International Journal of Scientific Research in Multidisciplinary Studies
Vol.5, Issue.11, pp.72-79, November (2019)
Research Paper
E-ISSN: 2454-9312
P-ISSN: 2454-6143

Determinants of Smallholder Maize Farmer's Extent of Adoption of Modern Farming Practices in Kukhanyeni Constituency of Eswatini

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Available online at: www.isroset.org

Received: 12/Nov/2019, Accepted: 20/Nov/2019, Online: 30/Nov/2019

Abstract-Eswatini still import maize from the neighbouring countries to supplement its internal demand, whereas it has potential of being self-sufficient in this staple food. The government and others stakeholders have introduced new technologies to improve productivity but their effects are not yet known. Therefore, this study aimed at analysing the effects of new farming practices on rural smallholder dry maize productivity. The results of this study indicate that the average age of the farmers was 41 years, with mean years in school of 10, mean farming experience of 15 years, average household size of 10 people, average land size of 2.44 hectares and average farm maize output of 1117.1 Kgs/ha. Interviewed farmers were mostly male (60%) and married (66%). The most adopted new farming practices used by smallholder farmers were tractor drawn (86%), used hybrid seeds (79%), mono-cropping (73%), agro-chemical use in controlling pests (71%), and liming (61%). The farmers were still using hand hoe for weeding and dependent on rainfall. Factors influencing maize farmer's productivity were farmer's age, cropping system, liming and use of irrigation. Determinants of farmers' adoption to agricultural modern technologies in maize production included farmer's age, marital status, access to extension services, membership to a farmer cooperative and maize yields. This study concludes that older smallholder farmers, practicing mono-cropping and use liming in their fields are more likely to harvest low yields though can improve their yields with increased irrigation. Furthermore, extension workers and other farmer service providers should note that older farmers, receiving more extension services and members of cooperative groups are less likely to adopt modern farming technologies while married farmers with relatively higher maize yields are more likely to adopt more modern farming technologies. The study recommends that stakeholders should develop programs that attract youth in farming, and train them in proper use of mono-cropping system, and liming while investing in establishing more irrigation schemes.

Keywords- Modern farming practices, Maize, Productivity, Smallholder farmers, Kingdom of Eswatini

I. INTRODUCTION

In the Kingdom of Eswatini, agriculture is still regarded an important contributor to the national economic development especially amongst the rural communities. It provides raw materials and source of employment to a large Eswatini population, therefore a best incentive for boosting incomes of the rural poverty stricken communities [1]. According to Eswatini Economy Profile (EEP) (2018) agriculture contributes 6.5% of the Gross Domestic Product (GDP) and the small-scale agriculture employs about 70 % of the population [2]. The major agricultural related enterprises in the country include production of sugar, beef production and canned fruit exports moreover vegetables, tuber and squash among others. Maize as a staple food crop remains vital in nutritional and income generating sources among the majority of small-scale farmer households. The country's agricultural sector is facing numerous agricultural problems which include climate change, high transaction cost, inefficient supporting programmes for instance unorganized small-scale farmers, lack of information and access to markets and lack of innovation in agricultural sector like ineffective technological transfer. In addition, agricultural sector faces poor property right and lack of privatisation. Moreover, numerous efforts are implemented to revitalize the tradition poor technology agriculture from low productivity to modernised agricultural commercialization [3].

The Eswatini average maize yields are estimated at 4.42 tonnes/ha produced on the Swazi Nation Land [4]. With relatively good farming practices, estimated yields of grain maize is 6-7 tonnes/ha. Therefore, adoptions of new technologies are important for farmers to reduce the gap in productivity of maize. There are numerous factors that hinder farmers to reach their potential productivity. Dlamini *et al.* (2012) concluded that problem faced by maize farmers are low rainfall, high temperatures, delayed ploughing, lack of income ,high cost of fertilizer and herbicide's and poor National Maize Corporation (NMC) pricing system [5]. Smallholder farmers in Eswatini are not different from elsewhere in Africa and other poor communities across the globe. This category of farmers is characterised by owning small plots of land, field crops like maize intercropped with pumpkins and some varieties of legumes for subsistence purposes using household labour [6]. They depend on rainfall to water their crops, use hand hoes and other traditional tools to cultivate, and in most cases use kraal manure and other to improve their fertility according [7].

