#7893 THE ROLES OF KEY PUBLIC SERVICES ON THE ADOPTION OF CLIMATE-SMART AGRICULTURAL TECHNOLOGIES IN COFFEE-BASED FARMING SYSTEM OF ETHIOPIA

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ABSTRACT

This study explored the adoption status of Climate Smart Agricultural (CSA) practices and factors that influenced their adoption including the key public services (education, extension, and communication devices). The study used quantitative primary data collected from smallholder farmers from major coffee-growing regions of the country: Oromia and SNNP. A multivariate probit (MVP) model was used to study factors that influenced the adoption of climate-smart agricultural technologies namely manure application, minimum tillage, intercropping, use of improved forage, and physical soil and water management practices. The effect of the education level of the household head, farmers' extension access, and the role of communication technologies in technology adoption was also observed. The study result showed that 35% of the farmers applied manure on their farm plots. Application of minimum tillage was also experienced by 36% of the farmers. Intercropping, improved forages and, physical soil and water management structures were adopted by 45, 19, and 47% of the farmers, respectively. The findings of the study also revealed the positive and significant effect of education, extension (access to extension services and participation on field days), and ownership of communication devices specifically radio on the adoption of climate-smart agricultural practices. However, more than half of the farming community has not yet adopted improved technologies and practices of these factors. Policymakers and public authorities must pay due attention to problems affecting effective extension service provision. The positive effect of radio ownership on technology adoption also suggests the need for launching more rural FM radio channels to farmers which focus on the provision of agricultural information and knowledge.

Keywords: climate-smart, extension, forage, intercropping, manure, and multivariate

INTRODUCTION

Adoption starts from knowing the existence of any improved technologies or practices. Thus, awareness is the main factor that affects the adoption of agricultural technologies. Next to awareness, farmers analyze to try or wait for the use of technologies which is highly affected by the education level of the household. However, the role of education, extension, and communication devices such as radio is neglected in different adoption studies. This study stresses to show the effects of these variables on the adoption of different climate-smart agricultural practices. The purpose of the study was to investigate the role of education, extension, and communication on the adoption of climate-smart agricultural technologies in the coffee-based farming system of Ethiopia. Moreover, the study was anticipated to explore demographic, socio-economic, and institutional factors affecting the adoption of climate-smart agricultural technologies, study climate-smart agricultural technologies' adoption status and analyze the interrelationship between the adoptions of different climate-smart agricultural technologies.

MATERIALS AND METHODS

Study Area and the Data

The study used quantitative primary data collected from smallholder farmers from major coffee-growing regions of the country: Oromia and SNNP. Gedeo, Sidama, Kafa, and Sheka zones from the SNNP region and Ilubabor, Jimma, West Wollega, and Kellem Wollega zones from the Oromia region were coffee-producing zones selected for the study.

Sampling and Data Collection

A multistage sampling technique was employed to select the population for the study which involved both purposive and random sampling techniques. A total of 953 sample households were selected for the study (584 from SNNP and 369 from Oromia Regions). Data was collected from the sampled households through a structured questionnaire administered.

Data Analysis

Descriptive statistics were used to describe the collected and cleaned data. A multivariate probit (MVP) model was also used to factors that influenced the adoption of climate-smart agricultural technologies (Minimum Tillage, Manure Application, and Physical Soil and Water Management Practices). Farmers adopt a mix of technologies to enhance declining soil fertility and mitigate climate change. This implies that the adoption decision is inherently multivariate, and attempting univariate modeling would exclude useful economic information about interdependent and simultaneous adoption decisions (Dorfman, 1996). Ignoring these interdependencies can lead to inconsistent policy recommendations (Marenya and Barrett, 2007). Thus, the use of a multivariate probit model is vital.

RESULTS AND DISCUSSION

Farm Household Characteristic

The descriptive result of the study showed of the total sample, 61% of farmers fall under SNNP and the rest 39% was from the Oromia region. About 90% of farmers were male-headed households. Farmers' mean age was 42.6 years with a minimum of 21 and a maximum of 90 years. The average family size of the respondents was 6.3 families. The minimum education level of the household head was 0 and the maximum was 12 years with a mean of 4.8 years. The mean distance from homestead to farm plots was 2.6 km with a maximum of 11 km. About 54 and 37% of farmers have access to radio and credit, respectively. More than 85% of farmers have also access to the extension of soil and water management which is really better despite the quality of the services. However, only 24% of farmers have participated in field days. About 25% of farmers also participated in off-farm income-generating activities. The mean total land in the study area was 1.8 hectares. Study area farmers also have on average 4.2 tropical livestock units (TLU). Coffee is the main cash crop in the study area. The study result showed 60% of farmers have adopted improved coffee varieties.

