Vol.13(4), pp. 232-242 October-December 2021
DOI: 10.5897/JAERD2021.1259
Articles Number: 509C16567969
ISSN: 2141-2170

http://www.academicjournals.org/JAERD

ACADEMIC JOURNALS

Journal of Agricultural Extension and Rural Development

Full Length Research Paper

Factors influencing smallholder farmers to participate in farmer-led research of agro-ecological practices in selected areas, Tanzania

Luambano Kihoma[1*], Ayubu J. Churi[2], Camilius A. Sanga[2] and Eugenio Tisselli[3]

[1]Department of Agricultural Extension and Community Development, College of Agriculture, "Sokoine University of Agriculture" (SUA) P. O. Box 3032, Morogoro, Tanzania.
[2]Centre for Information and Communication Technologies, SUA, P. O. Box 3218 Morogoro, Tanzania.
[3]Institute of Integrative Biology, Eidgenossische Technische Hochschule, Zurich, Switzerland.

Received 6 July 2021; Accepted 23 September2021

Declining crop productivity is a great challenge facing smallholder farmers in Tanzania. Agro-ecological practices can improve crop productivity in a sustainable way and produce healthy food among smallholder farmers. Initiation of "Farmer-Led Research of Agro-Ecological Practices" (FLRAG) may enhance farmers' capacities for innovation and co-develop suitable agro-ecological practices. This study aimed at identifying factors influencing smallholder farmers to participate in FLRAG. A cross-sectional survey was used to collect qualitative and quantitative data from 90 smallholder farmers in Mvomero, Bagamoyo and Masasi districts in Tanzania. Data were also collected from key informants who were extension officers. The study identified that experience in farming, easiness in accessing agro-ecological inputs, interest in doing experiments and farm size ownership are the factors that substantially influence smallholder farmers to participate in FLRAG. Therefore, researchers are advised to select participants of FLRAG by considering the mentioned factors. Furthermore, farmers selected to participate in FLRAG are advised to the use of ugunduzi app" that was developed purposefully to enhance agro-ecological research in order to test and understand its potential on smoothing agro-ecological research activities.

Key word: Smallholder farmers, crop productivity, sustainable farming, farmer-led research, agro-ecological practices, Ugunduzi App.

INTRODUCTION

Over the past decades, agriculture has remained the mainstay of economies of many developing countries (Africa Development Bank (ADB), 2018). In Tanzania, more than 65% of the population is engaged in agricultural activities, and most of them are smallholders who averagely owned 2.2 ha, constituting about 80% of total farms (Agricultural Sector Development Programme (ASDP) Phase II, 2017). However, declining crop

*Corresponding author. E-mail: luambanokihoma@gmail.com. Tel: +255 754 854 104.

productivity is a great challenge facing smallholder farmers in the country (Karugia et al., 2013; Mkonda and He, 2017). Soil fertility degradation is one of the key factors contributing to poor productivity performance among smallholder farmers (ASDP II, 2017). Global climate change crisis and poor use of agro-chemicals in agricultural production have been reported to increase severe loss of fertile soil nutrients in the country (Nonga et al., 2011; Adedeji et al., 2014; Lahr et al., 2016; International Center for Tropical Agriculture (CIAT) and World Bank, 2017; Mkonda and He, 2018). Therefore, there is a need to have alternative measures for sustainable land management to protect soil quality which may ultimately improve crop productivity among smallholder farmers.

It has been demonstrated by previous studies that agro-ecological initiatives are sustainable, socially and economically viable with healthier environment maintenance and good farming approaches (Wilbois and Schmidt, 2019: Kwiatkowski and Harasim, 2020; Tittonell et al., 2020). The Technologies not only protect soil nutrients to improve crop productivity but also produce nutritious food to the community (Altieri et al., 2017; Taghikhah et al., 2020; Wezel et al., 2020). Agro-ecological approaches use natural resources available in local areas for improving soil fertility, plant health and crop productivity. The technologies include organic crop fertilization, crop rotation, intercropping, mulching, cover crops, crop diversity, terraces, natural control of pests and diseases (Schoonhoven and Runhaar, 2018: Kwiatkowski and Harasim, 2020). However, most of the agro-ecological approaches originated from indigenous innovations which have given minimal or no attention to scientists, hence undocumented scientifically (Waters-Bayer et al., 2015; Tambo and Wunscher, 2017; Richardson et al., 2021). The situation impedes efforts of promoting agro-ecological practices as among alternative solutions to smallholder farmers which can increase crop productivity with sustainable land management (Agula et al., 2018; Chizallet et al., 2018; Pagliarino et al., 2020). To figure out this problem, the idea of involving farmers in research works in order to integrate local and scientific technological innovations which will be scientifically documented as recommended by Wettasinha et al. (2014), Kummer et al. (2017), Gaba and Bretagnolle (2020) and Tribaldos et al. (2020). Hence, promoting farmer-led research was designed deliberately to include farmers' ideas which will be formally recognized and disseminated (TWN and SOCLA, 2015; Vogl et al., 2015; Fioret et al., 2018).

Farmer-led research is a type of participatory research that is led by farmers in close collaboration with researchers (Fioret et al., 2018). It is a kind of research which aims to find out better technologies among many already recognized by farmers in their areas (Pimbert, 2011; Tambo and Wunscher, 2017; Richardson et al., 2021). It differs from other kinds of participatory research such as farmer-scientist research initiatives in which farmers and researchers jointly plan, implement, collect, analyse data and provide results (Fioret et al., 2018). Farmer-led research also differs from on-farm experiments in which farmers participate by being given material inputs and sometimes paid to carryout research on their fields (Pimbert, 2011; Kummer et al., 2017). In on-farm experiments, scientists initiate technologies and want to prove quality of their ideas from the real ground by involving farmers.

