Profitability analysis of Sustainable Agriculture Practices to Smallholder Maize Farmers in Kilosa District Tanzania

Joseph Mugula*, Fulgence Mishili**

* School of Agriculture Economics and Business Studies, Sokoine University of Agriculture P.O Box 3007, Morogoro,Tanzania
** Senior Lecturer (Applied Economics) Sokoine University of Agriculture P.O Box 3007, Morogoro,Tanzania

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Abstract- This study was done to assess smallholder farmer's decision to adopt sustainable agriculture practices (SAPs) based on the assessment of profitability margin among smallholders SAPs adopters and Non adopters in Kilosa district, Morogoro. A total of 550 respondents were chosen for the study after a random sampling of the baseline dataset as a follow-up to SIMLESA adoption pathway project. Gross margin was developed using plot-level data gathered from smallholders maize farmers in Kilosa Tanzania. The results showed that smallholders SAPs adopters recorded a relatively higher gross margin compared to the non-adopters. The reason for the difference in gross margin was that most of the smallholder's maize farmers weren't exposed to the extension services thus they became unaware of the technologies' attributes which limited their ability to make decision on whether to adopt SAPs. Furthermore, high prices attached to the farm inputs were mentioned to be among the factors affected farmer's decision to adopt SAPs. Thus, decision to adopt SAPs was largely influenced by the profit margin between different practices and that a farmer was likely to adopt SAPs after comparing the returns obtained to a number of agriculture practices. The results provide insight into the further efforts needed to encourage greater adoption of SAPs in Tanzania.

Index Terms: SAPs, Adoption, and Profitability margin

1. INTRODUCTION

Agriculture sector and smallholders farmers have been considered as a backbone of the Tanzania's economy for decades as a majority of people who are farmers have fallen into this category. In spite of the contribution of smallholder farmers to the economy and food security, still they haven't come close to reach the potential farm produce due to the social-economic factors such as education, income, and extension services to name the few along with the need to be exposed to suitable agriculture practice that would maximize the farm produce and protect the environment. These sustainable agriculture practices are not well known to most farmers due lack of communication and for financial reasons. SAPs being one of the most profitable and friendly practice has not been widely adopted by the majority smallholders farmers especially in rural areas despite of the advantageous outcomes to smallholders farmer's welfare and production.

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, the 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 could be of help to alleviate the current production setbacks. According to Oladele (2005), several parameters have been identified as influential factors to the adoption behavior of smallholders farmers from

qualitative and quantitative models. Researchers investigating farmers adoption behavior have accumulated considerable evidence showing that information on the profit margin of different agriculture practices have an effect on the farmer's decision to adopt particular agriculture practice (Oladele, 2005; Byakugila *et al*., 2008). Nevertheless, for the smallholder's farmer's decision to adopt a particular technology to be successful, it has to be supported by number of factors such as inputs and extension services.

The Profitability margin derived from maize production depends on the type of agriculture practice adopted by a smallholder farmer for that particular cropping year (Lugandu, 2013). Nevertheless, maize growing zones in Tanzania are different since maize varieties requirements such as soil and climate differs with agro-ecological zones, 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 performance in terms 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 such as financial and yield returns that a farmer expects to gain after the adoption.

Despite the demonstrated positive impacts of sustainable agriculture practices in terms of yield and financial returns, SAPs dissemination has been met with some resistance during the whole process of adoption (Chiputwa *et al.*, 2011). Where the adoption has been observed, not all components of SAPs have been adopted due to biophysical 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 adoption in Kilosa in terms of profit margin and its effect on the adoption behavior of smallholder's farmers to the adoption of SAPs, yet better knowledge of how profit margin affect adoption would help policymakers and researchers in designing more effective technologies that will be tailored to the needs of the farmers.

The main objective of the study was to determine the adoption level of sustainable agriculture practices and profitability margin for the adopters and non-adopters of SAPs in Kilosa District, Tanzania. In archiving the objectives, the information obtained would help to raise awareness among stakeholders especially policy makers and implementers on variables crucial for implementation of the adoption of sustainable agriculture practices and be able to design policies and strategies that enhance adoption of sustainable agriculture practices through use of profitability variables of agriculture practices.

II. METHODOLOGY

This study was conducted in Kilosa Districts in Morogoro Region, Tanzania. The location was selected because it's the potential maize producing district, moreover maize was chosen since it is the main crop promoted for food security in the District. Furthermore, 550 smallholder maize farmers from the village household register were chosen after a random sampling. This was a follow-up study to SIMLESA project to trace farmers who were exposed to SAPs in the study area. For the sampled household, the head or his representative was interviewed. The Gross Margin was used to compute the production costs against the revenue for the adopters and non-adopters of SAPs. Nevertheless, Gross margin was used for the analysis since it enables to compare the relative profitability of alternative cropping options that have similar land, machinery, and equipment requirements, it indicate the costs of production of alternative agriculture, which helps to make farm management decisions. It was useful in analyzing the performance of individual agriculture technology and discovers areas where one could possibly make improvements.

