

Original Research Article**BUILDING SUSTAINABLE RURAL
LIVELIHOODS: WOMEN AND ADOPTION OF
IMPROVED FARMING TECHNOLOGIES IN
ZAMBIA**

ABSTRACT

Aims: The main aims of this study were two; 1. To identify key factors that affect women farmers' awareness and knowledge of existing improved farming technologies and 2. To determine the factors that influence women farmers' adoption of animal draught (ox plough) and agroforestry technologies in Zambia.

Study design: The study was a survey in which semi structured questionnaires were used to interview women household heads.

Place and Duration of Study: The study was conducted in Mkushi and Mazabuka districts in the central and Southern provinces of Zambia respectively. Data was collected between June 2012 and September 2012.

Methodology: Mkushi and Mazabuka districts located in the central and Southern provinces of Zambia respectively were purposively selected because they lie within the "maize belt" of Southern Africa where maize production intensification technologies have been implemented since the 1990's. Five camps from Mkushi and three from Mazabuka were randomly selected, after which stratification of women farmers was done among adopters and non adopters. Finally, random selection gave 50 adopters and 114 non adopters from the two strata. Data was analysed using stata software. Descriptive statistics and the multi-stage logit formed the basis of analysis. The first stage of the logit model looked at awareness of existence of the technologies by the women farmers and the second stage looked at likelihood of adoption of ox plough and agroforestry technologies after being aware of them.

Results: Results revealed that much as women non adopters used more fertilizer per hectare, adopters had higher maize yields at 949Kg/ha compared to 861.9Kg/ha for non adopters. This is mainly attributed to the advantages that come with sustainable agricultural practices like agroforestry.

Access to communication gadgets like phones and membership to farmers' groups was found to increase the probability of awareness of technologies among women farmers by 90% and 35% respectively.

The size of land under cultivation was found to increase likelihood of adoption of ox plough technology by 29% while at the same time reducing the likelihood of adopting agroforestry technologies by 68%. This is because with increasing scale of production farmers tend to

switch to advanced technologies like tractors but also cut down trees to open up land rather than planting them.

Conclusion: Communication related factors are key in creating and increasing awareness of existing technologies among women farmers. Similar factors seem to promote adoption of both animal draught (ox plough) and agroforestry technologies among women farmers though expanding scale of production leads to more likelihood of ox plough adoption and later transition to more sophisticated machinery like tractors.

Keywords: Women, Technology adoption, Multi-stage Logit model, Zambia

1. INTRODUCTION

1.1 Women and Agriculture in Zambia

The agricultural sector in Zambia supports about 80% of the population that is exclusively dependent on agricultural related livelihoods many of whom are poor people in the rural country side. The sector contributed 18% and 20% to GDP in 2011 and 2013 respectively and continues to be the largest employer of the Zambian labour force [1, 2]. It employs the majority of the working population at 52.2% [3].

Women comprise 50.7% of the total population of Zambia and form 51.6% of the economically active segment of the working population. The majority of the women in Zambia (50.2%) live in the rural areas with 24.1% of rural households headed by females [3]. Many households have less than two hectares of land in the rural area with 71% falling under this category [4]. This is a clear indication that land being a limiting factor in agricultural production, the farmers many of whom are smallholders have to employ intensive farming technologies in order to raise their farm productivity to enable them produce for home consumption but also have a marketable surplus [5]. The main crops grown by the rural people by household numbers in 2011/2012 season in Zambia are maize (86%), groundnuts (39.2%), cassava (37.5%), cotton (20%) and sweet potatoes (12.7%) [6].

In addition, the government has been implementing the food security pack and the fertilizer support program (FISP) through the ministry of agriculture and cooperatives (MACO) since the year 2000 through distributing fertilizer and hybrid maize seed to the farmers in a bid to improve on food security. Currently over 85% of all farmers in the study area apply fertilizer (though in inadequate amounts) and use hybrid maize seed [3]. [7] reported that only 29% of female headed households had adopted improved tree fallows after ten years of promoting the technology .Therefore the core problem to sustain production is adoption of other

40 production enhancing technologies like agroforestry for soil fertility and fuel and ox ploughs
41 for affordable smallholder mechanisation.