Oladele and Fawole (2007) defined traditional farming methods as a primitive farming practice where production of crops is not dependent on any formal knowledge of farming but only based on indigenous farming knowledge passed from generation to generation through careful observation [8]. Traditional farming practices is a widely used techniques consist of monoculture of often traditional maize varieties, low nitrogen application rates, less or no irrigation, removal of crop residues for animal feed and little or no use of herbicides and pesticides. According to Mkhabela (2006), intercropping is practiced to minimize total crop failure [9]. Labour is provided by family labour for farming processes such as weeding and harvesting by women and children, women basically carrying out most of the farming activities and men has a majority percentage in the land ownership status [10]. This farming practice tillage is done by hoes to ox drawn implements and post-harvest is stored in containers and mud tanks and wood ash and smoke is the method for grain pest and insect control. Modern agriculture mainly focuses on resource exploitation, energy exploration, production enhancement and profit maximization. It covers all the advancements applied in agriculture to increase per unit production of food through well-developed farm mechanisation, well developed irrigation equipment, and use of carefully developed seeds and agro-chemical inputs. Modern agriculture relies on synthetic fertilizers, pesticides, herbicides, soil conditioners and plant growth regulators; these all chemicals are murderous for soil sustainability and biological life and a threat to environment.

Among crops of importance that need modern farming methods for increased productivity includes maize. Maize plays an important role in Eswatini firstly, it is a staple crop, improves food security of the country and it has economic benefits in the entire country [4]. Despite the availability of new technologies to improve productivity some smallholder farmers still depend on household labour, rain-fed, use hand hoes on some farm operations, less fertilizer and farm chemicals to control weed and pests [7-8]. According to Magagula *et al.* (2007) characteristics of modern agriculture in maize farming are inorganic and integrated fertilization, irrigation, herbicide and pesticide use, monocropping, liming, usage of high yielding seed varieties and farm mechanization [11].

The government of the Kingdom of Eswatini, Non-Governmental Organization (NGO) and private sector are availing the necessary knowledge and information needed by smallholder farmers in terms of modern farming practices; however, agricultural productivity is still low especially on the Swazi Nation Land (SNL). This level of productivity cannot meet the food demand of ever-increasing population in Eswatini. To close the gap the government through NMC imports dry maize from neighbouring countries especially South Africa. Among other factors responsible for low productivity include socio-economic characteristics of farmers and farming practices as evidenced in literature reviewed by the researchers. Government extension services and other organisations like FAO-UN, World vision, SEDCO, Techno-serve have tried to train farmers on the use of modern farming practices in Eswatini but there is less information related to the effect of these practices on smallholder farmers' productivity. Therefore, this study was aimed at contributing to the body of literature on the determinants of adoption level of modern farming practices and the effect of these farming practices on productivity of rural smallholder maize farmers' in Kukhanyeni constituency of Eswatini. The main objective of the study was identifying the determinants of adoption level of modern farming practices among smallholder maize farmers in Kukhanyeni Constituency of Eswatini. Specifically the study was aimed at; identifying smallholder maize farmer's socio-economic characteristics and farming practices; analysing the determinants of farmer's adoption level of modern farming practices; and factors influencing productivity of smallholder farmers.

II. METHODOLOGY

Study Area

Kukhanyeni constituency is area under the Manzini region of Eswatini. It is an area about 30 km from Manzini town under Manzini region which is dominated by rural communities and its closer to Luve and Ludzeludze rural development areas which plays a crucial role in providing agricultural extension services such as subsidised tractor hire, liming schemes and other extension services. The area has 13 imiphakatsi (chiefdoms) and temperature range from 2.5 to 45 degrees Celsius with an average annual rainfall from 217mm to 2000mm. the major agricultural activities carried out in this area include small-scale vegetable, maize farming and rearing of livestock (cattle, small ruminants and indigenous chicken).

