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The Nexus Between Access to Agricultural Extension Services and Adoption of Sustainable Soil Conservation Practices in Limu Districts, Oromia, Ethiopia

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Abstract
Provision of agricultural extension service is the primary mechanism that increases smallholder farmer's adoption of sustainable soil conservation practices. This study was, therefore, attempted to examine the nexus between access to agricultural extension services and the adoption of sustainable soil conservation practices in western oromia in the case Limu districts. Data was collected from both primary and secondary data sources. Primary data was collected using a structured questionnaire collected from 771 sample respondents. Descriptive, inferential, and seemingly unrelated bivariate probit regressions (SUBPR) were used for data analysis. The results of the SUBPR indicated that sex of household head, educational attainment of household head, credit, access to information and income were among the common underlying factors affecting access to agricultural extension services and adoption of sustainable soil conservation practices in Limu districts. Therefore, government should strengthen rural credit institutions, dissemination of information, and infrastructural development issues were some of the areas that should be considered.

Keywords: Agricultural Extension, Soil Conservation, Seemingly Unrelated Bivariate Probit, Ethiopia

1. Introduction

Agriculture remains the backbone of the Ethiopian economy. It contributes 27.5 billion dollars or 34.1% to the GDP, employs some 79% of the population, accounts for 79% of foreign earnings, and is the major source of raw material and capital for investment and capital for investment and market [1]. To strengthen the sector, the Government of Ethiopia has demonstrated a strong commitment to agriculture and rural development through the allocation of over 10% of the national budget to deliver enhanced production technologies and support services [2].

The Ethiopian extension system uses Farmers Training centres (FTC) based agricultural extension approach, coupled with farmer groups such as one-in-five and development units, which are considered an entry point for the grass-roots extension services and for the bottom-up extension approach. FTCs assisted by development agents and farmer groups are expected to give a wide range of agricultural extension services, forward-looking and sustainable farmer-owned agricultural extension system. The extension system in Ethiopia has great potential to help farmers throughout the country. The government established and operationalized 25 ATVETs in different parts of the country to produce skilled development agents (DAs) sought to establish a Farmer Training Centre (FTC) in each kebele and deployed three DAs with specializations in crop, livestock and natural resources to each FTC.

To date over 70,000 DAs have been trained and graduated, of whom about 45,000 are currently deployed in agricultural extension [3]. And Ethiopia has one of the densest agricultural extension systems in the world [2]. This agricultural extension agent has been teaching and training smallholder farmers on soil conservation practices. The major reason is that Ethiopia annually loses 1900 million tons of soil due to soil erosions [1]. These were losses of productive topsoil and for all practical purposes irreversible as it takes many years to generate a ton of topsoil. To increase crop productivity and without lowering soil fertility, the government has been providing extension services for smallholder farmers in Ethiopia.

Extension services initiatives have historically supported the adoption of technologies in Ethiopia [4]. At least 50 years have passed since the extension's inception in the country [5]. The backbone of the economy is agriculture. Subsistence agriculture is the dominant agricultural system. With high population density, rugged topography with a steep slope, and high intensity of orographic rainfall, there is the erosion of topsoil in Ethiopia. The extension services currently emphasize the safeguarding of natural resources in Ethiopia.

The Extension System provides education on conserving natural resources [6]. Farmers' knowledge of soil conservation practices also differs, so farmers may practice different soil conservation techniques depending on their degree of perception and knowledge [7]. Despite the numerous benefits attributed to soil conservation practices, its adoption among smallholder arable crop farmers has received little attention. Therefore, the major objective of this study is to examine the link between access to agricultural extension services and the adoption of soil conservation practices in western oromia: the case Limu districts, oromia, Ethiopia.

1.1. Literature Review

What are Agricultural Extension Services?

Agricultural extension is defined as the transferring of information and technologies related to agriculture from the researchers to the farmers through agricultural extension research to improve crop yields and farmers' income. Improving the efficiency and effectiveness of the extension service provision through the rewarding and sanctions mechanisms at the grassroots level and familiarizing with different actors can improve awareness about the change and enable farmers to access its benefits [6]. According to, agricultural extension service refers to the process of extending need and demand-based knowledge and skill from a center of learning to those in need (farmers and other actors) to solve their immediate problems (soil infertility, pesticides, soil erosion, and others) and increase production and productivity of farmland thereby achieve quality life [8]. Indicated that agricultural extension is the primary mechanism that enhances agricultural production [6]. The appraisal of different studies showed that the agricultural extensions have made a great contribution to the livelihoods of the farmers in Ethiopia. To increase land fertility and crop production, the extension provides a variety of soil conservation practices.