Farmer-led research is rooted from farmers' informal research in which all farm trials are initiated and carried out by farmers on their own (Tambo and Wunscher, 2017; Woodhouse et al., 2017; Hansson, 2019). However, in farmer-led research there is involvement of other agricultural actors. They include researchers, extension agents and donors for providing training, advisory services and other types of support if any, but all other research activities remain in the hands of the famers (Woodhouse et al., 2017; Fioret et al., 2018). For this study, the focus was farmer led research of agro-ecological practices. The idea was to promote local innovations identified by farmers within their areas.

The FLRAG not only provides an opportunity for farmers to be part in a formal research but also integrates agro-ecological approaches which most of them are farmers' knowledge based. The research promotes bottom-up approaches by upgrading farmers' innovations and experimentation aiming to improve soil fertility and pest control in sustainable ways with low costs (Vogl et al., 2015: Fioret et al., 2018; Pagliarino et al., 2020; Richardson et al., 2021). The identified technologies could be scientifically documented and disseminated widely through formal publications. Setting some criteria in selecting participants who will be involved in the investigation process is important for success of the exercise. Meaningful criteria depend on understanding the factors that may influence farmers to participate in research work. Therefore, this study was carried out to identify the factors that may influence smallholder farmers to participate in FLRAG. The aim was to assist researchers to identify committed participants who will participate in the investigation process to provide meaningful results. Furthermore, the results contributed to research findings of related studies. Policy makers may use the findings for developing conducive policies which can support and promote more FLRAG in Tanzania and probably elsewhere.

CONCEPTUAL FRAMEWORK

The conceptual framework of the study was developed from the literature reviewed. It was noted that there were several studies that have been conducted to identify factors that may influence farmers to participate in different kinds of agricultural research. Some of them

investigated sustainable farming and land management technologies (Jamilu et al., 2015; Thanh and Yapwattanaphuna, 2015; Vogl et al., 2015; Kummer et al., 2017; Schoonhoven and Runhaar, 2018; Sun et al., 2018; Liu et al., 2019), others looked into modern agricultural technologies (Etwire et al., 2013; Adesina and Favour, 2015; Mwangi and Kariuki, 2015; Akinmusola et al., 2016; Kummer et al., 2017; Nahayo et al., 2017; Sunny et al., 2018; Khoza et al., 2019; Murendo et al., 2019; Phali et al., 2020). These factors can be categorized in different ways depending on the purpose of the research, environmental conditions and preference of the researcher to particular topics (Mwangi and Kariuki, 2015; Schoonhoven and Runhaar, 2018).

For example, socioeconomic characteristics such as sex, age, education, personal interest of learning and experience in farming have been reported in numerous studies (Etwire et al., 2013; Adesina and Favour, 2015; Greiner, 2015; Jamilu et al., 2015; Thanh and Yapwattanaphuna, 2015; Akinmusola et al., 2016; Kummer et al., 2017; Nahayo et al., 2017; Sun et al., 2018; Sunny et al., 2018; Khoza et al., 2019; Liu et al., 2019; Murendo et al., 2019; Phali et al., 2020) and can be categorized as personal holding attributes. Other authors analysed economic issues such as farm size, land tenure, size of the household, costs of research, costs of technologies, access to loans and off-farm incomes (Etwire et al., 2013; Adesina and Favour, 2015; Jamilu et al., 2015; Akinmusola et al., 2016; Nahayo et al., 2017; Schoonhoven and Runhaar, 2018; Sun et al., 2018; Sunny et al., 2018; Liu et al., 2019; Murendo, et al., 2019; Phali et al., 2020).

Furthermore, some studies investigated into the technological perspectives which include availability of the technology, performance of the technology, suitability of the technology, environmental compatibility of the technology and distance to technological markets (Vogl et al., 2015; Murendo et al., 2019). The issues such as access to extension services, social group belonging, access to markets and access to information can be categorized as institutional factors which reported by Etwire et al. (2013); Jamilu et al. (2015); Mwangi and Kariuki (2015); Nahayo et al. (2017); Schoonhoven and Runhaar (2018) and Khoza et al. (2019). Physical factors such as climate issues which include high rainfall receiving and drought areas were also looked (Liu et al., 2019).

Although several studies had already been done before this study on identifying factors that could influence farmers to engage in research to investigate and adopt various agricultural technologies in other parts of the world, FLRAG has not been well investigated in Africa, Tanzania in particular. Therefore, this study was done in Tanzania to fill this gap using three selected districts of Tanzania. About 25 factors were identified from different papers reviewed. The mapping concept by Maxwell (2005) was used to merge and pull together related ones to have 13 factors which fit and tested for this study. The factors observed to share common themes were clustered in one category to form 3 different categories as indicated in Table 1. The merged and pulled together related factors which observed to share common themes to have 13 factors and categorize to form 3 categories as shown in Figure 1.

MATERIALS AND METHODS

The study was conducted in Mvomero, Bagamoyo and Masasi Districts in Tanzania. Presence of research projects promoting agro-ecological practices in all these three Districts was the main reason to select the areas as case studies. It was assumed that most of the smallholder farmers around these areas had a certain level of knowledge about agro-ecological practices. In Mvomero District there were research projects promoting agro-ecology, particularly Sustainable Agriculture Tanzania (SAT) and the Uluguru Mountains Agricultural Development Project (UMADEP) as it reported during this survey by key informant from Mvomero district, May, 2019. One project officer from Chambezi Project Research Centre (CPRC) on May, 2019 reported that, the centre in collaboration with “The Swiss foundation for development cooperation fund in Tanzania” (SWISSAID Tanzania), promotes agro-ecological practices in Bagamoyo District. Other report was from officer of SWISSAID Tanzania who said that, organization such as Tanzania Alliance for Biodiversity (TABIO), Tanzania Organic Agriculture Movement (TOAM), SWISSAID research and advocacy for agro-ecology and 9 local farmers’ agro-ecological organizations who supported by SWISSAID Tanzania were available in Masasi District.