The nature of the present study was quantitative and cross-sectional. Primary data were collected by using self-designed, well-structured and pre-tested questionnaires. The questionnaire was pre-tested for data reliability and validity. Information were collected through face-to-face interviews with the help of questionnaires and analysed through statistical software.

A stratified sampling technique was used in this study for the selection of maize farmers from two groups; a first group was those farmers who supplied and contracted under National Maize Cooperation in 2018 and second group who produce maize for selling locally or under respective areas of Kukhanyeni constituency. 90 farmers were selected and interviewed by using questionnaire. Collected information were captured in Microsoft excel software. Descriptive statistics, multiple-linear regression model using Statistical Package of Social Science (SPSS 20) and the Tobit regression model were employed as analysis tools by using the STATA software.

Multiple-linear regression model was specified as:

$$Y= \beta_0 + \beta_1X_1+ \beta_2X_2 + \beta_3X_3+ \beta_4X_4 + \beta_5X_5+ \beta_6X_6 + \beta_7X_7+B_8X_8 + error…………………… (1)$$

Where, Y= maize yield (kg/ha) is the dependent variables, an estimated of maize productivity; β_0 **=** constant**;** β_1 to β_8 **=** coefficient of the independent variables. X_n= independent variables listed as follows: X_1=Farmers age (Years), X_2= Education level of household head (Years), X_3=Faming Experience (Years), X_4=Cropping system (0 = monocropping, intercropping =1), X_5=Liming = (applied = 0, not applied =1), X_6=Fertilizer usage= (Organic = 0, inorganic =1), X_7=Irrigation = (Rainfall dependence=0, Irrigated=1) and X_8=Pest and disease control= (Natural =0, Chemical control=1). The error = error term.

Following Idrisa *et al*. (2012) the Tobit model can be presented as [12]:

$$Y^*_i = \beta xi + \mu…………………………………………………………….(2)$$

Then empirically the Tobit model for the i^{th} farmer can be mathematically expressed as:

$$Y_i = \beta_0+ \beta_1X_1+ \beta_2X_2+…………..\beta_nX_n; i= 1, n……………..(3)$$
$$0 \text{ if } Y^* \leq T$$

$$Yi = Y*_i , \text{ if } 0 < Y* < 1 (i= 1,…..n)………………………………………..……..………(4)$$
$$1 \text{ if } Y*_i > T$$

where: Y_i = the observed dependent variable *i.e.* the fraction of number of technology farmers uses divided by the total package of available modern technologies farmers can adopt. Y^*_i = the non-observable latent variable representing the use of available technologies; T = the critical (cut off) value which translates into $Y^*_i > T$ as a farmer adopts, and $Y^*_i < T$ as a farmer rejects the modern farming technologies; and n = the number of observations. The dependent variable used in Tobit model is continuous and this model is reported to be advantageous compared to the dichotomous choice model like the Logit and Probit models because it eases the ability of estimating the intensity of use of technologies during the adoption process [12].

III. RESULTS AND DISCUSSIONS

Results generated in terms of farmers' demographic and farm characteristics indicate that on average farmers are aged 41 years, with an average of 10years in school, 15 years of farming experience, and each respondent hosting 10 household members on average. Farmers' land size was ranging between 0.5 and 4 hectares with a mean hectare of 2.44. Farmers harvested on average 1 117.08kg of maize. This indicates that most farmers are above their youthful age, they have attained some education important for reading and interpreting written information on how to use modern technologies, important for improved level of adoption. Farmers have got enough experience in growing of maize though sometimes this may derail the pace at which farmers adopt new technologies since they would be comfortable with the old tradition rudimentary technologies, thus being risk averse. The yield harvested by the farmers (1 tonne/ha) is very compared to the yields estimated by the national maize corporation of 6 -7 tonnes/ha.