42

43 The main agricultural intensification technologies applied in maize production are use of
44 fertilizer and hybrid seed, use of ox-ploughs for land preparation, zero tillage in addition to
45 agroforestry which is one of the sustainable agricultural systems being promoted in Sub
46 Saharan Africa [8]. However, the main challenge is that the level of adoption of these
47 technologies is still low among smallholder farmers. Despite the fact that 55% of the farmers
48 use fertilizer on their fields, the rate is still at 170kg/ha below the recommended 200kg/ha
49 [6]. However, the observed low levels of technology adoption are a result of a set of issues
50 that are sometimes under the farmer's control and in other cases external to them [9].

51 **1.2 Factors affecting women technology adoption**

52 Women household head farmers face a number of challenges in their bid to sustain their
53 families. In the first case, they have to cater for the household food security and then they
54 have to produce a marketable surplus to earn some income. All this calls for extra efforts in
55 organising labour and other inputs to be able to produce enough. However, a number of
56 factors hamper women's ability to acquire the necessary technologies which include access
57 to extension services, gender disparities with their male peers and ability to associate with a
58 social club like a farmer's group or association for collective action [10]. In other cases,
59 labour constraints and inaccessibility of technologies rather than their availability hinder
60 women from adopting them [11].

61 Though many rural women lack opportunities for off farm work, but studies have always
62 pointed to earning extra income outside the farm promoting technology adoption. This is due
63 to the fact that such incomes are invested in promoting new or better technologies on the
64 farm like buying oxen, ploughs, improved seeds and fertilizers [12].

65 In many cases, improved technologies tend to be laborious, in that man power is needed to
66 undertake them. This tends to put off many women from taking up such technologies given
67 their age or energy and the fact that women's time is also devoted to other household chores
68 such as cooking, fetching water and gathering fuel wood, as well as child care [13]. [8] found
69 that the number of active household members who can ably provide labour on the farm
70 positively and significantly promoted adoption of agroforestry technologies in Malawi. In

71 addition, the same authors found age of the head of household to have a negative effect on
72 adoption.

73 In many parts of Africa, women have limited rights on possession, ownership and access to
74 land. Their security of tenure on land is usually not guaranteed which incapacitates them
75 from taking on or expanding use of certain agricultural technologies that are tenure sensitive
76 [14, 15]. [16] stated that perceived stability of access to land, via stability of personal and
77 social relationships is a more important determinant of technology adoption than mode of
78 access.

79 2. METHODOLOGY

80 2.1 Study area and Sampling procedure

81 Mkushi and Mazabuka districts of Zambia in the central and southern provinces respectively
82 formed the study area where women headed households were interviewed in 2012. This
83 selection of the two districts was not random but purposive so as to ensure sufficient
84 variation as to factors assumed crucial for women related agricultural development within the
85 “maize belt”. The districts were also selected because of the government restocking
86 program that has introduced more cows some used for ox ploughing in addition to
87 agroforestry programs in the area since the 1990’s.

88 The districts were divided into agricultural blocks (stratification), which in turn based on
89 extension/administrative arrangements are divided into agricultural camps, which is the unit
90 catered for by an extension officer. A camp is further divided into zones corresponding to a
91 number of villages/communities located in the same neighbourhood. For the village
92 diagnostics and household survey, five camps (Musakamba, Musofu, Kalombe, Chitina and
93 Nkumb) in Mkushi and three Camps (Dumba Settlement, Oliver Settlement, Nega Nega) in
94 Mazabuka were selected as “village units”/sampling frames. Thereafter, women headed
95 households were randomly selected where 100 were from Mkushi and 64 from Mazabuka
96 giving a total sample of 164 households.