Adoption Patterns of Climate-smart Agricultural Practices

The study result showed that 34 and 37% of farmers in the SNNP and Oromia regions use manure on their farmland, respectively. The use of minimum tillage was higher at SNNP than in the Oromia region with an overall mean of 36%. About 20 and 61% of farmers in the Oromia and SNNP regions used intercropping, respectively (mean = 45%). Only 9% of farmers in Oromia and 25% in SNNP regions used improved forage. The result also exhibited that 49% of respondents in the Oromia region use physical soil conservation structures which are higher as compared to the SNNP region (44%). On average, 47% of respondents used soil and water conservation structures on their land along the study regions (Figure 1).

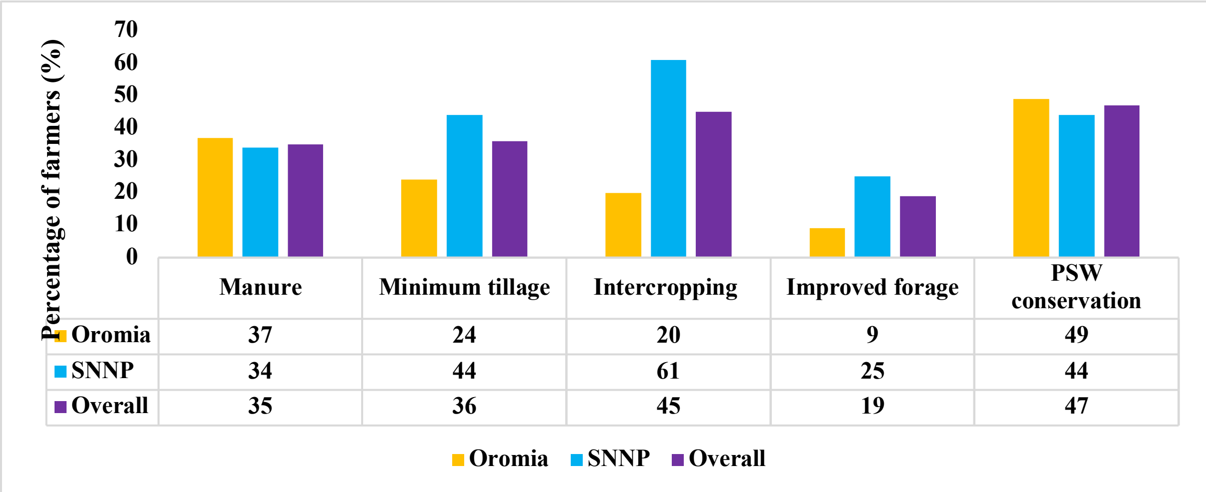

Figure 1. Adoption status of climate-smart agricultural technologies

Econometric Result

The pairwise coefficients of intercropping and manure application, use of improved forage and manure application, physical soil and water conservation and manure application, physical soil and water conservation and minimum tillage, use of improved forage and intercropping, physical soil and water conservation and intercropping and physical soil and water conservation and the use of improved forage are revealed to be positively and significantly correlated indicating complementarity among the paired practices. However, the pairwise coefficient of minimum tillage and manure application was negative and significant which implies the substitutability of the improved paired practices.

Factors Affecting Manure Application

A positive and significant relation was seen between household head age and the application of manure. The result is consistent with Ketema and Bauer, (2011). Family size negatively and significantly affects the use of manure. The result is contrary to Tao *et al.,* (2014) who found a positive relationship between family size and manure application. Distance from homestead to farm plots also affects the use of manure negatively and significantly due to the bulky nature of manure which hampers the transportation of manure to the further plots. The result is in line with Mesfin *et al.,* (2016). Access to natural resource management extension affects the application of manure positively and significantly. The result is in line with Makokha *et al.,* (2001) and Abebe and Debebe, (2019). Likewise, participation in field days affects the application of manure positively and significantly. TLU or livestock ownership affects the use of manure positively and significantly. The result corroborates with Mesfin *et al.,* (2016). The result also showed a positive and significant relationship between manure application and participation in off-farm income generation activities. The result contrasts with Makokha *et al.,* (2001) where a negative relationship between manure application and participation in off-farm income-generating activities was found.