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 the adoption of sustainable agriculture practices in maize production, the following model was used:

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

The mathematical notation for calculating the Gross margin is given by the equation below:

$GM = P_i Y_i – R_i C_i$ .... (2)

Where:

GM = Gross margin
$P_i Y_i$ = Total revenue
$R_i C_i$ = Total variable cost
P_i = Farm price of maize produce
Y_i = Output of maize produce
R_i = Price of variable input used
C_i = Quantity of the variable input used (Kgs)
TVC = Total variable cost

$TVC = X_1 + X_2 + X_3 + X_4 + X_5 + X_6 + X_7$ .... (3)

Where: (values are in Tshillings)

X_1 = Cost of seedlings
X_2 = Cost of fertilizers
X_3 = Cost of labor
X_4 = Cost of transport
X_5 = Cost of herbicides
X_6 = Cost of pesticides
X7 = Other variable cost
Gross Margin = TR-TVC
Net Profit = GM–TFC

The difference of statistical means was used to test whether there is a significant difference in the net profit of adopters and non-adopters of SAPs farming system. It was tested thus:

$$T = \frac{X_i - X_j}{\sqrt{\frac{S_i}{n_i} + \frac{S_j}{n_j}}}$$

Where:

X_i = Mean net profit for the adopters
X_j = Mean net profit for the non-adopters
S_i = Sample variance for the adopter
S_j = Sample variance for the non-adopters
n_i = Number of adopters
n_j = Number of non-adopters

III. RESULTS AND DISCUSSION

Socio-Economic Characteristics of the Respondents

The socio-economic characteristics of smallholder's farmers presented under this section include: age, gender, marital status, educational level, main activities and household size.

Age of the respondents

The survey results for the adopters of SAPs indicate that, there was a small number of people engaged in farming activities at the age above 61 years (Table 1).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 1: Distribution of respondents by age

Age	%
21-30	7
31-40	29
41-50	46
51-60	17
61-70	1
Total	**100**

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 2). 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 2: Proportion of respondents by Gender

Sex	%
Males	52
Females	48
Total	**100**

Marital status of the respondents

The majority of respondents were married (50%) (Table 3) 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 marriages were mostly done when people have completed primary level education thus unmarried young men and women were generally low compared to the married ones. Hence the availability of labour was assured to undertake the adoption of SAPs in the study area.

Table 3: Distribution of respondents by marital status

Marital status	%
Single	23
Married	50
Widow	5
Separated	22
Total	100

Education level of the respondents

From the results in (Table 4), 78% of SAPs adopters had primary school education, 14% had secondary school education, 2% had university level education and 6% had no formal education. 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 4: Education level of the respondents

Education Level	%
No formal Education	6
Primary school	78
Secondary school	14
Beyond Secondary	2
Total	**100**

Main occupation of the respondents

From (Table 5) 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 low level of education hence become unable to get a sufficient job opportunity to invest more on activities relating to the adoption of SAPs in the study area.

Table 5: Distribution of respondents by their main occupation

Occupation	%
Self-Employment	90
Petty business	4
Carpentry	2
Employed	4
Total	**100**

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 large work force and were more likely to adopt new agricultural technologies.

Adoption Level of Sustainable Agriculture Practice among Small Holders Farmers

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

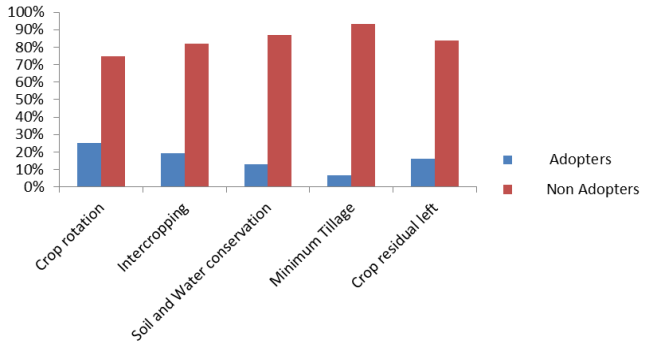

Figure 1: Adoption level of sustainable agriculture practices

(i) Crop rotation:

Smallholders' maize farmers had different combination of crops that were rotated once the main season was over including common beans and pigeon peas. However the findings from (Figure1) shows that, 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 was contributed by the effect of climate change on their farming activities, under such circumstances some of the crops weren't be able to cope with the changes that came along with the climate change such as inadequate rainfalls or drought.

