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Determinants of Research-Extension-Farmers Linkage in the Process of Technology Transfer: The Case of Dangila District, Ethiopia

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Abstract: The study was conducted at Dangila district, Amhara region, Ethiopia. The concept of linkage in this study is communication and work together to develop and disseminate improved agricultural technologies to farmers. Researchers and development agents are the main actors in the process of technology release and transfer and their achievement depends on strong linkages with each other. The lack of integration and coordination between agricultural research and extension has resulted in confusion as to who should undertake on-farm verifications and pre-extension trials before making technologies directly available to farmers. The objective of this study was to identify and describe the factors that influence farmers' participation on the technology demonstration. Simple random and purposive sampling techniques were used for selecting respondents and study area for this study. The data collection tools also included interview schedules and check lists. The data were analyzed through binary logistic regression model. The binary logistic regression model analysis result indicated that, Sex, education, extension advisory service and land ownership factors were significantly influence the farmers' participation on the technology demonstration. In general perspective role of linkages in the process of technology transfer in Ethiopia were weak. The major reasons were non/little involvement of farmers in the research system, top-down approach, poor use of linkage mechanisms and strategies.

Keywords: Linkage, Technology Transfer, Factors Affecting, Research-Extension-Farmers

1. Introduction

The concept of linkage in this study is communication and work together to develop and disseminate improved agricultural technologies to farmers. Researchers and development agents are the main actors in the process of technology release and transfer and their achievement depends on strong linkages with each other. Extension system and research coordinated through information exchange and feedbacks on the technology [12]. Some developed countries experience implies that like, USA and Netherlands research, extension and farmers linkage were bottom-up approach that creates effective utilization of staff manpower, improve collaboration and strengthen linkages between actors [2]. But in Ethiopia research, extension and farmers system were top-down that leads weak linkage, agricultural relations and little/no farmers representation on the research process [16].

Weak linkages between research-extension and farmers that is observable still today, efforts were made since 1986 to establish strong and functional linkages. One of the options applied was by organizing committees /councils at a national level to link agricultural research and extension organizations. Accordingly, the first committee was organisedin1986 and named as Research Extension Liaison Committee (RELC). RELC was organized mainly at national level with major purposes of providing forum for stakeholders to share information and improve the adoption of agricultural technologies. It was also commissioned to undertake diagnostic studies on weaknesses of the national

researchandextensionsystemsandtostudyfactorsaffectingthead optionofpotentially useful technologies. However, RELC was criticized in its no involvement of farmers and in its irregular, ad-hoc and non-institutionalized meetings [9, 4].

Flow of information from research center to farmers requires continuous contact between actors. If the link is weak the agricultural productivity will not increase. These system criticisms the technical weakness, involving only big farmers, practicing top-down administration, poor dissemination of improved agricultural technologies [10]. Still the extension system in Ethiopia is limited with the consistency and quality of extension implementation, weak coordination between actors and feedback systems [11].

Researches have not been generally based on the real problems of farmers and they rarely took into account farmers' circumstances in terms of objectives, resources and limitations. Until recently the researches had been conducted in an environment which was totally different from that of small farmers and whatever little research outputs were disseminated to farmers had been directly given to extension workers without prior on-farm verification for their acceptability. The lack of integration and coordination between agricultural research and extension has resulted in confusion as to who should undertake on-farm verifications and pre-extension trials before making technologies directly available to farmers. Disseminated research outputs due largely to the loose link between research and extension and/or the physical separation of researchers from farmers. Many of the farmers are not aware of the existence of technologies developed by researchers. The objectives of this study were listed as follows:

1. To analyze factors affecting farmers participation on the technology demonstration.
2. To identify and describe research-extension and farmers linkage in the process of technology transfer.

2. Methods and Materials

2.1. Research Design

2.1.1. Sampling Unit

This research applies cross-sectional research which uses collection of data from representative sample from the population at a single point in time [3], cited by [7]. The sampling units of this study were farmers who had been participating at least one of linkage mechanisms for a minimum of three years before to this study. These criteria are important to guarantee that respondents had the essential information and awareness on the study.