Descriptions of the study areas

The study areas are located between latitudes 6°00 and 20°00 South of the Equator and between longitudes 36°00 and 39°00 East of the Greenwich. The weather conditions are tropical with an average annual temperature and rainfall of 26°C and 97.6 mm respectively (Tanzania National Bureau of Statistics (TNBS), 2016). According to the National Census of 2012 the population size of Mvomero District was 312,109, while the population of Bagamoyo District was 311,740 and that of Masasi District was 260,856 (United Republic of Tanzania (URT) report, 2013). The main economic activities of the people in these areas are agricultural activities, trade, livestock keeping, fishing, Mari culture, tourism and formal employment activities (TNBS, 2016).

Agro-ecological activities in the study areas

During a preliminary survey, it was observed that several research projects promoting agro-ecological practices were operating in the study areas as it was mentioned earlier. Furthermore, it was also observed that most of these projects were working as a team to provide knowledge of the practices. They were addressing training in agro-ecological methods, practical exercises and financial support to farmers via farmer groups. During the survey, key informant from Mvomero District in May, 2019 reported that, there were more than 224 farmer groups with about 2850 members in Mvomero who had received training on agro-ecological approaches. According to key informant from Masasi District who interviewed in May, 2019, he reported that, there were 217 farmer groups available in Masasi with about 3704 members in total who had received agro-ecological training. And for Bagamoyo District, a

Table 1. Developing conceptual framework.

Factors from literature reviewed	New merged factors	Category
Age	Age	Personal attributes
Education	Education	
Experience	Experience	
Sex	Sex	
Marital status		
Interest in learning	Knowledge	Economic factors
Interest of experimenting	Trials	
Land size ownership	Land size ownership	
Household size	Household size	
Market access	Availability of the markets, Price perception	
Land tenure		
Availability of inputs	Access to inputs	
Distance to inputs markets		
Environmental compatibility		
Off farm income		
Cost of technology	Production cost perception	
Research costs		
Technological performance		
Access to loan		
Climate conditions		
Access to extension services	Awareness	Information factors
Social group belonging		
Communication assets ownership		
Access to information		

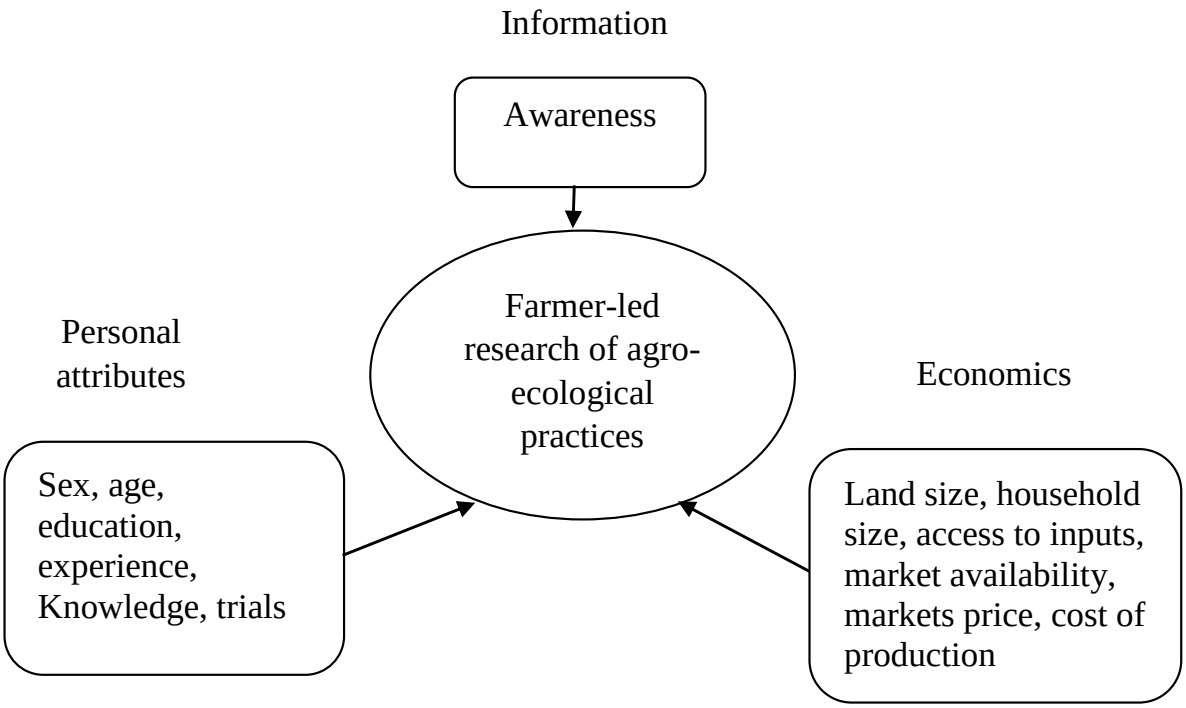

Figure 1. Conceptual framework of the study.

key informant from the district reported that, a total of 13 farmer groups with 272 members had received agro-ecological training in Bagamoyo.