Factors Affecting the Use of Minimum Tillage

The age of the household head affects the adoption of minimum tillage negatively. The finding is in line with Ketema and Bauer (2012) and Prakash *et al*., (2018) and contrasts with Grabowski *et al.,* (2014). The relationship between minimum tillage adoption and mean distance to farm plots was also positive which corroborates with the finding of Zulu-Mbata *et al.,* (2016). The education of the household head affects the adoption of minimum tillage positively and significantly. The result agrees with Ketema and Bauer (2012), Grabowski *et al.,* (2014), and Prakash *et al.,* (2018). Radio ownership of the household head affects the adoption of minimum tillage positively and significantly as information from radio enhances the adoption of improved technologies. Besides, farmers who have access to natural resource management extension services are more likely to use minimum tillage. The result is in line with Ketema and Bauer, (2012), Marenya *et al.,* (2017), and Prakash *et al.,* (2018). Participation in field days also affects the adoption of minimum tillage positively and significantly. These three communications and extension services enhance the information exchange on improved agricultural technologies. Land size affects the adoption of minimum tillage positively and significantly. Grabowski *et al.,* (2014), Ngoma *et al.,* (2014), Zulu-Mbata *et al.,* (2016), and Prakash *et al.,* (2018) also found the same result. Marenya *et al.,* (2017) also found a positive relationship between minimum tillage use and land size in Ethiopia which contrasts with the finding of the study in Kenya and Tanzania.

Factors Affecting the Use of Intercropping

The age of the household heads and participation in off-farm income-generating activities affect the adoption of intercropping positively and significantly. Female-headed households also use intercropping than male-headed households. The negative relationship between credit access and adoption of intercropping. Both education and participation in field days affect the adoption of intercropping positively and significantly which witnessed the positive role of education and extension on the adoption of agricultural technologies. The positive relationship between the use of intercropping and access to extension service agree with Ketema and Bauer, (2012). Land size and adoption of improved coffee varieties also affect the adoption of intercropping negatively and significantly due to the subsistence nature of intercropping, which is also in line with Ketema and Bauer, (2012). An increase in family size also enhances farmers to use of intercropping. The result also corroborates with Ketema and Bauer, (2012) and contrast with Ekepu and Tirivanhu, (2016). The negative relation between TLU and adoption of intercropping showed that those farmers who use intercropping have a small land size and they do not have space to rear livestock.

Factors Affecting the Adoption of Improved Forage

Female-headed households have less likely to adopt improved forage than male-headed counterparts. Female household heads are resource-poor especially land. Thus, they opt to plant other crops than forage to feed their family member. The education level of the household head affects the adoption of improved forage positively and significantly which is also agreeing with Lapar and Ehui, (2003). Extension on natural resource management is directly related to the adoption of improved forage which is in line with Beshir, (2014) and Abebe *et al.,* (2018). Both education and extension services affect the adoption of agricultural technologies positively through enhancing the search, evaluation, decision, and utilization of new information. Mean distance from farm plots has a negative and significant effect on the adoption of improved forage. Forage is a new technology for farmers and farmers plant the grasses in and around the homestead. The result is consistent with Abebe *et al.,* (2018). TLU also affects the adoption of improved forage positively. The result also supports the finding of Beshir (2014). Coffee improved variety adoption affects the adoption of improved forage positively and significantly.

Factors Affecting the Adoption of Physical Conservation Structures

Source of information and knowledge such as ownership of radio and access to extension services affect the adoption of physical soil and water conservation structures positively and significantly. The positive relationship between the adoption of soil and water conservation structures and extension service was also found by Birhanu and Meseret, (2013); Damtew *et al*., (2015); Asfaw and Neka, (2017); Issahaku and Abdulai, (2019) and Wordofa *et al.,* (2020). Better exposure to education increases farmers' better understanding of the benefits and constraints. However, the result contrasts with Belachew *et al.,* (2020). Construction of physical soil and water conservation structures is capital, time, and labor-intensive. Both coffee variety adoption and TLU which help the farmer to generate more income have positively and significantly affected the adoption of physical soil and water conservation structures. The result is consistent with Nigussie *et al.,* (2015); Issahaku and Abdulai, (2019), and Belachew *et al.,* (2020).