97 2.2 Analytical methods

98 To outline the factors that influence women farmers’ knowledge and adoption of given
99 farming technologies a multi-stage logit model as used by [17, 18] with modifications was
100 employed to analyse the data. The model is specified as;

$$101 \Pr_{\text{aware}} (\text{KNOW} = 1, \text{ADOPT} = 1) = \frac{1}{1 + e^{-\beta_0 - \beta_1 \text{KNOW} - \beta_2 \text{ADOPT} - \beta_3 \text{AGE} - \beta_4 \text{SEX} - \beta_5 \text{EDUCATION} - \beta_6 \text{WEALTH}}} \quad (3)$$

102 Where, KNOW and ADOPT are dichotomous dependent variables (1 if the farmer has
103 knowledge or adopts a farming technology, 0 otherwise) and e = base of natural
104 logarithms. The farmer first gets knowledge of the technology as represented in equation (4).

$$105 \quad Y = \beta_o + \sum_{i=1}^{i=n} \beta_i X_i + \mu_j \dots\dots\dots (4)$$

106 Where X_i includes a vector of variables in the model that affect a woman farmer's
107 awareness of the existence of available farming technologies, β_i parameters to be
108 estimated and μ_j = error term. Y represents the access to extension services. Extension and
109 credit have for long been advocated as instruments that accelerate adoption of technologies
110 by small farmers especially when adverse effects of economies of scale in technology use
111 have been mitigated [5].

112 Where X_i is defined by the following variables; Age of the woman household head
113 (HH_AGE). Education level of the woman household head specified as the number of years
114 completed in formal school (HH_EDUC). Household size measured as the total number of
115 people living in the household including children (HH_SIZE), engagement in a micro
116 businesses by a woman head of household (MICRO_BIZ). Distance from farm to the nearest
117 village centre (km) (DIST_VILCENTR), main maize selling point (MAIZE_SALPT) which may
118 be the farm gate or outside the farm which is an indicator of the woman farmer's knowledge
119 of what happens outside her farm. Possession of a communication gadget like a phone or
120 radio/TV (COMM_GADGET) taken here as an indication that the farmer can use news, text
121 messages and adverts to access information. Membership to a farmer group or association
122 (GRP_MEMBER), ability to make voluntary savings (VOL_SAVINGS) which measures the
123 farmer's ability to invest in new or better farming technologies and total maize harvest in the
124 most recent year (MAIZE_PROD1).

125 After the woman farmer gets knowledge of the existence of a technology, she makes a
126 decision to adopt or not to adopt that technology subject to the economic and demographic
127 factors faced. Hence, the second stage of the model estimates the variables responsible for
128 adoption or non-adoption as indicated in equation (5).

$$129 \quad T_i = \beta_o + \sum_{i=1}^{i=n} \beta_i X_i + \mu_j \dots\dots\dots (5)$$

130 Intensification of a single component of farm system (with little change to the rest of the
131 farm) - such as home garden intensification with vegetables and/or tree crops has been

found to improve on food production among households and generally improve food security and sustainability of the farming business [19].

Where X_i is defined by the following variables; Age of the woman household head (HH_AGE). Age is also taken as a measure of farming experience in this study, education level of the woman household head specified as the number of years completed in formal school (HH_EDUC). Household size measured as the total number of people living in the household including children (HH_SIZE), Non-farm income (NONFAM_INCOME) earned by the woman head of the household was measured as all income from activities other than farming including micro businesses, remittances and pensions in US dollars. Distance from farm to the nearest village centre (km) (DIST_VILCENTR), highest unit price earned for maize in the most recent season (UPRICE_HIGH1) measured in US dollars, possession of a communication gadget like a phone or radio/TV (COMM_GADGET), Membership to a farmer group or association, taken as an indication of collective action participation by a woman farmer but also signifying ability to share knowledge and information with others (GRP_MEMBER) and total land under cultivation in the most recent year, measured in hectares (TOTCULTIV_LAND).