1.2. Empirical Literature

There are several studies conducted to show the linkage between access to agricultural extension services and the adoption of sustainable soil conservation practices. Analyzed the linkage between information acquisition and the adoption of sustainable land management practices (SLMP) and found that the years spent in school; agricultural extension service; the number of extensions visits and the years of farming, influenced both information acquisition and the adoption of soil conservation practices [9].

The empirical results showed that farmers who accessed agricultural extension services had a higher probability of adopting the sustainable soil conservation practices (crop rotation, contour plowing, minimum tillage and manure application), and those who did not benefit from extension services would have had an equally higher likelihood of adoption of sustainable soil conservation practices had they accessed the services [10].

In Ethiopia, evaluated various studies and indicated = that agricultural extension contributes to improving farming, improving commercialization, educating farmers, conserving natural resources, promoting new technology, promoting sustainable agriculture, and disseminating information across various settings [6].

However, the study by underlines that 'access' to agricultural extension services does not guarantee 'adoption' of the technologies or better farm practices, as all the variables emerging as significant in the case of 'access' do not emerge as significant for 'adoption' of agricultural technologies [3].

2. Methodology

Limu Wereda was one of the east Wallagga districts in oromia regional state of Ethiopia. It was found to be 134km away from Nekemte, which was the capital city of the zone and 464km from Addis Ababa. It was bordered in the South by Sasiga, in the West by Haro Limu, in the North by Ebantu and the East bordered by Gida Ayana districts, respectively [11]. The area lied within 8.31°52’ to 10.190 44N Latitude and 36.97°51-37.11°52E Longitude. The district had 20 kebeles of which 17 are rural-based administration areas and 3 kebeles were urban. According to, the total population of the district was 93359 of which males accounted for 46189 and females accounted for 47170 of the total population of the district, 97.32% were rural agricultural households [12]. The estimated total area coverage of the districts was 108587 hectares. The area was well known for its high vegetation cover and most of the surrounding area was covered by tropical rain forest comprising a rich mixture of woody species arranged in many stories. The district was characterized by a long rainy season that extends from March / April to October. The mean annual rainfall ranged from 1000mm to 2400mm. Over 85% of the total annual rainfall occurred in 8 months’ rain seasons. The mean temperature of the district ranged from 100c (lowest) and 330c highest.

The dominant soil type of the district was loamy soil. The area was characterized by subsistence mixed farming system in which both crops and livestock productions were common economic activity [11]. Major cereal crops grown in the district were maize, barley, sorghum, wheat, millet, teff. Moreover, root crop was produced in the district include sweet potato and taro (godere) and fruit products like bananas and avocado are produced in the district.