2.1.2. Sampling Method

Simple random sampling and purposive sampling techniques were used for selecting respondents and study area for this study. The Dangila district was selected purposively for this study because it is one of frequently technology verification and demonstration sites of Adiet research and Fogera rice research centers, Bahir Dar and Injibara Universities. Gayita kebele were selected from the district purposively based on their prior implementation of linkage mechanisms with researchers and extension workers. The farmers were selected by using simple random sampling technique who was implemented one of linkage mechanisms with researchers within three years prior to this study.

2.1.3. Sample Size Determination

The sampling frame was prepared from the selected kebeles to select the farmers and had selected 165farmer respondents randomly. Extension workers selected who were conducted linkage mechanisms with agricultural research in three years prior to this study for key informant group discussions.

The sampling size was determined by using Yemane formula [15] due to its simplicity and predetermined population. N=280 and 0.05 precision level was decided:

$$n= \frac{N}{1+N(e)^2}$$

Where,
n=sample size
N=the population size
e=precision level

2.2. Method of Data Collection and Analysis

2.2.1. Method of Data Collection

Interview schedules and check lists were used as data collection tool. Interview schedule methods were used to collect data from the farmers interviewed by enumerator and checklists also used to collect qualitative data through focus group discussions. Three focus group discussions were conducted to collect qualitative data by using checklists. In each group 5-8 members were involved and discussed. The interview schedules were prepared to collect primary data like socio-demographic characteristics of respondent's factors affecting farmers' participation on the linkage mechanisms. The qualitative data also collected by face to face interview and group discussions with the selected key informant extension workers who were voluntary to provide valuable information.

2.2.2. Method of Data Analysis

The data were verified, coded and entered into a computer and were analyzed using SPSS software package version 20.0. Descriptive data analysis was used to analyze frequencies, percentage, minimum, maximum, mean and standard deviation. The inferential statistics analyze the factors affecting farmers' participation on linkage mechanisms by using binary logistic model. Qualitative data was analyzed through narration.

2.3. Binary Logit Model

Factors influencing farmers' participation on technology demonstration were also analyzed through binary logit model. Binary logit model is used to analyze factors affecting independent variables on the dependent variables which the dependent variable is dichotomous like the value of 1 if

independent variable influenced and 0 other wise. The farmers' decision to participate on the technology demonstration based on binary option and the independent variables may as dummy, categorical or ordinal.

Farmers' decision related to participation on the technology demonstration is chosen by dummy variable:

$$\text{Di} = \int \begin{matrix} 1 \text{ if the farmer participate on the technology demonstration} \\ 0 \text{ if the farrmer not participate on the technology demonstration} \end{matrix}$$

To determine the factors affecting farmers' decision on whether participate or not, the binary logistic model is constructed as follows [8]:

$$1n\frac{pi}{1-pi} = \alpha + \sum_{n=1}^{n} \beta nxni$$

Where:

P_i=probability of farmers participation

α=the intercept variable

β=vector of regression coefficient

X_{ni}=vector of n independent variable

1n=natural log of logit model

As a result, for this data logistic regression is appropriate model to measure how independent variables affect farmers' participation likelihood of being participated or not. The Logit function can be derived from odds ratios:

$$\text{Log odds ratio}=log\frac{success}{failure} = log\frac{y=1}{y=0} = \beta 0 + Xi\beta \qquad (1)$$

Where, y_i=1 represents an individual "i" is being participated (success), and y_i=0 represents an individual "i" is being not participated (failure), xi is column vector of independent variables.

3. Results and Discussion

3.1. Demographic and Socio Economic Characteristics of Farmers

89.7% of sample farmers were men and 10.3% of farmers' respondents' women (table 1). In the study area in most linkage mechanisms men farmers were involved and the women farmers decision dominated by men. An average sample farmer respondent's age was 41 years old. 67 years was the maximum age and 30 years was minimum age of respondents in the study area. 69.7% of farmers were received trainings related to the importance of linkages and linkage mechanisms for technology transfer. The training mostly given by researchers and extension workers participate on the training with farmers. But, 10.3% of sample farmers confirmed, they were not received training related to linkage mechanisms. In the study area, there were number of trainings conducted by different non-governmental projects. However, the content of training was not including linkage related topics. Table 1 result indicated that, 70.9% of farmers accessed extension services by development agents where as 29.1% of farmers were not get extension advisory service regarding to linkages and linkage activities in the study area. The current extension advisory system focus of seasonal activities that slow down the linkage related extension service. In general, majority of extension workers provide linkage and linkage mechanisms related extension service was in needs of researchers and collaborative activities with researchers.