The research projects were also encouraging farmers to carry out simple informal experiments to increase their level of understanding of the training. By 2018 most projects had started to promote FLRAG aimed to have scientific documentation of agro-ecological research results. According to key informants from all study areas who interviewed during this survey on which this paper is based, more than 20% of the smallholder farmers in all the study areas had started to participate in FLRAG. SWISSAID Tanzania went further by developing a mobile based application named *Ugunduzi* app aimed to support farmers in their agro-ecological research activities. The application was intended to help farmers in data collection, keeping farm records, analysing costs and benefits of the farms and sharing information in the form of pictures and voice messages. During the time of this survey, the application was in the process of being tested by farmers on the ground.

Study population

The study population was smallholder farmers who belonged to farmer groups. According to key informants who interviewed during this survey from study areas, they reported that, in Mvomero there were 224 farmer groups which had more than 2850 members; in Masasi there were 217 farmer groups which had more than 3704 members; and there were 13 farmer groups with 272 and above members in Bagamoyo.

Research design and sampling technique

Cross-sectional research design was used in the study. The design allows qualitative and quantitative data to be collected at one point in time (Babbie, 1990). Purposeful and simple random sampling techniques were used in the study. In each study area, one ward was purposefully selected to have three wards. A ward having a large number of farmer groups was the main factor used to be selected. It was assumed that, large number of groups provided the possibility for more farmers in the respective ward to receive agro-ecological training and practical exercises. After wards selection, identification of smallholder farmers who belonged to farmer group from selected wards was done through agro-ecological projects training officers and from farmer groups' leaders. Smallholder farmers who participated in FLRAG and those who did not were also identified in order to select participants from these two groups. Simple random sampling technique was used to pick 30 farmers from each selected ward, including 15 who were participating in FLRAG and 15 who were not. Therefore a total of 90 respondents from three wards were selected. According to Robin (1998), for a study facing budgetary and other resource constraints such as time, space and energy, a sample size of 30 and above is enough. By considering available resources including time and money, only 90 respondents were used as the sample for this study to represent the targeted population. Targeted population of this study were smallholder farmers who belonged to different farmer groups within study areas.

Data collection

A structured questionnaire was developed and used for collecting quantitative data. The questionnaire was pre-tested, and modifications were made according to the context of the research before conducting the actual survey. Individual interviews were conducted to collect primary quantitative data. For qualitative data collection, guideline questions were developed and face to face interview was used to collect the data from individual farmer and from key informants. Data from farmers were also collected through focus group discussions, in which three cases focus group discussions, one in each study area with 6 to 7 smallholder farmers, were carried out. The discussion aimed to understand in detail if the farmers had some knowledge concerning agro ecological approaches, including their knowledge about influence of participating and not participating in FLRAG. From key informants such as extension officers, farmers' group leaders and research projects officers, data were collected through individual interviews. The aim was to understand availability of projects dealing with promoting agro-ecological practices within the study areas and how they operated on providing knowledge to farmers. The information was aimed to provide a clear picture which could help in selecting study participants. Secondary data were collected from different sources of information such as libraries, internet and from agro-ecological reports from different civil society organisations and government agricultural centres. Moreover, secondary data were collected to get historical perspectives of the farmers and their environment within the study areas and knowledge concerning agro-ecological practices.

Data analysis

Qualitative data collected were analysed by using content analysis. Statistical package of Social Sciences (SPSS) programme was used to analyse quantitative data. Descriptive statistics were employed to explain frequencies and percentages of quantitative variables. Binary Logit Model was used to determine influence of some factors on smallholder farmers' participation in FLRAG. Logistic regression models are used to analyse relationships between a dependent and one or more independent variables by estimating probabilities using a logistic function (Abonazel & Ibrahim, 2018). Binary logit model is appropriate when the response takes one of only two possible values representing success and failure of an attribute of interest (Abedin et al., 2016). For this study participation in FLRAG is the dependent variable "Y" which takes only one response of either participating, a success response or non-participating, a failure response from 13 explanatory variables "X_1 to X_{13}". Success takes 1 value and failure takes 0 value. It explained using Rodríguez (2007) equation below.

$$Y_i = \begin{cases} 1 \text{ If participating in farmer-led research of agro-ecological practices} \\ 0 \text{ If not participating in farmer-led research of agro-ecological practices} \end{cases}$$

X_1 to X13 = Explanatory variables,

According to Abdulqader (2017) the formulation of the equation was as follows:

Let p = Probability of Success

$$Y = \frac{p}{1-p}$$

The ratio is called odds ratio

This quantity will increase with the value of x, ranging from zero to infinity

The quantity $\ln\left(\frac{p}{1-p}\right)$ is called the log odds ratio

Assumes the log odds ratio is linearly related to x.

$$\ln\left(\frac{p}{1-p}\right) = \beta_0 + \beta_1 x$$

$$\frac{p}{1-p} = e^{\beta_0 + \beta_1 x}$$

Therefore, for this study;

$$Y = \ln \frac{p}{1-p} = b_o + b_1X_1 + b_2X_2 + b_3X_3 + ...+ b_{13}X_{13}$$

Where,

x_1 to x_{13} = Indicate the predictor variables, for instance X_1 is Age, X_2, Sex, X_3 Education, X_4 Experience in farming, X_5 Household size, X_6 Awareness of FLRAG, X_7 Land farm size ownership, X_8 Accessing agro-ecological inputs, X_9 Farming production costs, X_{10} Trials after receiving knowledge, X_{11} Agro-ecological knowledge, X_{12} Agro-ecological products market availability and X_{13} is Price perception of the products, b_o = intercept and b_1 to b_{13} are the slope parameters in the model.