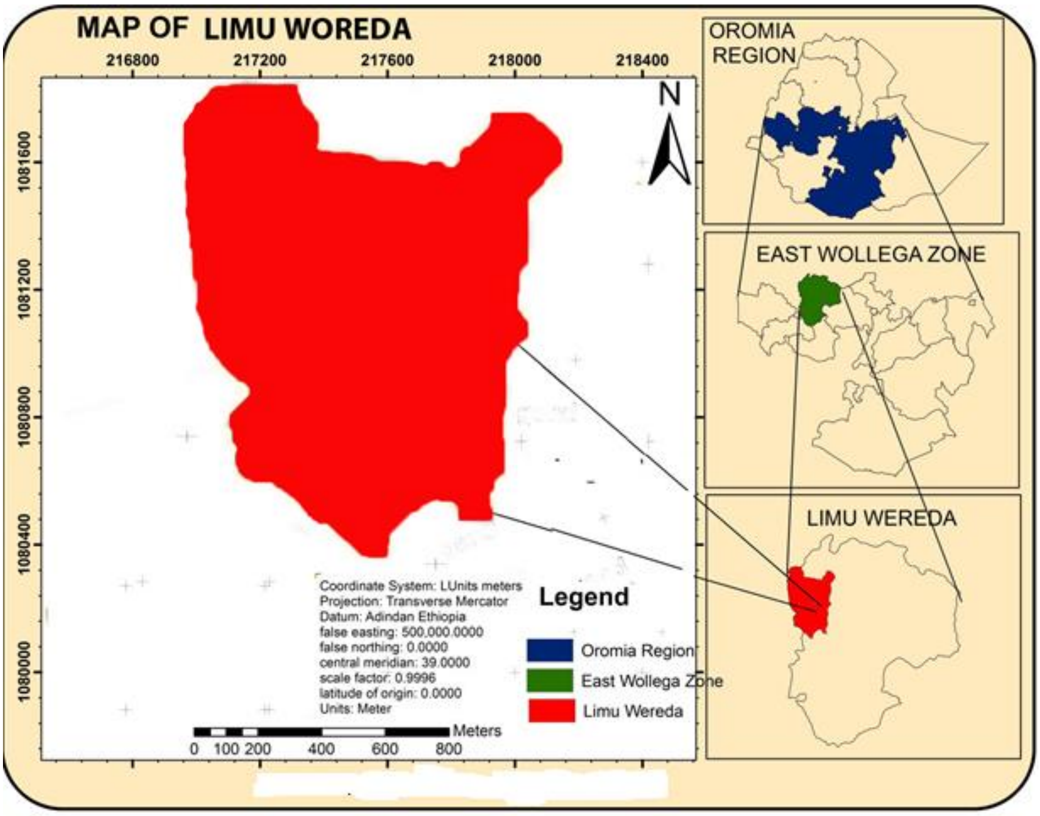

Figure 1: Map of Limu Woreda, East Wollega, Oromia, Ethiopia

In this research, both primary and secondary data were collected. Primary data were collected using structured questionnaires. Questionnaires were distributed to 771 sample household heads. First, from 17 rural kebeles in the district, eight Kebeles Namely Bolale Kebele, Degem Silase Kebele, Harqumbe Kebele, Melka Lami Kebele,Ofata Jaha Kebele, Saketa Kiltu Babo Kebele, Saphera Kebele And Waro Kebele were selected based on recommendation by Wereda Agricultural offices. The sample frames for this study were obtained from respective kebeles. Based on this household size proportional sampling was done to make representatives from each kebele.

Descriptive statistics and econometric models were used to analyze the data collected from the households. Descriptive statistics such as mean, percentage, frequency, and standard deviation, minimum and maximum were used to analyze the socio-demographic characteristics of households and constraints of coffee production.

To examine the relation between nexus between access to agricultural extension services and adoption of sustainable soil conservation practices, a seemingly unrelated bivariate probit model was used. The two dependent variables are dichotomous to represent whether a farmer received extension services (1= yes; 0 otherwise) and whether the farmer adopt sustainable soil conservation practices (1 = yes; 0 = no). In the ordinary probit model, there is only one binary dependent variable Y and so only one latent variable Y* is used. In contrast, in the bivariate probit model, there are two binary dependent variables Y_1 and Y_2, so there are two latent variables: Y_1^* and Y_2^*. It is assumed that each observed variable takes on value 1 if its underlying continuous latent variable takes a positive value, otherwise zero. Then, the seemingly unrelated bivariate probit regression model can be specified as:

$$Y_{1i} = \begin{cases} 1 \text{ if } Y_{1i}^* > 0 \\ 0 \text{ otherwise} \end{cases}$$

$$Y_{2i} = \begin{cases} 1 \text{ if } Y_{2i}^* > 0 \\ 0 \text{ otherwise} \end{cases}$$

$$\text{with} \qquad (1)$$

$$Y_{1i}^* = X_1\beta_1 + \varepsilon_1$$

$$Y_{2i}^* = X_2\beta_2 + \varepsilon_2$$

Where Y_{1i} and Y_{2i} are mutually dependent or endogenous, Y_{1i} is binary coded access to extension services, Y_{2i} is binary coded adoption of soil conservation practices, X's are exogenous variables, ε_1, and ε_2 are the stochastic disturbance terms.