Furthermore, Wollni (2010) argued that, 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: refers to one of the sustainable agriculture practices which is 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 to the majority of farmers who depends on rain-fed agriculture.

However, (Figure1) result shows that the adoption level was significantly low (19.2%) for the adopters compared to (81.8%) for the non-adopters. According to the interviewed extension agent, the reason for the low adoption was due to different soil characteristics in their farms which did not allow other crops to be grown, hence became a limiting factor to the farmers. Nevertheless, Lack of extension services in rural areas have played a significant role for the SAPs not to be fully adopted as farmers became unaware of the ongoing changes in techniques and information on the adoption of SAPs.

(iii) Soil and Water Conservation

Soil and water conservation methods have not been well known among smallholders' farmers in the rural areas (Figure1). 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 aren't delivering the information and advices 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 includes intensive tillage technique which changes the cover and structures of 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.

Furthermore the result from (Figure1) shows that, adoption rate was very low among small holder's farmers (6.7%) while (93.3%) did not adopt the technology. Kshirsagar (2002) reported that, the reason for the low adoption was 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 higher return in yield and income. Nevertheless, lack of extension services in the study area played a role to the low adoption rate due to lack of training, advice and information.
Table 6:

(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 have been used to conserve soil from being destructed by natural and manmade causes.

Nevertheless, adoption of the technology among smallholder's farmers was (16%), and the majority (84%) of the farmers did not adopt the technology. Lugandu (2013) argued that, the reason for the low adoption rate was due to the presence of conventional agriculture inputs such as chemicals, fertilizers which compensated the use crop residuals in other activities apart from conserving the environment. Many farmers didn't adopt 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 of large and medium size.

Table 7: The adoption level of sustainable agriculture practices

Adoption Level of SAPs package in Kilosa District

It was observed that 22% of the interviewed households in Kilosa districts were 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 reported 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 2.

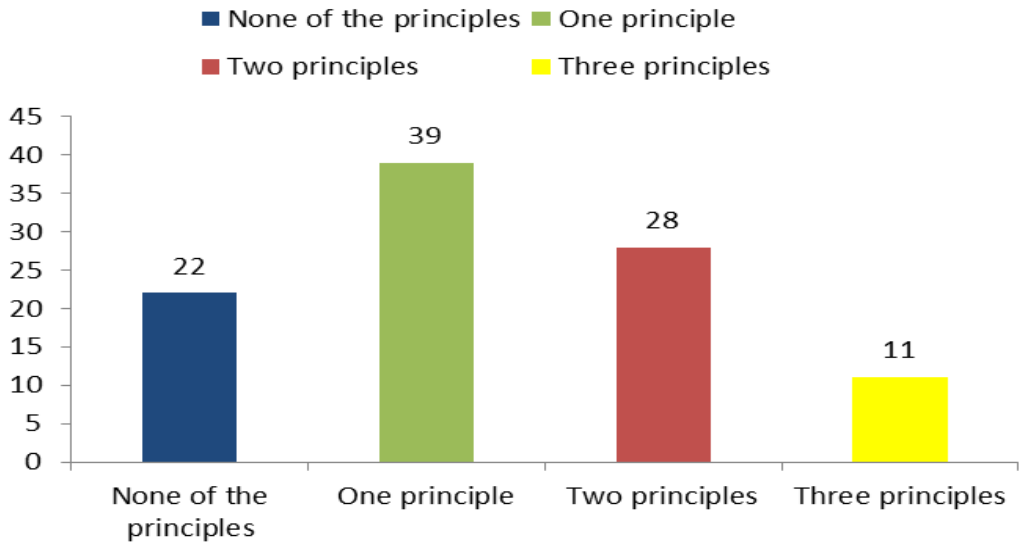

Figure 2: Adoption Level of SAPs package in Kilosa District

Adoption intensity of sustainable agriculture practices

The adoption intensity of the SAPs differs significantly (figure 3) as the proportionate area used for the adoption was very small compared to the area used by non-adopters, this was 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.