No assumptions of normality, linearity, and homogeneity of variance for the independent variables are required in the logistic regression. Standard errors are used to examine and detect the multicollinearity problem (Abedin et al., 2016; Abdulqader, 2017).

Definitions of variables

One dichotomous dependent variable of either participate or not participate in FLRAG was measured. The value of 1 was for those who participated and 0 for those who did not participate in FLRAG. For the purpose of this study, 13 independent variables were used as predictors, 9 of which were dummy variables and 4 were continuous variables. Table 2 provides a description of the predictor dummy variables. For continuous variables, emphasis was unit's measured and hypothetical perception (Table 3).

RESULTS

Descriptive statistics of explanatory dummy variables

Out of the 90 smallholder farmers who were interviewed, 46.7% were male and 53.3% were female. Concerning education, 87.8% of the respondents had received only basic education and below. On agro-ecological knowledge acquisition, it was found that 100% of respondents interviewed in this study had some knowledge on the practices. About 87.8% had received training on agro-ecological practices from projects which were promoting agro-ecological practices within their areas and 12.2% had acquired knowledge of agro-ecological practices from other sources such as leaders of their groups and from their fellow farmers. It was also found that more than a half (53.3%) who had knowledge of agro-ecological practices which they had acquired from whatever source had tried to experiment the practices on their farms.

Furthermore, from focus group discussions with farmers, it was found that agro-ecological approaches such as crop rotation, intercropping, cover cropping, applying organic fertilizer, mulching, applying natural pesticides like ash, aloe-vera and neem's had been being practised by farmers before training from the projects. In discussion with the participants, they reported that in 2018, most research projects dealing with agro-ecological practices within their areas started to promote FLRAG. During the survey, 58.9% of the respondents were aware of the research. Furthermore, 54.4% of the respondents said that they could easily access agro-ecological inputs. Concerning production costs, 42.2% of the respondents perceived that producing using agro-ecological approaches production costs is low, but the rest 57.8% said that production cost could be high especially on accessing inputs such as farmyard manure. About 30% of the respondents said that markets for agro-ecological products were there, and 41.1% said that price of the products was high (Table 4).

Factors influencing smallholder farmers to participate in FLRAG

Results from the binary logistic regression model demonstrated that the variables trials after receiving knowledge and access to agro-ecological inputs had shown strongly statistically significant influence on participation in FLRAG at 1% level of significance ($P<0.01$). Experience in farming and farm size ownership indicated significance influence for smallholder farmers to participate in farmer-led research of agro-ecological practices at 5% level ($P<0.05$). Furthermore, the variables farming production costs perception and education level of the respondent had shown slightly significant at 10% level of significance ($P<0.1$).

On the other hand, the variable experience in farming showed statistically significant influence with a negative coefficient. Negative coefficient effect means that the group of respondents on a particular variable which was given less chances to influence, scored more chances to influence. In this study it means that, the prediction was given high chances to the group of farmers who spend much time on farming to participate in FLRAG than the other group, but the results showed that the group of farmers who spend less time in farming had higher chances to participate in FLRAG. The same was with educational level; smallholder farmers who had lower level of education were given higher chances to participate in FLRAG than those with higher education. But the results indicated that farmers with higher level of education could participate in FLRAG with slightly significant influence. Furthermore, the results from the model indicated that Nagelkerke R^2 was equal to 0.647 meaning that the independent variables entered in the model had the capacity of predicting their influence to the dependent variable by 64.7% (Table 5).

DISCUSSION

From the model results, it was observed that smallholder farmers who used much of their time in farming activities had lower chances to participate in FLRAG than farmers who spend less time on farming. The results may imply that, as farmers increase spending time on farming activities, there is a possibility of conducting many trials, therefore the utility of finding new technologies may decrease. The results are in line with Nahayo et al. (2017) and Murendo et al. (2019) who reported the same.

Table 2. Summary of the predictor dummy variables.

Dependent variable	Predictor variable	Description of predictor variables	Dummy	Value given
Participation of farmer-led research of agro-ecological practices	Sex	Male respondent	Male	1
		Female respondent	Female	0
	Education	Who received only basic education and below	Low level of education	1
		Who received secondary education and above	High level of education	0
	Source of agro-ecological knowledge received	Who received agro-ecological practices knowledge from projects	Project knowledge receivers	1
		Who received agro-ecological practices knowledge from other sources	Other sources knowledge receivers	0
	Trials after receiving agro-ecological knowledge	Who tried to experiment after receiving knowledge	Tried	1
		Who didn't tried to experiment after receiving knowledge	Not tried	0
	Awareness of FLRAG	Who were aware on FLRAG	Aware	1
		Who were not aware on FLRAG	Not aware	0
	Accessing agro-ecological inputs	Who can easily access agro-ecological inputs	Accessible	1
		Who get difficulty in accessing agro-ecological inputs	Difficulties	0
	Farming production costs	Who perceive agro-ecological production cost is low.	Low cost perceivers	1
		Who perceive agro-ecological production cost is high.	High cost perceivers	0
	Agro-ecological products market availability	Who reported markets of agro-ecological products are available.	Market available	1
		Who reported markets of agro-ecological products are not available.	Market not available	0
	Price perception of agro-ecological products	Who perceive price of agro-ecological products is high.	High price	1
		Who perceive price of agro-ecological products is normal.	Normal price	0

Table 3. Explanatory continuous variables.

Variable	Unit measured in	Hypothesis
Age	Years	+
Experience	Years	+
Household size	Number	+
Land farm size ownership	Acre	+

Table 4. Descriptive statistics of explanatory dummy variables.