Fitting the bivariate probit model involves estimating the values of β_1, β_2, and ρ. To do so, the likelihood of the model is maximized as:

$$L(\beta_1,\beta_2)=[\Pi\, p(Y_1=1,\ Y_2=1|\ \beta 1,\beta 2)^{Y_1Y_2} P(Y_1=0,\ Y_2=1|\ \beta_1,\beta_2)^{(1-Y_1)Y_2}$$
$$p(Y_1=0,\ Y_2=0|\ \beta_1,\beta_2)^{(1-Y_1)(1-Y_2)} P(Y_1=1,\ Y_2=0|\ \beta_1,\beta_2)^{Y_1(1-Y_2)}] \quad (2)$$

The coefficients of these parameters need to be transformed to the bivariate probit model is based on whether or not ρ is significant. If a Wald test shows that ρ is significant, then both access to extension services and adoption of soil conservation practices are endogenous. If ρ is insignificant, then no endogeneity bias is present and both equations can be estimated separately as binary probits.

3. Results and Discussion

In this section discusses and presents observation results to describes characteristics of sample households and econometrics results were discussed.

Table 1: Tabulation of Dummy Variables by Access to Extension Services

Variables	Category	Have you received any training or have you visited/contacted agricultural extension agents in the last cropping season?			Pearson Chi2
		no	yes	Total	
Sex of household head	Female	115(52.25%)	105(47.73%)	220(100%)	10.96***
	Male	216(39.2%)	335(60.8%)	551(100%)	
Access to credit	No	216(51.18%)	206(48.82)	422(100%)	25.92***
	Yes	115 (32.95%)	234(67.05%)	349(100.00%)	
Access information	No	282(50.54%)	276(49.46%)	558(100%)	47.70***
	Yes	49(23%)	164(77%)	213(100%0	
Adoption of sustainable soil conservation practices	No	324(56.74%)	247(43.26%)	571(100%)	171.38***
	Yes	7(3.5%)	193(96.5%)	200(100%)	

Note: *** p<.01, ** p<.05, * p<.1

Source: Computed from own survey data (2023)

From the total sample female respondents, 105(47.73%) of them have access to extension services while from the total male respondents, 335(60.8%) have access to extension services. The Pearson Chi2 result is 10.96 and indicates that there is a statistically significant association between sex of respondents and access to extension services at less than 1% significance level. In terms of access to credit, from the total respondents who received no credit only 102(24.17%) of them have access to extension services while from those who received credits 98(28.08%) received extension services. The Pearson chi-square result (chi–square =25.92) showed that there is a statistically significant association between access to credit and access to extension services at less than a 1% significance level. Of the total sample respondents who access to information 164 (77%) of them have received extension services. The chi-squared result is 47.7 and statistically significant at a 1% significance level. Of the total respondents who adopted sustainable soil conservation practices, 193(96.5%) of them were who received extension advice from development agents. Confirmed that access to extension services had a substantial impact on the adoption of sustainable soil conservation practices [10].

Table 2: Tabulation of Dummy Variables by Adoption of Soil Conservation Practices

Variables	Category	Have you practiced oil conservation methods in your crop field?			Pearson Chi2
		no	yes	Total	
Sex of household head	Female	185(84.09%)	35(15.91%)	220(100%)	16.12***
	Male	386(70.05%)	165(29.95%)	551(100%)	
Access to credit	No	320(75.83%)	102(24.17%)	422(100%0	1.52
	Yes	251(71.92%0	98(28.08%)	349(100%0	
Access to information	No	436(78.14%)	122(21.86%)	558(100%0	17.47***
	Yes	135(63.38%)	78(36.62%)	213(100%0	

Source: Computed from own survey data (2023)

From the total male respondents, 386(70.05%) of them were non-adopters of sustainable soil conservation practices while from the total male respondents, 165(29.95%) of them were adopters of sustainable soil conservation practices. The chi-square result is 16.12 and statistically significant at a 1% significance level. This shows the association between sex of respondents and the adoption of soil conservation practices.

In terms of access to information, those who have access to information, 36.62% of respondents have practiced sustainable soil conservation activities. The chi-squared result is 17.47 and indicates that there is a statistically significant association between access to information and the adoption of sustainable soil conservation practices.