Table 1 Socio economic characteristics of farmers and Maize Yields

Statistic	Range	Minimum	Maximum	Mean	Standard deviation
Farmers age (years)	49	18	67	41.07	12.064
Educational level (years)	18	0	18	10.6	4.493
Farmers experience (years)	39	1	40	15.43	10.690
Household size (number)	20	3	23	9.79	4.959
Land size (hectare)	3	0.5	4	2.24	1.051
Yields(kg/ha)	3 625	75	3 700	1 117.08	973.143

Source: Survey Data, 2019.

Table 2 presents the age groups of the farmers. About 26 % of the farmers were aged between 49 and above years, 26% of farmers were aged between 40 and 49 years, 28% of them aged between 30 and 39 years, and 19% were aged less than 30 years .Moreover the results showed a fairy poor participation of younger age group in maize farming, Dlamini et al. (2012) concluded that agriculture seemed to be a less important activity to younger age groups [5].

Table 2: Age Distribution of farmers

Parameter	Distribution	Frequency	Percent
Age(years)	Less than 19	03	03.3
	20-29	15	16.6
	30-39	26	28.9
	40-49	23	25.6
	Above 49	23	25.6

Source: Survey Data, 2019.

There were more males (67%) participating in maize farming compare to female (33.3%), this might influenced by responsibilities given to males as head of the family and this study was in line with the results reported by Dlamini *et al.* (2012) which showed that the nationwide maize production is dominated by males [5].

Table 3: Farmers gender

Gender	Frequency	Percent
Male	60	66.7
Female	30	33.3

Source: Survey Data, 2019.

Based on the results presented in Table 4, most farmers were married (66%) and 22% of the farmers were reported single. Being married may have advantages of sharing and coming-up with meaning farming decisions compared to the unmarried farmers. Also this may indicate presence of children who provide free farm labour, and this ease adoption of technologies that would otherwise need more manpower when applying them. Balarane and Oladele (2012) concluded that it becomes easier for farmers to use their children as family labour for operations like planting, weeding and harvesting [13].

Table 4: Marital status of farmers

Parameter	Distribution	Frequency	Percent
Marital status	Single	20	22.2
	Married	59	65.6
	Windowed	5	5.6
	Divorced	6	6.7

Source: Survey Data, 2019.

Table 5 reports that 60% of farmers had household members of less than ten members and 36% of the farm household had more than 10 members. Household members act as a plentiful resource for farm labour [14]. However, Dlamini et al. (2012) concluded that high household members deplete resources meant for farming thus reducing farm productivity [5].

Table 5: Household size

Parameter	Distribution by members	Frequency	Percent
Household number	Less than 10	54	60.0
	10-20	32	35.6
	Above 20	4	4.4

Source: Survey Data, 2019.

Results in Table 6 illustrates moderate literacy rates of farmers as only 3% have no formal education, 6% have attended tertiary level and the majority of farmers (47%) had attended secondary education, 31% of farmers had attained high school with 12% having attained a primary level of formal education. Schooling has been shown to provide external benefits by improving human capital important in adoption of new technologies. Dlamini et al. (2012) concluded that low literacy rates in maize production leads to poor technical and economic efficiencies [5].

Table 6: Education level of farmers

Parameter	Distribution	Frequency	Percent
Education level	No formal education	03	3.3
	Primary school	11	12.2
	Secondary school	43	47.8
	High school	28	31.1
	Tertiary	05	5.6

Source: Survey Data, 2019.

In Table 7, the fraction of about 61.1% of farmers was earning income from other sources other than maize farming. They had diversified to other agricultural activities like vegetable farming and livestock production. Lastly only 38.9% of farmers indicated that they do not earn off-farm income. The poor dependence on maize farming as the main source of income may be caused among other factors by low return from National Maize Corporation pricing strategies and high production cost which promotes incentive to access other forms of income to complement the scaling inputs prices [5].