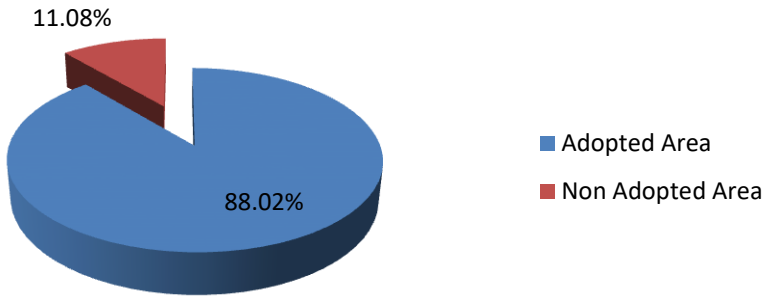

Figure 3: The adoption intensity of the SAP over the Land use

Profitability analysis for Adopters and Non-adopters

Table 6: 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	

A total of 550 respondents were used to analyze the objective of determining the profitability margin for the adopters and non-adopters of SAPs in maize farming. The SAPs average yields recorded 1680 kg and 2640 kg per Hectare for the non-adopters and adopters of fully packaged SAPs, respectively, which was equivalent to 14 and 22 bags of 120 kg, respectively as shown in Table 6. The result showed that adopters were better off in terms of yield and revenue as compared to the non-adopters of SAPs in Kilosa District as shown in Table 6.

The results indicated that once SAPs is applied along with other supporting factors such as extension agents and inputs, it could have a significant effect on 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 smallholders, 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 less gross margin per hectare of 563 675 Tshs as compared to adopters 634 200 Tshs for the adopters as shown in Table 6. 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. Nevertheless, the inadequacy of inputs and high prices attached to the inputs such as fertilizers and agrochemicals has contributed to the low adoption level of SAPs among smallholders maize farmers.

Previous studies on SAPs adaptation suggested that there is a positive correlation between SAPs and farm yield which implies that farm yields increase when SAPs is applied (Mazvimavi, 2011), the observations are is in line with the findings of this study. The possible explanation for the higher net benefits for adopter farmers could be that the smallholder's maize' farmers had fully embraced the SAP practices, and soils had regained their fertility.

The t-test of the difference of mean was used to determine the extent of the difference in the net profit/ha of the adopters and non-adopters. The average net farm income for adopters was significant ($p<0.05$), which shows that there is a significant difference between the net profit of the adopters and non-adopters (Table 7).

Table 7: T-Test of difference of mean among adopters and non-Adopters of SAPs

Categories	Mean	Standard Error	N	T-value	Sig.
Adopters	1.611795	0.13178	100	19.896**	0.05
Non-Adopters	1.02715	0.01131	450		

IV. CONCLUSION AND RECOMMENDATION

Adopters of SAPs recorded a relatively higher gross margin than their counterparts because of the practices employed to produce crops for the particular year. SAPs provided adopters with environmental and income benefits. Non adopters had not received a relatively beneficial package due to the inaccessibility to the necessary inputs, extension services, especially in rural areas. Nevertheless, non-adopters farmers perceived the use of chemicals methods (conventional) as one of the effective means to get the expected returns without considering the environmental disadvantages especially on the soil fertility which in long run may pose a threat to the production of crops in their farms.

The study concludes that adoption of sustainable agriculture practices should be fundamental for sustainable agriculture development as it significantly upgrade the community livelihood.

The economic profit of all principles of SAPs to adopters is only a fraction of the factors that influenced the adoption of SAPs. Ignoring the inclusion of social and environmental benefits analysis might create a false picture about the benefits of SAPs. 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 consideration of the various benefits of interventions for the promotion of SAPs could affect perception and hence the choice of SAPs farming practices.

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 profitable among smallholders maize farmers, the government should intervine in the most important areas of production such as infrastructures, inputs and extension services and try to make them accessible to the smallholders farmers at affordable price. The effect would help to facilitate the adoption process of SAPs among smallholders farmers and help them afford the necessary inputs for a successive adoption of SAPs.

Moreover, farmers should be encouraged to form groups, this would encourage them to learn from each other and have easy access to necessary inputs at affordable price.

Furthermore, Most of the farmers were not able to afford the necessary inputs for the adoption of SAPs due to the high prices attached to the farm inputs, the financial institutions should be established in rural areas and be of help to the smallholder's farmers by setting the interest rate low. This will allow farmers to purchase the required inputs for their farming activities.

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DECLARATION OF INTEREST

The author of this paper declare no any conflict of interest with any part.

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AUTHORS

First Author – Joseph Jovin Mugula, School of Agriculture Economics and Business Studies, Sokoine University of Agriculture (SUA) Address: P.O. Box 3007, Morogoro, Tanzania *mugulajr @gmail.com*

Second Author – Dr. Fulgence Mishili, Senior Lecturer, School of Agriculture Economics and Business Studies, Sokoine University of Agriculture (SUA) Address: P.O.Box 3007, Morogoro, Tanzania *fjmishili@yahoo.com*