Table 3: Two-Sample T-Test for Comparison of Those Who Have Access to Extension Services with Others Who Received No Extension Service

Variables	Mean of Access to extension services		Difference	Standard Error	t value
	No(=331)	Yes (=440)			
age of household head	46.272	44.818	1.454	0.991	1.45
Educational attainment of household head	4.359	6.009	-1.65	0.506	-3.25***
Landholding in hectares	1.509	1.523	-0.014	0.099	-.15
distance from all-weather roads in kms	7.423	5.87	1.552	0.322	4.8***
Annual income in (,000) ETB	16.531	18.846	-2.315	2.251	-1.05

*** p<.01, ** p<.05, * p<.1

Source: computed from own survey data (2023)

The mean of education for those who received extension service was 4.359 while the mean for those who received extension service was 6.009 grades. The t- value is 3.25 and shows that there is a statistically significant difference between the two groups in terms of Educational attainment of respondents.

In terms of distance from the all-weather road, the mean for those who received an extension visit is nearer to the road. The t-value is 4.8 and shows that there is a statically significance difference between the two groups in terms in terms of distance to all-weather roads.

Table 4: Two-Sample T-Test for Comparison of Those Who Have Access to Extension Services with Others Who Received No Extension Service

Variables	Mean of Adoption of sustainable soil conservation practices		Difference	Standard error	t-value
	no (=571)	Yes (=200)			
age of household head	46.002	43.845	2.157	1.119	1.95*
Educational attainment of household head	5.051	6.015	-.964	.575	-1.7*
Landholding in hectares	1.531	1.477	.053	.111	.5
distance from all-weather roads in kms	6.726	5.998	.728	.368	2**
Annual income in (,000) ETB	16.221	22.511	-6.29	2.533	-2.5**

***** p<.01, ** p<.05, * p<.1**

Source: computed from own survey data (2023)

Table 5: Seemingly Unrelated Bivariate Probit

Independent variables	Access to extension services			Adoption of sustainable soil conservation practices		
	Coefficient	St.Err.	t-value	Coefficient	St.Err.	t-value
Sex of household head(1= male; 0= = female)	0.276***	0.106	2.61	0.472***	0.12	3.93
Educational attainment of household head	0.016**	0.007	2.26	0.004	0.007	0.62
Landholding size l;’	-0.076	0.047	-1.61	-0.155***	0.051	-3.03
Received credit(1= yes; 0= no)	0.431***	0.096	4.5	0.067	0.1	0.67
Access to information (1 =yes; 0= no)	0.687***	0.111	6.2	0.434***	0.107	4.06
Distance to all weather road	-0.054***	0.011	-4.95	-0.026**	0.012	-2.27
Annual income in (,000) birr	0.004**	0.001	2.4	0.007***	0.002	3.13
Constant	-0.066	0.129	-0.51	-0.915***	0.148	-6.17
athrho	1.1318***	0.112	10.12			
Mean dependent variable = 0.259 SD dependent variable = 0.439 Number of observation =771 Chi-square = 117.58***						

*** p<.01, ** p<.05, * p<.1
Source: computed from own survey data (2023)

The result indicated the probability that access to agricultural extension services related to the probability of adoption of sustainable soil conservation practices through unobserved effects captured in the error terms of the models. The athrho result indicated that there is a linkage between access to extension services and the adoption of sustainable soil conservation practices. The probable justification is that the provision of extension services improves the awareness of farmers and reduces the primitive way of soil conservation practices. This result is congruent with the finding [9].

Table 6: Descriptive Statistics of Predicted Probabilities

Names of estimated probabilities	Mean	Std. Dev.	Minimum	Maximum
Pr(dependent =1, dependent 2 =1) (p11)	0.248	0.115	0.016	0.757
Pr(dependent =1, dependent 2 =0) (p10)	0.319	0.101	0.018	0.633
Pr(dependent =0, dependent 2 =1) (p01)	0.011	0.01	0	0.097
Pr(dependent =0, dependent 2 =0) (p00)	0.011	0.01	0	0.097

Source: computed from own survey data (2023)

Table 7: Marginal Effects After Seemingly Unrelated Bivariate Probit Regression Model
y = Pr (access to extension=1, adoption of sustainable soil conservation practices = 1)

variables	dy/dx	Std.Err.	z
Sex of household head*	0.1328***	0.030	4.360
Educational attainment of household head	0.002	0.002	0.810
Landholding size	-0.046***	0.015	-3.030
Received credit	0.031	0.030	1.040
Access to information	0.151***	0.036	4.200
Distance from home to farm land	-0.009**	0.004	-2.590
Annual income in (,000) birr	0.002***	0.001	3.180