Variable	Response	Frequency	Percentage
Sex	Female	48	53.3
	Male	42	46.7
Education	Low level education	79	87.8
	High level education	11	12.2
Source of agro-ecological knowledge	Project source knowledge receivers	79	87.8
	Non project source knowledge receivers	11	12.2
Trials after receiving agro-ecological knowledge	Tried	48	53.3
	Not tried	42	46.7
Awareness of FLRAG	Aware	53	58.9
	Not aware	37	41.1
Accessing agro-ecological inputs	Accessible	49	54.4
	Difficulties	41	45.6
Agro-ecological farming production costs	Low cost perceivers	42	46.7
	High cost perceivers	48	53.3
Agro-ecological products market availability	Available	27	30
	Not available	63	70
Price perception of agro-ecological products	High	37	41.1
	Normal	53	58.9

Data from survey result of 2019.

Table 5. Factors influencing smallholder farmers to participate in FLRAG.

Variable	Coefficient	S.E.	Wald	P-value	Exp (B)
Age	-0.041	0.040	1.039	0.308	0.960
Sex	-0.737	0.804	0.841	0.359	0.478
Household size	0.086	0.188	0.212	0.645	1.090
Experience in farming	-0.119	0.055	4.758	0.029**	0.888
Agro-ecology knowledge	-1.442	1.118	1.663	0.197	0.237
Trial after receiving agro-ecological knowledge	3.324	.965	11.875	0.001***	27.783
Access to agro-ecological inputs	3.080	.929	10.998	0.001***	21.752
Farm size ownership	.432	.167	6.676	0.010**	1.541
Agro-ecological products markets availability	-1.096	.846	1.679	0.195	0.334
Agro-ecological products price perception	-0.170	0.725	0.055	0.815	0.844
Awareness of FLRAG	0.237	0.739	0.103	0.749	1.267
Farming production cost	1.657	0.929	3.182	0.074*	5.242
Education level	-2.342	1.258	3.469	0.063*	0.096
Constant	2.341	2.495	0.880	0.348	10.395

Data from survey result of 2019. Nagelkerke R Square = 0.647, -2 Log likelihood = 64.99, Chi-square = 59.773, *** = 1% level of significance, ** = 5% level of significance and * = 10% level of significance.

However, the result contradicted with Adesina and Favour (2015) and Akinmusola et al. (2016) who reported that, farmers who had more years of farming activities are more likely to participate in agricultural research to gain

more knowledge. From the model results, it was also observed that farmers who were interested in conducting trials after receiving knowledge had shown statistically significant to participate in FLRAG than their counterparts. This implies that having positive personal driven behaviour of finding development individual has, it could be easier for such kind of person to contribute by acting towards achieving the development including farming activities than people who lack of that behaviour. The result concurred with the findings reported by Thanh and Yapwattanaphuna (2015), Vogl et al. (2015) and Kummer et al. (2017).

Furthermore, it was revealed from the model result that, farmers who can easily access agro-ecological inputs are more likely to participate in FLRAG than their counterparts. This indicates that availability of the technologies encourages farmers to act positively towards achieving agricultural development activities. The results correlated with that obtained by Vogl et al. (2015) and Murendo et al. (2019) who reported the same. On the other hand, large farm landowners showed significant influence to participate in FLRAG than small farm landowners. This means that the more the capacity of owning a big land farm, the more the capacity of being ready to use some of it for other development issues. It could be easier for a farmer who has large land for farming to use some of it for research purpose while continuing with normal production. For small farm landowners, it could be hard decision to use small land they have for trials. The findings correlated by those of Adesina and Favour (2015), Jamilu et al. (2015), Thanh and Yapwattanaphuna (2015), Kummer et al. (2017), Nahayo et al. (2017) and Murendo et al. (2019).

Result from the model also indicated that, there was slightly significance influence for smallholder farmers who have high level of education to participate in FLRAG than their counterpart. This may indicates that, as farmer gets more knowledge the utility of finding more new knowledge of different aspects including farming knowledge may also increases. The same findings also reported by Etwire et al. (2013), Kummer et al. (2017) and Khoza et al., (2019). However, the result contradicted with the findings reported by Jamilu et al. (2015) who said that, as farmer being more educated the probability of participating in agricultural research activities is going down. Another result from the model showed that, there was slightly significance influence for smallholder farmers who perceive producing using agro-ecological practices the production cost could be low, to participate in FLRAG. This could imply that, costless technologies are more preferable by smallholder farmers to improve their livelihood.

CONCLUSION AND RECOMMENDATIONS

The study findings identified that, less experience in farming, farmers' interest of conducting research, easiness in accessing agro-ecological inputs, land farm size ownership, Education level farmers has and low production cost perception of producing using agro-ecological practices are the factors that influence smallholder farmers to participate in FLRAG. Therefore, in planning FLRAG, researchers should be advised to consider the mentioned factors in setting criteria of selecting participants. It is also advised that selected participants should use the *ugunduzi* app which was developed purposefully to enhance agro-ecological practices to understand its potential for supporting farmers and smallholder farmers in particular to smooth their research activities.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

ACKNOWLEDGEMENT

We express our sincere thanks to SWISSAID Tanzania for funding and supporting this study. We are also grateful to Sokoine University of Agriculture (SUA), the Swiss Federal Institute of Technology (ETHZ) and Sustainable Agriculture Tanzania (SAT) for their valuable support to make this study a success.

REFERENCES

Abdulqader QM (2017). Applying the Binary Logistic Regression Analysis on the Medical Data. Science Journal of University of Zakho 5(4):330-334.