Table 7: Off-farm income

Off-farm income	Frequency	Percent
Yes	55	61.1
No	35	38.9

Source: Survey Data, 2019.

Dlamini *et al.* (2012) concluded that there is a need to equip farmers with necessary production skills as maize low productivity is a major concern as it is a staple crop and food security indicator [5]. According to results displayed in Table 8, 54% of farmers had access to extension and advisory services. The acquired information sometimes is a crucial resource and knowledge transfer to farmers especially the illiterates. About 45% farmers were not utilizing the extension services or extension services were not reaching them. Extension services and training is another important ingredient of improved human capital provided mostly by government, parastatal and NGOs for improved farmers productivity.

Table 8: Extension and advisory services

Access Extension & advisory services	Frequency	Percent
Yes	49	54.4
No	41	45.6

Source: Survey Data, 2019.

Rural schemes and cooperative membership promotes market competiveness, economies of scale, farmers receive farm inputs at low cost and rural schemes such as irrigation schemes, food distribution schemes can improve productivity as food security thus reducing household poverty. Over 62% of farmers' respondents were not part of any scheme yet these are necessary in provision farm inputs and can act as alternative sources of finance important to purchase farm inputs.

Table 9: Rural schemes and cooperative membership

Membership to cooperative	Frequency	Percent
Yes	34	37.8
No	56	62.2

Source: Survey Data, 2019

Farmers' farming practices

According to results presented in Table 10, the most used modern farming practice by farmers where tractor for ploughing (86% of respondents), planting hybrid maize variety (79% of respondents), mono-cropping (73%), use of chemicals for pest/insect control (71%), and application of lime to improve on the soil pH. The less used modern farming technologies by maize farmers were weeding using herbicides (48% of respondents) and used of irrigation to water crops (47%). These results indicate that farmers mainly depend on rainfall to water their crops and use hand hoe to weed their fields. Due to unreliability of rainfall and tedious use of hand hoe for weeding keeping other factors constant, farmers are more likely to harvest low yields. Although 54% of farmers indicated that they were using inorganic fertilizers this indicate a relatively lower use the technology important for increased yields.

Table 10: Smallholder maize farming practices

Variables	TRADITIONAL	Freq.	%	IMPROVED	Freq.	%
Cropping System	Intercropping	24	26.7	Monocropping	66	73.3
Ploughing (Tillage)	Hoe, ox drawn implements	13	14.4	Tractor drawn implements	77	85.6
Seed Procurement	Traditional or Non hybrid	19	21.1	Hybrid maize varieties	71	78.9
Fertilizer Usage	Kraal manure/compost	41	45.6	Inorganic fertilizer	49	54.4
Weeding	Mechanical	47	52.2	Chemical	43	47.8
Irrigation	Rainfall dependence	48	53.3	Irrigation	42	46.7
Pest/Disease Control	Natural control	26	28.9	Chemical control	64	71.1
Post-Harvest Handling	poorly planned cribs	43	47.8	Maintained cribs	47	52.2
Liming	Not applied	35	38.9	Applied	55	61.1

Source: Survey Data, 2019.

Determinants of farmers' maize productivity

A multiple linear regression model was employed to analyse the relationship between farmers' socioeconomic characteristics, farming practices, and productivity. Results of this model show that at least 49 % in the variation of dependent variable yield/ha was explained by independent variables. The F-value indicates that the explanatory variables combined, significantly influence changes in the farmers' productivity at 5% level, thus rejecting the null hypothesis.

