However, the availability of extension agents in the rural areas have been a challenge in recent years, these extension agents are hard to be spotted in their workplace or to the fields. The quality of the service provided by extension agents have also been a limiting factor, farmers in rural areas haven't been subjected to demonstrations fields or training hence they are limited to the information which could be crucial for the adoption of agriculture technologies.

CHAPTER FIVE

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusion

The overall objective of the study was to understand the sustainable intensification of technologies among smallholders maize farmers on Kilosa district. By descriptive analysis, profitability analysis and logistic regression models, the study found that, we have enough evidence at ($p<0.005$) to reject null hypothesis (Ho) which states that: the socio economic and institutional factors do not significantly influence the adoption of SAPs among smallholders maize farmers in Kilosa District.

The study concludes that, adoption and practicing of sustainable agriculture practices should be fundamental for sustainable agriculture development. As they both significantly withstand the upgrading of community livelihood.

Additionally, farm total size, household income, extension services, gender and family size and age were found significantly to be the factors influencing the adoption of sustainable agriculture practices. With regards to profitability margin, for adopters and non-adopters, they were found to be statistically different. As adopters recorded a relatively higher profit margin compared to non-adopters.

The economic profit of SAP is only a fraction of the factors that influence adoption of SAPs. Ignoring the inclusion of social and environmental benefits analysis might create a false picture about the benefits of SAP technology. Farmers' emphasis on only economic benefits could lead to the choice of shorter term benefit technologies that might have negative impacts in the long run. Inadequate considerations of the various benefits of interventions for the promotion of SAPs could affect perception and hence choice of SAPs farming practices.

5.2 Recommendations

In view of the major findings of the study and the above conclusion the following were recommended:

The adoption level of SAPs in Kilosa District was low compared to other technologies. Suggesting that, the Government should emphasize more on the insemination of these SAPs to smallholder's farmers and assist them in acquiring necessary inputs such as education, extension services, and credit services in the study area.

Socio economic and institutional factors were found to be the major factors affecting the adoption of SAPs. This suggests that farmers are likely to adopt SAPs fully package if they have these socio economic inputs including education, income, land, labour, extension services. Therefore it is important for farmers to engage themselves in different actives such as small business apart from agriculture so as to improve their income. Also, the government should establish a clear framework to support smallholders' farmers' example financial institutions to address farmers' credit needs on loan terms with low-interest rate and provision of extension services in remote areas.

Adopters of SAPs were found to be better off in terms of profit and yield compared to partial/non-adopters suggesting that farmers should adopt all the three principles of SAPs if they are to reap all the benefits to their farms regarding the output and profit. They are also advised to pay attention to all necessary inputs required for the proper adoption of SAPs to their farms.

To make SAPs an efficient farming system and facilitate its adoption process the following preconditions are recommended (i) strengthening extension services by the government and other stakeholders (ii) providing smallholder farmers with financial, institutional and technical support services (iii) stakeholders including the public and private sector be sensitized more on increasing investments on SAP (iv) launching SAP learning and experience sharing intervention with smallholders.

5.3 Areas for further research

This study was conducted on the basis of socio economic and institutional factors influencing adoption of SAPs in Kilosa District and did not go to the impacts of SAPs on the environment and challenges that farmers faces when adopting the full package of SAPs, therefore, it is recommended that further studies should be conducted on impacts of SAPs to the environment and on challenges facing smallholders farmers when adopting the full packaged SAPs.

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