Abedin T, Chowdhury Z, Afzal AR, Yeasmin F, Turin TC (2016). Application of Binary Logistic Regression in Clinical Research. Journal of National Heart Foundation of Bangladesh 5:8-11.

Abonazel MR, Ibrahim MG (2018). On Estimation Methods for Binary Logistic Regression Model with Missing Values. International Journal of Mathematics and Computational Science 4(3):79-85.

Adedeji O, Reuben O, Olatoye O (2014). Global Climate Change. Journal of Geoscience and Environment Protection 2:114-122.

Adesina TK, Favour E (2015). Determinants of Participation in Youth-in-Agriculture Programme in Ondo State, Nigeria. Journal of Agricultural Extension 20(10):104-117.

Africa Development Bank (ADB) (2018). East Africa Economic Outlook. Africa Development Bank Group. Abidjan, Côte d'Ivoire, 32p.

Agricultural Sector Development Programme Phase II (ASDP) (2017). Agricultural Sector for Industrial Development. National Coordination Unit, Dodoma, Tanzania, 25p.

Agula C, Akudugu MA, Dittoh S, Mabe FN (2018). Promoting sustainable agriculture in Africa through ecosystem-based farm management practices: evidence from Ghana. Journal of Agriculture and Food Security 7(5):1-11.

Akinmusola O, Soyebo KO, Farinde AJ, Amujoyegbe BJ, Latifou I, Gaya H, Fatunbi O, Ilesanmi RY (2016). Determinants of Cocoa Farmer's Participation in the Innovation Platform of the humid tropics Programme in Southwestern Nigeria. International Journal of Environmental and Agriculture Research 2(11):1-11.

Altieri MA, Nicholls CI, Montalba R (2017). Technological Approaches to Sustainable Agriculture at a Crossroads: An Agro ecological Perspective. Journal of Sustainability 9(3):349.