Table 11: Determinants of farmers' maize productivity

Variables	Coefficients	Std. Error	t-value	Sig.
Constant	2031.050	504.641	4.025	0.000
Farmers age	-23.096	12.418	-1.860	0.067*
Educational level	24.383	20.484	1.190	0.237
Farmers experience	14.200	14.578	0.974	0.333
Cropping system	-302.313	178.776	-1.691	0. 095*
Liming	-954.759	173.506	-5.503	0.000***
Fertilizer usage	-208.237	167.707	-1.242	0.218
Irrigation	373.458	173.729	2.150	0.035**
Pest and disease control	224.165	207.055	1.083	0.282
Adjusted R^2 = 49.4				
F Value =11.86				
P-value =0.02				

Source: Survey Data, 2019.

Where significant level ***, **, * at 1%, 5%, 10% significant level respectively.

The farmer's age, the cropping system, and liming had a negative and significant influence on farmer's maize productivity at 10%, 10% and 1% levels, respectively. Thus, a unit increase in farmer's age by one year results in a 23Kgs decrease in output. This may be due to the reduction in energy to carry out the rigorous farming activities that need more energetic youthful age. Empirical evidence from other research publication proves that productivity of farmers often increases with age, reach some maximum level and then decreases, the younger farmers are capable of carrying out effectively physical farm activities compared to older farmers therefore older farmers may not be as efficient as the middle aged farmers [15]. In this study also the mean age size was 41 years which means average maize farmers are 41 years old so they are less productive. Moreover older age groups are poor in adopting knowledge and technologies in agriculture

Since the cropping system variable was a dummy where intercropping was coded as one and mono-cropping as zero, an increase in the number of farmer's use of intercropping reduces productivity by 302kgs. Application of technologies targeting one crop in a mix of different crops on the same plot can be challenging due to the fact that different crops are prone to different species of insect pest attacks, disease incidence and development of weed flora, some may be herbicides and insecticides resistant, striving for the same micronutrient and ultimate reduction in crop productivity. Liming is a very import farming practice that aims at improving the pH of the soils due to their increased acidic levels mainly caused by the farming processes from tillage to irrigation and water infiltration in agricultural soils. Agricultural soils are reported to be acidic with damaged soil texture and structure as farmers continue using synthetic fertilizers, pesticides, herbicides, soil conditioners and plant growth regulators [16]. The practice of liming was a dummy where applied was coded zero and no application a one. Therefore, less use of liming by farmers by one unit results in a reduction of farmers' productivity by approximately 955 units of output/ha.

Smallholder farmers irrigate farms through gravitational river water harnessed from upstream rivers and with conjunction with their involvement in irrigation schemes. Irrigation had a positive and significant influencing productivity at 5% level. A unit increase in irrigation results in an increase in yields/ha by 375kg. This result is in line with what is expected since the technology avails water for the plant at all times more yields will be expected compared with the rain fed farming. Irrigation relieves the plant water stress during unfavourable weather condition as maize crop is susceptible to heat stress caused by dry spells especially during the growth stages of reproduction and grain filling. If not attended to, this can result in quantitative and qualitative grain loss [17].

The determinants of farmer's extent of adoption of modern farming practices

Farmer's extent of adoption of modern farming technologies in the study area was estimated using the Tobit model statistical analysis. The extent of use was measured in terms of the proportion of technologies the farmers used divided by the package of technologies availed to farmers. The package included application of inorganic fertilizer, weeding using herbicides, irrigation, and modern post-harvest technologies. The findings of the study presented in Table 12 show that farmer's age, marital status, extension services, membership to a cooperative, and maize yields had a significant influence on the extent of adoption of modern farming technologies in the study area.

The results in Table 12 indicate that the coefficient of farmer's age was significantly negative at P<0.1. This means that as farmers grow older beyond the mean age of 41 years they the reduce on adoption of new technologies, thus young farmers less than 41 years of age are more likely to adopt more modern technologies than the older ones. These results match with those reported by Kaliba *et al.* (2018) who found that age had a negative significant influence on extent of adoption of the improved sorghum varieties in Tanzania [18]. Nchinda *et al.* (2010) reported that in some cases the age of the farmer may have a positive influence on the extent of adoption of new technologies [19].