Table 1: Variable description

Variable	Description (units)
CROP_EXTSVC	Extension services related to crop production (dummy)
ADOPTER	Woman head of household who adopted either an ox-plough or Agro forestry technology
HH_AGE	Age of the woman head of household (years)
MICRO_BIZ	Woman engages in running a micro business (dummy)
COMM_GADGET	Access to a communication gadget like a phone or radio (dummy)
HH_EDUC	Education level of woman head of household (years in formal school)
HH_SIZE	Size of the household (Number of people living in the household)
DIST_VILCENTR	Distance to the nearest village centre (Km)
GRP_MEMBER	Woman being a member of any farmer group or association (dummy)

MAIZE_SALPT	Maize selling point regularly used by the woman farmer (farm gate=1, otherwise=0)
VOL_SAVINGS	Woman farmer's ability to make voluntary savings (dummy)
MAIZE_PRODN1	Quantity of maize produced by the woman's household in the current year (Kg)
OX_PLOUGH	Woman farmer adopted use of an ox plough (dummy)
AGROFORESTRY	Woman farmer adopted agro forestry as a technology (dummy)
NONFAM_INCOME	Income a woman head of household earns outside the farm in non-farm related work (USD).
UPRICE_HIGH1	Highest price earned per Kg of maize in current year (USD)
TOTCULTIV_LAND	Total land the woman's household put under cultivation in current year (ha)

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151 2.3 Empirical estimation procedure and hypothesis testing

152 Estimation of the model outlined above in equations followed a series of regression
 153 diagnostics. Variables used in both stages of the model were first checked for normality
 154 using Exploratory Data Analysis using the coefficient of kurtosis and skewness. Regression
 155 diagnostics included tests for multicollinearity, self-selection bias and heteroscedasticity.
 156 Multicollinearity was tested using the variance inflation factor (VIF) while heteroscedasticity
 157 was checked using Breusch-Pagan/Cook-Weisberg tests [20].

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159 3. RESULTS AND DISCUSSION

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161 3.1 Characteristics of farmer women household heads

162 Tables 2 and 3 show the social economic characteristics of the sampled women headed
 163 households who adopted either the ox plough or agroforestry technologies in maize
 164 production. Results in table1 indicated that adopter households had a significantly ($P = .05$)
 165 lower number of household members providing labour with four persons compared to five
 166 persons for the non adopters. This is because in some cases like the ox plough technology,
 167 farmers hire outside labour rather than do the ploughing themselves. This is however
 168 counter to the results by [8] that those households with more household labour are more
 169 likely to adopt a technology than those with less labour force.

Table1 results further indicated that adopters had smaller land under maize cultivation (2.73 ha) compared to non adopters (3.5 ha). Adopters also applied less fertilizer annually on average (318.2Kg) compared to non adopters (342.61Kg). However results indicated that adopters produced more maize per unit area at 949.1Kg/ha compared to the non adopters at 861.88Kg/ha. This is an important result that indicates how technologies like ox ploughs and agroforestry can increase yields while reducing costs on fertilizer as well as reducing risks associated with unpredictable crop failure for the resource constrained women farmers. [21] noted that the low fertilizer use in many African maize farming systems are a result of risk aversion, lack of agricultural credit and fertilizer availability and timely delivery.