(*) dy/dx is for discrete change of dummy variable from 0 to 1
Source: computed from own survey data (2023)
*** p<.01, ** p<.05, * p<.1

3.1. Sex of Household Head

In most developing countries gender differences are significant. Male headed households are dominant in agriculture. The coefficient of this variable is positive and statistically significant at less than 5% significance level. This indicates that being male increases the probability of simultaneously both access to agricultural extension services and adoption of sustainable soil conservation practices. The probable justification is that farming families headed by males are generally have higher standards of living than female headed families when measured by income and wealth this result is consistent with the findings of who stated that as sex of the household head becomes female, the tendency to participate in public agricultural extension services decreases [13]. This result confirms the findings of that male-headed households are more likely to be engaged in the adoption of soil conservation practices than female-headed households [14]. The result of this study further found that being male increases the probability of simultaneous access to extension services and adoption of sustainable soil conservation practices by 13.28% and is statistically significant at a 1% significance level. This finding also corroborates the findings of that women farmers were predicted to have considerably lower extension access scores than men [15].

3.2. Landholding Size

Land is the most important conventional input in agriculture. It was expected that the larger the landholding size the more the households to participate in the access to agricultural extension services and adoption of sustainable soil conservation practices. Our finding indicates that with increase in land size by 1 hectare, simultaneously access to agricultural extension and adoption sustainable soil conservation practices reduced by 4.6%. This variable is statistically significant at 1% significance level. Identified farm size as the most important variable explaining participation decisions by farm household heads in agricultural extension services [13]. This result keeps the findings of who found that farmers with a small area of land were more likely to invest in soil conservation than those with a large area [16].

3.3. Access to Information

Information is very much information to get advisory services from development agents and to adopt sustainable soil conservation practices. Acquiring and possessing of information is costly. The effect of this variable was captured by ownership of information assets, such as a radio, a television, and a phone, and proximity to grain markets could potentially reduce the costs of investing in acquiring information. The marginal effect of this variable is (mfx= 0.151) and statistically significant at less than 1% significance level. This indicated that both access to information and adoption of sustainable soil conservation practices. This finding supports the findings of that the adoption rate of soil conservation practices is significantly influenced by farmers' knowledge level of farmers [5].

3.4. Distance from to Farmland

This variable was included to indicate whether day to day follow up of their land has an impact on adoption of soil conservation practices. The marginal effect of this variable is -0.009 and statistically significant at less than 5%. This indicates that the further away the farm land from farmer's home place, the less access to extension services and adoption of sustainable soil conservation practices. This study provides evidence that improvements in the availability of all-weather roads can help enhance farmers' access to agricultural extension services and easily adopt sustainable soil conservation practices. This result confirms the findings of that a one-minute increase in the distance of farmland from a farmer's home decreases the adoption of introduced soil conservation practices [14]. Supported that road access strongly influences access to extension services [15]. Similarly, Getu Mitiku and found that Distance to the nearest input market has a negative and significant influence on the probability of participation in agricultural extension services [16].

3.5. Annual Income

This variable has a positive coefficient in both access to extension services and adoption of sustainable soil conservation practices at 1%. The marginal effect shows that as the household income increases by increases by one thousand birr the probabilities simultaneous access to agricultural extension services and adoption of sustainable land management by 0.2%, other things remain constant. This variable shows economic status of households to buy new farm tools to adopt soil conservation practices. This result supports the finding [17].

4. Conclusions and Recommendations

The major objective of this study was to investigate the nexus between access to agricultural extension and the adoption of sustainable soil conservation practices in Limu districts of east Wollega Zone. Since sustainable soil conservation practices can be adopted due to access to agricultural extension services, a seemingly unrelated bivariate probit regression was fitted. Results indicated that there is a strong positive association between access to agricultural extension and the adoption of sustainable soil conservation practices. Since extension services were the main instrument used in the promotion of demand for modern technologies, appropriate and adequate extension services should be provided. This could be done by designing an appropriate capacity-building program to encourage development agents to reduce the shifting job, Strengthen the DA education system, provide more funding to sustain quality centers, ensure the provision of equipment or inputs to demonstrate best farming practices, increase coordination among institutions that delivered extensions services.

Disclosure Statement: The authors declare no conflict of interest

Compliance with Ethical Standards

This article does not contain any studies involving animals performed by any of the authors.

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