Table 1. Factors affecting adoption of climate-smart agricultural practices

Variables	Manure Application (MA)	Minimum Tillage (MT)	Intercropping (IC)	Improved Forage (IF)	Physical soil and water Management (PM)
Region [SNNP]	-0.045 (0.094)	0.726*** (0.095)	0.950*** (0.100)	0.944*** (0.124)	-0.400*** (0.097)
Sex [Female]	0.042 (0.154)	0.052 (0.155)	0.378** (0.160)	-0.529** (0.223)	-0.118 (0.153)
Household head age in completed years	0.007* (0.004)	-0.009** (0.004)	0.007* (0.004)	0.002 (0.005)	0.003 (0.004)
Household head education in completed years	0.016 (0.013)	0.037*** (0.013)	0.049*** (0.014)	0.060*** (0.016)	0.007 (0.014)
Family size in number	-0.039** (0.019)	-0.015 (0.019)	0.069*** (0.021)	0.013 (0.022)	-0.000 (0.020)
Mean distance from farm plots in km	-0.006* (0.027)	0.137*** (0.026)	-0.015 (0.028)	-0.051* (0.031)	-0.028 (0.027)
Access to natural resource management extension [Yes]	0.491*** (0.135)	0.478*** (0.141)	-0.055 (0.144)	0.325* (0.168)	1.034*** (0.128)
Participation on field days [Yes]	0.372*** (0.105)	0.226** (0.103)	0.211* (0.113)	0.192 (0.123)	0.178 (0.115)
Radio ownership [Yes]	0.100 (0.091)	0.216** (0.090)	0.096 (0.096)	0.007 (0.109)	0.211** (0.094)
Tropical Livestock Units (TLU) in numbers	0.011* (0.012)	-0.019 (0.012)	-0.067*** (0.013)	0.059*** (0.013)	0.038*** (0.013)
Total land in hectares	-0.039 (0.030)	0.099*** (0.029)	-0.091*** (0.034)	-0.051 (0.034)	-0.027 (0.031)
Improved coffee adoption [Yes]	-0.154* (0.090)	0.025 (0.089)	-0.183* (0.095)	0.032** (0.109)	0.334*** (0.092)
Household credit access [Yes]	-0.231** (0.089)	0.067 (0.090)	-0.207** (0.097)	0.032 (0.107)	0.001 (0.093)
Off-farm income-generating activities [Yes]	0.401*** (0.102)	-0.151 (0.104)	0.528*** (0.112)	-0.024 (0.121)	0.048 (0.108)
Constant	-0.801*** (0.307)	-1.067*** (0.310)	-1.868*** (0.332)	-4.156*** (0.437)	-0.332 (0.311)
Number of draws = 5; Number of observations = 918; Wald $chi^2(70)$ = 668.57; Prob > chi^2 = 0.000					
Estimated covariance of the correlation matrix					
rhoMTMA = -0.158(0.053) *** rhoICMA = 0.227(0.054) *** rhoIFMA = 0.141(0.060) ** rhoPMMA = 0.220(0.054) *** rhoICMT= -0.019(0.056)			rhoIFMT = 0.009(0.059) rhoPMMT = 0.118(0.055) ** rhoIFIC = 0.077(0.061) rhoPMIC = 0.202(0.057) *** rhoPMIF = 0.265(0.061) ***		
Note: Numbers in the parenthesis is standard error					

*** (P < 0.01); ** (P < 0.05); * (P < 0.10).

CONCLUSIONS AND POLICY INTERVENTION

The study found a positive and significant effect of education, extension (extension services and participation on field days), and communication (ownership of radio) on the adoption of climate-smart agricultural practices. Thus, policymakers and public authorities must pay due attention to problems affecting effective farmers-extension linkage. Extension service is beyond expert assistance in the improvement of production and marketing. It also enables a flow of information and the transfer of knowledge and scientific findings. The agricultural extension workers have an effective and important role in helping farmers solve agricultural problems. Thus, extension workers must have a wide knowledge of various agricultural disciplines and they should have the ability to deal with farmers. The farmers' training center system which is partially functioning currently should also be strengthened to its full capacity. The positive effect of radio ownership on technology adoption also suggests launching FM channels to farmers which initially focuses on the provision of agricultural information and knowledge.

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