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187 **Table 2: Characteristics of farmer women household heads and technology adoption**

Variable	Overall mean	Mean (Std. Dev)	
	(Std. Dev)	Adopter	Non adopter (114)
	(164)	(50)	
Age of the woman head of household (years)	51.20 (11.67)	52.16 (10.99)	50.77 (11.98)
Education level of woman head of household (years in school)	4.93 (3.59)	4.28 (3.28)	5.21 (3.70)
Size of the household (Number of people living in the household)	7.36 (3.42)	7.00 (2.97)	7.51 (3.59)
Distance to the nearest village centre (Km)	7.04 (4.80)	7.16 (5.29)	6.99 (4.59)
Quantity of maize produced by household in current year (Kg)	2,780.49(2,619.20)	2,738.00(2,828.55)	2,799.12(2,534.81)

Quantity of fertilizer used on maize in current year(Kg)	335.17 (280.64)	318.20 (278.02)	342.61(282.68)
Number of household members providing labour	4.34 (2.49)**	3.74 (2.03)	4.60 (2.64)
Area of land under maize (ha)	3.26 (2.17)**	2.73 (1.62)	3.50 (2.34)
Maize yield in the current year (Kg/ha)	888.47 (484.40)	949.10 (521.81)	861.88 (466.97)

188 *Standard deviations in parentheses; Significant level: ** = 5%.*

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190 Results in table 3 show that there is a significant difference ($P = .05$) between the percentage
191 of women household heads who engage in micro businesses who are adopters of the ox-
192 plough or agroforestry technologies and those are non adopters. It is indicated that 76% of
193 women adopters of these technologies were engaging in micro businesses as well
194 compared to 57.89% of the non adopters. The reason for this is that incomes from outside
195 the farm are used to invest in farm technologies that enhance agricultural production. This is
196 consistent with the findings of [22] that earning off farm income, in this case income from the
197 micro businesses enhances and positively affects the likelihood of natural resource
198 management practices.

199 Results also indicated that a significantly ($P = .05$) higher percentage of technology adopters
200 (84%) possessed a communication gadget like a mobile phone, radio or television compared
201 to the women non adopters at 64.91%. This result points to the fact that access to
202 information through a number of media concerning agricultural technologies can augment
203 adoption among smallholder farmers. [23] noted that mobile phones significantly reduce
204 search costs for information concerning input and output prices in addition to complementing
205 existing extension services where they are used by farmers.

206 Table 3 results also pointed out the scenario that a significantly ($P < .01$) higher percentage
207 of non adopter women farmers (43.86%) had access to credit compared to only 20% of the
208 technology adopter women farmers. This is consistent with the previous result that more
209 adopters are involved in micro business to earn income outside the farm than non adopters
210 and hence adopters face a higher production risk than their counterparts given the
211 investment they make in taking up the new technologies. Therefore, the non adopters resort
212 to borrowing as a safety net to smooth their consumption through paying school fees, buying
213 consumables and other services. In the same line, more non adopters made voluntary
214 savings (85.96%) compared to adopters (84.00%). The result is in support of [24] who found

215 that actually production risk suppresses demand for credit among smallholder farmers who
216 would want to invest in production technologies.

217 **Table 3: Characteristics (%) of women household heads and technology adoption**
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Characteristic (Variable)	Overall sample (164)	Adopter (50)	Non adopter (114)
Percentages			
Woman engages in running a micro business (dummy)	63.41**	76.00	57.89
Access to a communication gadget like a phone or radio (dummy)	70.73**	84.00	64.91
Membership to a farmers' group/association (dummy)	90.24	92.00	89.47
Maize selling point regularly used by the woman farmer (dummy)	34.15***	0.00	49.12
Woman farmer's ability to make voluntary savings (dummy)	85.37	84.00	85.96
Woman head of household has access to credit (dummy)	36.59***	20.00	43.86

219 *Significant level: * = 10%; ** = 5%; *** = 1%.*
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221 **3.2 Factors affecting women farmers' awareness of and knowledge of farming** 222 **technologies**

223 The results of the first stage of the multi-stage logit model indicated that engaging in a micro
224 business significantly ($P < .01$) increased the likelihood of a woman's farmer awareness of a
225 farming technology by 9.7times than when the woman was not engaged in micro business.
226 This is basically because farming is their primary source of income and undertaking a micro
227 business involves moving outside the farm or village to look for merchandise, and in so
228 doing, the woman gets exposure to information on availability of given farming technologies.