Table 12: The Tobit regression estimating determinants of the level of technology adoption

Number of Obs	90.00
LR Chi Sq (7)	39.49
Prob>Chi Sq	0.000
Pseudo R^2	0.442

Log likelihood = -24.897

Dependent Variable (No. technology used/ No. technology introduced)	Coefficient	Std. Err	t-value	P>|t|	95% Confidence interval	
Farmer's Age(years)	-0.006	0.003	-1.84	0.070 *	-0.012	0.000
Marital Status (Dummy)	0.152	0.068	2.22	0.029 **	0.016	0.287
Household size(number)	0.010	0.007	1.45	0.151	0.004	0.025
Off-farm income (Dummy)	-0.037	0.066	-0.55	0.581	-0.169	0.095
Extension services(Dummy)	-0.190	0.063	-3.01	0.003 ***	-0.315	0.064
Cooperative Member (Dummy)	-0.165	0.069	-2.37	0.020 **	-0.299	0.026
Yields(Kg/ha)	0.000	0.000	4.33	0.000 ***	0.000	0.000

Constant	0.571	0.15 1	3.7 7	0.000	0.2 70	0.872
/sigma	0.284	0.02 4			0.2 37	0.331

Source: Survey Data 2019.
Where significant level ***, **, * at 1%, 5%, 10% significant level respectively.

The marital status dummy (Married = 1and 0 otherwise) had a positive and significant (P<0.1) influence on the extent of farmer's adoption of modern farming technologies. The results are consistent with a study carried by Kaliba *et al.* (2018) who also reported a positive significant relationship between marital status and adoption of new technologies. According to Kaliba *et al.* (2018), reported that married couples have more chances of accessing extension services that can provide key information related to new technologies compared to divorced, widowed, or single farmers who rely on other farmers to access credible meaningful agricultural information [18].

Farmers' access to extension services has been always important to availing agricultural information key for farmers' acceptance and adoption of new technologies. Results in Table 12 indicate that access to extension services negatively and significantly influenced the extent of adoption of improved modern farming technology at 1% level. The findings however differ from those reported by Idrisa *et al.* (2012). Farmer's membership to cooperative variable is significant and negatively related to the extent of modern farming technology adoption, implying that farmers belonging to cooperatives hardly adopt more modern farming technologies than the non-members of cooperatives [12]. These results differ from those reported by Danso-Abbeam *et al*. (2017) who found out that belonging to a farmer based organisation had a positive and significant relationship with the extent of adoption of improved maize varieties [20]. Although the weight of the coefficient is very small, maize yields had a positive and significant relationship between with the extent of adoption of modern farming technologies. For the higher yield of maize, the more incentives are required for the farmers to adopt more modern technologies.

IV. CONCLUSION AND RECOMMENDATION

The main key modern technologies used frequently by farmers were tractor for ploughing, planting hybrid maize variety, mono-cropping, use of chemicals for pest/insect control, and liming of the soils. The less used modern farming technologies by maize farmers were weeding using herbicides and used of irrigation. Determinants of farmer's maize productivity were farmer's age, liming, cropping system and irrigation, respectively. To improve on maize productivity the results suggest to encourage youth join maize farming, promote mono-cropping, increased liming and irrigation of the maize fields. Determinants of farmers' extent of adoption of modern farming technologies included farmer's age, marital status, extension services, and membership to a cooperative and maize yield. Thus for a farmer to adopt more modern technologies needs to be young, married, access quality extension services, and mostly doesn't rely on the agricultural information gotten from a cooperative group but from a knowledgeable extension worker and works had to achieve high yields.

Therefore, the study recommends that government of Eswatini, NGOs, CBOs and the private sector have to develop strategies that encourage youth to join farming as an employment opportunity. The same stakeholders should finance establishment of irrigation facilities in communities to help farmers move away from rain fed agriculture, and provide input subsidies like lime for soils conditioning, and encourage farmers to practice mono-cropping on a larger scale. Farmers' access to quality extension services is also important for conveying the right message related to these technologies.

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