The assumption of researcher on the land variable in this study was the main determinant to participate the farmers on the linkage activities. To this regard, greater land ownership increase farmer's interaction with researchers and extension workers. In the study area the maximum land holding was 2ha and minimum 0.25ha. The average land holdings of the sampled farmers in the study area were 0.99ha. The average active agricultural labor in the household was 4.32 (~4) and the maximum and minimum numbers of active labor on the household were 9 and 2 respectively in the study area. The number of family size increase within the household related to farmers participation on the linkage mechanism which supports as labor on the technology demonstration. The other data collected on the farmers was weather read and write or not that expected to improve the farmers' capacity to search information and use extension materials to know how to operate the technologies. It is therefore likely to increase the farmers' ability to identify and prioritize their problems on their own situation towards increasing technology transfer. The result shown that from the (Table 1) 65.5% of farmers can read and write and 34.5%cannot read and write. As observed during the field visits and discussions this has helped the farmers to be easy to access improved technologies and appropriate to use extension materials to operate the technology and improve their participation on linkage activities. As indicated in the table1, the farmers having maximum four times experienced and minimum one times experienced on the linkage activities, with an average experience of 1.79 (~2) times in linkage activities in the study area.

Table 1. *Demographic and socio-economic characteristics of farmers.*

No.	Variables		Descriptive	Mean	Standard deviation
	Continuous variables				
		Maximum	67		
1.	Age	Minimum	30	41.38	8.646
		Average	41.38		
		Maximum	2.000		
2.	Landholding	Minimum	.250	0.996	0.436
		Average	.99697		

No.	Variables		Descriptive	Mean	Standard deviation
3.	Family size	Maximum	9	4.32	1.505
		Minimum	2		
		Average	4.32		
4.	Experience	Maximum	4	1.79	0.854
		Minimum	1		
		Average	1.79		
	Dummy variables		Percent		
4.	Sex	Men	89.7	1.10	0.305
		Women	10.3		
5.	Training	Yes	69.7	0.70	0.461
		No	30.3		
6.	Education	Read and write	65.5	0.65	0.477
		Not read &write	34.5		
7.	Extension service	Yes	70.9	0.71	0.456
		No	29.1		

Source: own survey, 2021.

3.2. Factors Affecting Farmers Participation on the Technology Demonstration

The main objective of this study was factors affecting farmers' participation on the technology demonstration which analyzed through binary logistic regression model. The model analyzes influence of independent variables on the dependent variables. The selected variables were fit with the model well. Additionally, considering the tolerance and the variance inflation factor values, there was no collinearity among the independent variables of the estimated model. Results indicated that sex, literacy level, extension advisory service and land ownership had positive coefficient and was significant at 5% of probability level (see table below). As a result, the odds ration also use to see the strength of influences and significant influence is more likely to participate on the technology demonstration.

Sex: Gender had positive coefficient (1.895) and significant factor on the farmers' participation on the linkage activities at 5% probability level. The odds ratio result indicated that, men are 6.653 times more likely to participate on the linkage activities than women. Men have more decision making power and control of household's resource than women that creates interaction and communication with researchers and extension workers. Researchers and extension workers are limiting women participation on the meetings, demonstrations, field days, membership of FRG and trainings in the study area. Similar findings reported by [6] due to gender equality not fulfilled.

Education: the result of logistic regression analysis on the table 2 indicated that, literacy level of the farmer influence positively and significant at the 5% level of probability with positive coefficient of 1.535. One unit literacy rate increase is 4.643 times more likely to farmers participate on the linkage mechanisms. In this study farmers who can read and write were more likely participate on the linkage mechanisms. The farmers who can read and write and better educated improve farmers' capacity to search and use information from researchers and extension workers, easy to adopt the technology and effectively use extension materials as linkage mechanisms.