229 In addition, many of the extension trainings usually take place in town or village centres
230 where the micro business women usually go to trade. This seems to be in agreement with
231 the findings of [18] that farm operators, whose primary income source is farming, though
232 they may be engaged in other business, tend to seek out information on new farming
233 technologies.

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235 A woman farmer's access to a communication gadget such as a phone or radio was also
236 found to significantly ($P < .10$) increase the probability of awareness of farming technologies
237 by about 2.5 times than without the gadget. This is because mobile phones and radios in
238 modern times are used to disseminate and deliver information on agricultural prices, inputs
239 and new technologies. Imperfect information and knowledge concerning existence of inputs,
240 outputs and new technologies is very prevalent in developing world rural areas, though
241 information technology has potential to reduce the situation [25].

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243 Results also indicated that awareness of farming technologies decreased with increasing
244 education levels. Table 4 results indicate that every single year increase in education level,
245 leads to about 8% decrease in awareness. This is due to the fact that education has a
246 tendency of leading to migration of labour from the agricultural sector into other service and
247 industrial sectors. Therefore, the more women get educated the less they will be enthusiastic
248 about learning about new farming technologies. [26] also emphasised that Education and
249 training programmes have favoured the male leaving the rural women in many areas with
250 low education levels and more are illiterate compared to men.

251 Women farmers were found to be more likely to be aware of farming technologies the farther
252 away they are from the village centre. Every unit increase in the distance away from the
253 village centre could lead to 3.5% increase in awareness. This is because many of the
254 extension agents usually target those farmers outside the trading centres for training and
255 demonstrations. Furthermore, the farther the women farmers are from town the more they
256 will be entirely involved in farming as a core occupation, hence prompting them to seek
257 knowledge of new and better farming technologies which is solely provided by extension
258 workers who are sometimes overwhelmed by the number of farmers to attend to [27].

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265 **Table 4: Factors affecting women's awareness of a farming technology**

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Variable			
Access to extension (proxy for technology awareness	Coefficient	(Std. Err)	Odds Ratio
Age of the woman head of household (years)	0.015	0.023	1.015
Woman engages in running a micro business (dummy)	2.274***	0.674	9.722
Access to a communication gadget like a phone or radio (dummy)	0.897*	0.520	2.451
Education level of woman head of household (years in formal school)	-0.083	0.075	0.920
Size of the household (Number of people living in the household)	0.057	0.078	1.059
Distance to the nearest village centre (Km)	0.035	0.056	1.036
Woman being a member of any farmer group or association (dummy)	0.346	0.847	1.413
Maize selling point regularly used by the woman farmer (farm gate=1, otherwise=0)	1.240*	0.654	3.457
Woman farmer's ability to make voluntary savings (dummy)	-0.389	0.698	0.677

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*Significant level: * = 10%; ** = 5%; *** = 1%.*

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269 **3.3 Factors affecting women farmers' adoption of ox plough and agroforestry** 270 **farming technologies**

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272 Results of the second stage of the logit model indicated that access to a communication
273 gadget and total land the woman head of household put under cultivation were positive and statistically significant at the conventional levels for probability of adoption of ox plough

technology in maize farming. For the same technology, likelihood of adoption was negatively and significantly affected by age, education level, size of household, distance to the nearest village centre. The signs on coefficients are almost the same for both ox plough and agroforestry apart from age, household size, distance to village centre and total land under cultivation.

A one year increase in age leads to a 6% decrease in the likelihood of adoption of the ox plough technology but increases that of agroforestry by 8.3% (table 5). The main reason for this observation is that ox plough use is an energy demanding task, hence the older the woman farmer, the less they are likely to adopt it unlike agroforestry that is relatively less laborious. [28] noted that the benefits from agroforestry are long term yet the costs of abandonment can be high, this may be one of the reasons why its adoption increases with age.