Babbie ER (1990). Survey Research Methods. 2nd Edn. Belmont,

California: Wadsworth Publishing 395 p.
Chizallet M, Barcellini F, Prost L (2018). Supporting farmers' management of change towards agro-ecological practices by focusing on their work: a contribution of ergonomics. Journal of Cahiers Agricultures 27:1-10.
Etwire PM, Dogbe W, Wiredu AN, Martey E, Etwire E, Owusu RK, Wahaga E (2013). Factors Influencing Farmer's Participation in Agricultural Projects: The case of the Agricultural Value Chain Mentorship Project in the Northern Region of Ghana. Journal of Economics and Sustainable Development 4(10):36-43.
Fioret C, Johnson K, Lam S, Thompson M, Hargreaves SK (2018). Towards Farmer-Led Research: A Guidebook. Ecological Farmers Association of Ontario, Guelph, Ontario 25 p.
Gaba S, Bretagnolle V (2020). Social–ecological experiments to foster agro ecological transition. Journal of People and Nature 2:317-327.
Greiner R (2015). Factors influencing farmers' participation in contractual biodiversity conservation: a choice experiment with northern Australian pastoralists. Australian Journal of Agricultural and Resource Economics 60(1):1-21
Hansson SO (2019). Farmers' experiments and scientific methodology. European Journal for Philosophy of Science 9:1-23
International Center for Tropical Agriculture, World Bank (2017). Climate-Smart Agriculture in Tanzania. Country Profiles for Africa Series. International Center for Tropical Agriculture (CIAT); World Bank, Washington, D.C. 25 p.
Jamilu AA, Atala TK, Akpoko JG, Sanni SA (2015). Factors Influencing Smallholder Farmers Participation in IFAD-Community Based Agricultural and Rural Development Project in Katsina State. Journal of Agricultural Extension 19(2):93-105
Karugia J, Massawe S, Guthiga P, Macharia E (2013). Agricultural Productivity in EAC Region (1965-2010): Trends and Determinants. In: International Symposium and Exhibition on the Agricultural Development in the EAC Partner States at the 50 Years of Independence. 4 – 8 November 2013, Kampala, Uganda 38 p.
Khoza TM, Senyolo GM, Mmbengwa VM, Soundy P (2019). Socioeconomic factors influencing smallholder farmers' decision to participate in agro-processing industry in Gauteng province, South Africa. Journal of Cogent Social Sciences 5(1):1-14.
Kummer S, Leitgeb F, Vogl RC (2017). Farmers' Own Research: Organic Farmers' Experiments in Austria and Implications for Agricultural Innovation Systems. Journal of Sustainable Agriculture Research 6(1):103-119.
Kwiatkowski CA, Harasim E (2020). Chemical Properties of Soil in Four-Field Crop Rotations under Organic and Conventional Farming Systems. Journal of Agronomy 10:1-16.
Lahr J, Buij R, Katagira F, Van der Valk H (2016). Pesticides in the Southern Agricultural Growth Corridor of Tanzania (SAGCOT): A scoping study of current and future use, associated risks and identification of actions for risk mitigation. Wageningen Environmental Research, Wageningen, Netherlands 72 p.
Liu T, Bruins RJF, Matthew T, Heberling MT (2019). Factors Influencing Farmers' Adoption of Best Management Practices: A Review and Synthesis. Journal of Sustainability 10(2):1-31.
Maxwell JA (2005). Qualitative Research Design, An interactive approach: Second Edn. Chapter three: Conceptual framework: What do you think is going on? Sage Publications, Pub place - Thousand Oaks, California 31 p.
Mkonda MY, He X (2017). Yields of the Major Food Crops: Implications to Food Security and Policy in Tanzania's Semi-Arid Agro-Ecological Zone. Journal of Sustainability 9(8):1490.
Mkonda MY, He X (2018). Climate variability and crop yields synergies in Tanzania's semiarid agro ecological zone. Journal of Ecosystem Health and Sustainability 10:1-14.
Murendo C, Gwara S, Mpofu N, Pedzisa T, Mazvimavi K, Chivenge P (2019). The adoption of a portfolio of sustainable agricultural practices by smallholder farmers in Zimbabwe. In The 5th International Conference of the African Association of Agricultural Economists. September 23 – 26 Addis Ababa, Ethiopia pp. 1-16.
Mwangi M, Kariuki S (2015). Factors Determining Adoption of New Agricultural Technology by Smallholder Farmers in Developing Countries. Journal of Economics and Sustainable Development 6(5):207-217.
Nahayo A, Omondi MO, Xu-hui Z, Lian-qing L, Gen-xing P, Joseph S (2017). Factors influencing farmers' participation in crop intensification program in Rwanda. Journal of Integrative Agriculture 16(6):1406-1416
Nonga HE, Mdegela RH, Lie E, Sandvik M, Skaare JU (2011). Assessment of farming practices and uses of agrochemicals in Lake Manyara basin, Tanzania. African Journal of Agricultural Research 6(10):2216-2230.
Pagliarino E, Orlando F, Vaglia V, Rolfo S, Bocchi S (2020). Participatory research for sustainable agriculture: the case of the Italian agro ecological rice network. European Journal of Futures Research 8(7):1-16.
Phali L, Mudhara M, Ferrer S, Makombe G (2020). Determinants of Farmers' Participation in the Management of Smallholder Irrigation Schemes in Kwazulu-Natal Province, South Africa. Journal of Economics and Behavioral Studies 12(6):21-32.
Pimbert M (2011). Participatory Research and On-Farm Management of Agricultural Biodiversity in Europe. International Institute for Environment and Development, London, United Kingdom 80pp
Richardson M, Coe R, Descheemaeker K, Haussmann B, Wellard K, Moore M, Cady J M, Gubbels P, Tchuwa F, Rodrigo PY, Nelson R (2021). Farmer research networks in principle and practice. International Journal of Agricultural Sustainability 10:1-18.
Robin H (1998). What Sample Size is "Enough" In Internet survey Research? Interpersonal Computing and Technology: An Electronic Journal for the 21st Century 6(3):1-10.
Rodríguez G (2007). Lecture Notes on Generalized Linear Models. Chapter 3 Logit Models for Binary Data. Princeton University URL: https://pdf4pro.com/view/logit-models-for-binary-data-132287.html
Schoonhoven Y, Runhaar H (2018). Conditions for the adoption of agro-ecological farming practices: a holistic framework illustrated with the case of almond farming in Andalusia. International Journal of Agricultural Sustainability 16(6):442-454
Sun X, Zhang Z, Zhang Y (2018). Factors Influencing Farmer's Decision-Making Behavior on Rural Construction Land Transformation. Journal of Sustainability 10:1-17.
Sunny FS, Huang Z, Karimanzira TTP (2018). Investigating Key Factors Influencing Farming Decisions Based on Soil Testing and Fertilizer Recommendation Facilities: A Case Study on Rural Bangladesh. Journal of Sustainability 10(11):4331.
Taghikhah F, Voinova A, Shuklaa N, Filatova T (2020). Exploring consumer behavior and policy options in organic food adoption: Insights from the Australian wine sector. Journal of Environmental Science and Policy 109:116-124.
Tambo JA, Wunscher T (2017). Farmer-led innovations and rural household welfare: Evidence from Ghana. Journal of Rural Studies 55:263-274.
Tanzania National Bureau of Statistics (TNBS) (2016). Regional Profiles for Basic Demographic and Socio-Economic Profiles. Ministry of Finance Dar es Salaam, Tanzania 31 p.
Thanh VN, Yapwattanaphuna C (2015). Banana Farmers' Adoption of Sustainable Agriculture Practices in the Vietnam Uplands: the Case of Quang Tri Province. Journal of Agriculture and Agricultural Science Procedia 5:67-74.
Tittonell P, Piñeiro G, Lucas A. Garibaldi LA, Dogliotti S, Olff H, Jobbagy EG (2020). Agro ecology in Large Scale Farming: A Research Agenda. Journal of Frontiers in Sustainable Food Systems 4:214.
Tribaldos T, Oberlack C, Schneider F (2020). Impact through participatory research approaches: an archetype analysis. Journal of Ecology and Society 25(3):1-25.
Vogl RC, Kummer S, Leitgeb F, Schunko C, Aigner M (2015). Keeping the Actors in the Organic System Learning: The Role of Organic Farmers' Experiments. Journal of Sustainable Agriculture Research 4(3):140-148.
Waters-Bayer A, Kristjanson P, Wettasinha C, Van-Veldhuizen L, Gabriela QG, Kees Swaans K, Douthwaite B (2015). Exploring the impact of farmer-led research supported by civil society organizations. Journal of Agriculture and Food Security 4(4):1-7.
Wezel A, Herren BG, Kerr RB, Barrios E, Gonçalves ALR, Sinclair F (2020). Agro ecological principles and elements and their implications for transitioning to sustainable food systems. A review. Journal of

Agronomy for Sustainable Development 40(40):1-13.
Wilbois KP, Schmidt JE (2019). Reframing the Debate Surrounding the Yield Gap between Organic and Conventional Farming. Journal of Agronomy 9(82):1-16.
Woodhouse P, Veldwisch GJ, Venot JP, Brockington D, Komakech H, Manjichi A (2017). African farmer-led irrigation development: re-framing agricultural policy and investment? The Journal of Peasant Studies 44(1):213-233.