Extension service: advisory extension service had positive coefficient (0.230) and was significant at 5% probability level. The odds ratio indicated that, farmers had accessed to extension service are 1.259 times more likely to participate on the linkage mechanisms. This indicated that higher frequency of extension contact increase probability of farmer's interaction with researchers and extension workers. Farmers get regular extension service related to linkage is more likely to participate on the linkage mechanisms. This finding is similar with the work of [5] in Ethiopia. The linkage mechanisms used as extension method in the study area were method demonstrations and trainings at FTC, experience sharing.

Land holdings: land ownership had positive coefficient (1.918) and statistically significant at 5% probability level. The farmers who have large size of land are 6.804 times more likely to participate on the research activities. In the study area, the maximum land holding by sample respondents was 2 ha and the minimum was 0.25 ha. The average land holding of the sample farmers were 0.89 ha. Thus, farmers participate more in the linkage mechanisms when they feel they have the land tenure security. This implies that farmers have more land size increase their probability of participation on the linkage activities. The result confirms the work of [14] his studied in Nigeria and [13].

Distance from FTC: This variable was designed to evaluate the effect of exposure to farmers' participation on the farmer training centers generated from research organizations. Thus the study considered the diffusion of information on the technologies across distance from farmer training center. Distance from FTC influences farmers participation positively and significant at the 5% level of probability with positive coefficient of 1.813. Thus it was direct that nearness to agricultural demonstration sites influences farmers participation on the agricultural technology demonstration. The work of [1] result indicated that the relationship between FTC and farmers participation on the technology demonstration is directly proportional.

Table 2. *Binary logistic regression model result of factors influencing farmers' participation on technology demonstration.*

No.	Variables	Co-efficient	S. E	Significance	odds ratio
1.	Sex	1.895	.768	.014**	6.653
2	Age	.142	.361	.621	.728
3.	Training access	.845	.609	.166	2.327
4.	Experience	-1.182	.264	.382	.307
5.	Family size	-.137	.163	.401	.872
6.	Land ownership	1.918	.697	.006**	6.804
7.	Extension service	.230	.555	.033**	1.259
8	Distance from FTC	1.813	. 796	.017**	5.935
9	Literacy level	1.535	.574	.008**	4.643
	Constant	-2.895	1.180	.014**	.055
	Model Chi-square	62.060			
	Hosmer-Lemeshow test				
	Chi-square	10.139			
	Significance	.255			
	Cox and Snell R2	.313			
	Nagelkerke R2	.454			

**significant at $p<0.05$.

4. Conclusion and Recommendation

The objectives of the study were to identify and describe the factors influencing farmer's participation on the technology demonstration to transfer improved agricultural technologies. The study used binary logit model to evaluate the determinants of farmers' participation on the technology demonstration.

The agricultural research in Ethiopian generated many improved technologies. However, these technologies had low impact on the farmers' livelihood; due to lack of coordination and integration between agricultural experts and farmers and lack of farmers participation in research process. Those weak linkage systems bring, low adoption rates and decreased farming productivity. In general perspective role of linkages in the process of technology transfer in Ethiopia were weak. The major reasons were non/little involvement of farmers in the research system, top-down approach, poor use of linkage mechanisms and strategies.

Considering challenges to research-extension-farmers linkages globally especially in developing countries, capacity building for personnel and agencies saddled with extension service delivery should be given priority by government at all levels. There is need for government and agricultural agencies to organize and explore opportunities for staff exchange training across research and extension institutions and across countries to promote global dimension ideas, knowledge and lessons to enhance research-extension-farmers role performance in agricultural linkages. Therefore, the following recommendations are formulated based on findings:

1) Positive factors to influence farmers' participation on the technology demonstration were promoted and secured.
2) Adult education is important to the farmers as increase farmers' literacy level to seek agricultural information and use of extension materials as linkage mechanism.
3) Regular and frequent contact of farmers improve extension advisory service which have more informed about the use of agricultural technologies.
4) Land owner ship and land tenure security assure farmers interaction with researchers and extension workers.
5) Gender equality is another issue to guarantee sustainable farmers participation on the technology demonstration.

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