Collective action, represented by the woman head of household being a member of a farmer's group or association has negative impact of adoption of both ox ploughs and agroforestry technologies. Results in table 5 indicate that membership to a group reduces the likelihood of ox plough adoption by 5.9% and that of agroforestry by 4.5%. The reason for this is that these technologies are undertaken individually at the farm, and in the case of ox ploughs, there are specialized male attendants who do the ploughing using the oxen [13], hence group work may not be called for, actually a farmer may see it as time wasting.

Results also indicated that the highest price of maize received by the woman farmer decreased the likelihood of adopting both ox plough and agroforestry technology by big percentage points (table 5). This is because when the price is high, women farmers are more likely to expand their production as much as men farmers, which makes them to shift from ox plough to tractors and also clear new land rather than practicing agroforestry. [29] highlighted the fact that many women farmers in Africa are increasingly growing staple crops, and hence are affected by any policies like price stabilization policies in the same way as men farmers are affected.

Total land under cultivation by a woman farmer was found to significantly ($P = .05$) increase the likelihood of adoption of ox plough technology (by 29.4% for a unit increase in cultivated land). However, it was also found to reduce the probability of adoption of agroforestry technology by 68.4%. This is basically due to the fact that expanding the land under cultivation requires either a better land preparation technology than a hand hoe, or increasing the manual labour hired. Also when a farmer is to expand production, there is a high chance of foregoing agroforestry and instead open up virgin lands. [30] noted that access to land by women and its related security of tenure has an effect on technology adoption given its implications for credit and other inputs access.

Table 5: Factors affecting women's adoption of two farming technologies

Variable	Ox plough Adoption			Agro forestry Adoption		
	Coefficient	(Std.Err)	Odds	Coefficient	(Std.Err)	Odds
			Ratio			Ratio

Age of the woman head of household (years)	-0.060*	0.035	0.943	0.083*	0.051	1.087
Access to a communication gadget like a phone or radio (dummy)	1.300*	0.733	4.902	4.217*	2.255	67.842
Education level of woman head of household (years in formal school)	-0.239**	0.109	0.780	-0.153	0.129	0.858
Size of the household (Number of people living in the household)	-0.505*	0.300	0.614	0.419*	0.231	1.521
Distance to the nearest village centre (Km)	-0.005	0.088	0.994	0.092	0.185	1.097
Woman being a member of any farmer group or association (dummy)	-0.593	1.141	0.502	-0.448	1.473	0.639
Income a woman head of household earns outside the farm in non-farm related work (USD).	0.004	0.003	1.004	-0.005	0.007	0.995
Highest price earned per Kg of maize in current year (USD)	-29.667	20.014	2.840e ⁻¹³	-6.070	12.819	0.002
Total land the woman's household put under cultivation in current year (ha)	0.294**	0.145	1.383	-0.684**	0.334	0.505

*Significant level: * = 10%; ** = 5%; *** = 1%.*

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4. CONCLUSION

Though many factors came out to affect awareness and knowledge of farmers about existing technologies, interaction factors came out prominently. Those elements of society that allow women farmers to interact among themselves and other members such as communication through the phones, belonging to a group or association and point of sale of their produce create an atmosphere of sharing knowledge and create awareness about technologies.

Animal draught technology (ox plough) being energy demanding, its adoption is affected by age of the woman farmer beyond a certain point. However, economic status of the woman farmer as measured by the size of land under cultivation promotes ox plough adoption. Therefore, the more women farmers expand in their scale of agricultural operations the more they are likely to adopt better technologies such as shifting from the hand hoe to the ox plough and later to tractors.

The benefits from agroforestry are medium to long term. Therefore its likelihood of adoption by women farmers is promoted by such factors related to medium-long term like age of the woman head of household and size of the household (labour). However, expanding scale of production in terms of land put under cultivation negatively affects the likelihood of adoption of the technology.

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