

Analysis of Research–Extension-Farmers Linkage: The Case of Dangila District, Ethiopia

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Abstract: The extension system in Ethiopia is used pipeline extension model, which researchers develop technology, extension workers act as technology disseminator and farmers are technology users. Such top-down approach characterized by separate involvement of actors limits the farmers' opportunity to get knowledge and skills on the technology. The overall aim of the study was to identify and describe the linkages and linkage mechanisms among research- extension-farmers. Simple random, snowball and purposive sampling techniques were used for selecting respondents and study area for this study. The data collection tools also included interview schedules, questionnaires, and check lists. The data were analyzed through descriptive statistics and mann-whitney U-test non parametric statistical tool. The mann-whitney U test analysis result indicated that, linkages between research-extension and farmers show that, extension workers had strong linkage with farmers in the process of technology transfer and there is no statistically significance on the ratings of linkages between extension workers with researchers and farmers' with researchers. The linkage mechanisms also indicated that, trainings, method demonstrations and field visit linkage mechanisms were frequently and commonly used by majority of the partners. In conclusion, the linkages between farmers with researcher and extension with research were weak that needs strengthen through joint implementation of linkage mechanisms. 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 and poor use of linkage mechanisms.

Keywords: Linkage, Linkage Mechanisms, Technology Transfer

1. Introduction

Extension services can provide research institutions with information on research requirements and play a mediatory role between farmers and researchers. Extension services require a continuous flow of information from research institutions on new and improved practices. The extension system in Ethiopia is used pipeline extension model, which researchers develop technology, extension workers act as technology disseminator and farmers are technology users. Research, extension and farmers are the three main pillars of agriculture system and their effectiveness largely depends on the strong linkages among each other. Technology generation and transfer related to national agricultural productivity that

requires effective communication among stakeholders. In Ethiopia, 960 improved crop varieties, more than 96 improved technologies for livestock management, 45 for natural resource management, 9 for agricultural tools, and 5 for forestry had been released and recommended by different research institutes [13].

The first linkage platform which followed RELC was called Research-Extension and Farmers Linkage Advisory Council (REFLAC). REFLAC worked from 2000 to 2008. According to [5] better contribution to involving farmers and its research problem identification methods than previous councils. It also contributed in arranging demonstration of available agricultural technologies to farmers and extension workers through research site visits and discussions. However, it was dominated by research and the role of

extension organizations and the participation of farmers was limited.

Existence of specific linkage organization is mandatory to the success of multi-stakeholder platforms. In most cases, linkage mechanisms are used by research and extension organizations. They are usually dominated by the public sector with limited representation of farmers and the private sector. As a result, equal participation of linkage partners has been passive with limited awareness about the purpose and functions of linkage platforms. Awareness of the importance and benefits of collaboration by actors is essential if institutional arrangements have to be established to strengthen effective linkages among different actors. When key stakeholders are convinced about the benefits of participating in stakeholder platforms, they would then assume responsibility by assigning tasks to the right stakeholders and tracking their accomplishments and expected outcomes.

The extension advisory system in Ethiopia has top-down approach in which researchers generate the technology, extension workers transfer the technologies and farmers use technologies. Such pipeline extension approach restricts farmers and extension workers to familiarize the technology [4].

Released improved technology stay shelved on the research center, the case is weak relationships between researchers, extension workers and farmers in the process of linkage mechanisms implementation [2, 18]. In addition, once improved technologies were released, it expected to increase farming productivity. But, its demonstration and adoption process is difficult that is prior weak collaboration between researchers, extension workers and farmers. Farmers' livelihood improvement depends on strong linkages among actors [9]. Another importance of strong linkages between farmers, extension workers and researchers are easy dissemination and adoption of technologies, wise use and share resources and experts [1]. In this respect, the principal objective of strengthening research and extension linkages must be to cultivate greater and more effective interaction among stakeholders in the agriculture sector so as to increase agricultural productivity and thereby raise the living standard of the rural population. In this context, this study was taken up with the following objectives:

- 1) To analyze the strength of linkages between researcher with extension worker, researcher with farmers and extension workers with farmers.
- 2) To evaluate the existing linkage mechanisms between researcher, extension workers and farmers in the process of technology transfer.
- 3) To suggest some strategies to be followed for better research-extension-farmers linkage continuum.

2. Methodology

2.1. Research Design

This study applies cross-sectional research which uses

collection of data from representative sample of population at a single point in time [3, 20]. The sampling units of this study were farmers and extension workers from Dangila districts and agricultural researchers 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.

2.2. Sampling Method

The district was selected purposively for this study because it is one of frequently technology verification and demonstration sites of Adiet and Fogera rice research centers, Bahirdar and Injibara Universities. Three Kebeles namely: - Gayita, Gisa Mariam and Dengeshta were selected from the district purposively based on their prior implementation of linkage mechanisms with researchers. Researchers and extension workers were selected by using snowball sampling method. Because research unit requires the respondents implemented at least one of linkage mechanisms collaboratively, detail information and subject matter and expected to known their partners. The farmers were selected by using simple random sampling who was implemented one of linkage mechanisms with researchers at the selected Kebeles within three years prior to this study.

2.3. Sample Size Determination

The sampling frame was prepared from the selected kebeles to select the farmers and selected 165 farmer respondents randomly. Extension workers selected who were conducted linkage mechanisms with agricultural researches in three years prior to this study. Hence, 30 extension workers and 15 researchers were selected by using snowball sampling technique.

The sampling size of farmers was determined by using Yemane formula [19] 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 = minimum returned sample size,

N = the population size of farmers,

e = precision level.

2.4. Method of Data Collection

Interview schedules, questionnaires, and check lists were used as data collection tool. Interview schedule methods were used to collect data from the farmers interviewed by enumerator, questionnaires prepared to collect data from extension workers and researchers filled by them and checklists also used to collect qualitative data through focus group discussions. Three focus group discussions were conducted; one discussion with extension workers and two FGD also implemented with farmers. The qualitative data

also collected by face to face interview and group discussions with the selected key informant respondents who were voluntary to provide valuable information.

2.5. Type and Source of Data

Primary quantitative data such as linkages and linkage mechanisms between researches with extension, research with farmer and extension with farmer were types of the data that were collected on this study. Secondary data: related literatures and documents were reviewed and reports of the agricultural office and research organization were assessed.

2.6. 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 analyzed frequencies, percentage, minimum, maximum, mean and standard deviation. Inferential statistics also analyzes ordinal data by using mann-whitney U test in which non-parametric statistical tool. The tool analyses the linkages of two independent samples which is research with extension, research with farmer and extension with farmer.

Mann-Whitney U Test:

The mann-whitney U test is a non-parametric statistical test which analyzes the medians of two independent populations. The dependent variable is ordinal data and the null hypothesis is not normally distributed (median of distribution is zero).

Assume, sample of n_x observations ($x_1, x_2 \dots x_n$) from one population and sample size of n_y observations ($y_1, y_2 \dots y_n$) are another populations. The test compares every x_i first sample observation with y_i second sample observation and the total pair wise comparison result is $n_x * n_y$. The data from both samples are shared and the rank also from one to- n . An observation of the tied rank is an average of equivalent raw ranks [12].

To calculate the value of mann-whitney U test used the formula:

$$U = n_1 n_2 + \frac{n_2(n_2+1)}{2} - \sum_{i=n_1+1}^{n_1+n_2} R_i$$

U= Mann-Whitney U test,

N_1 = sample size of the first sample,

N_2 = sample size of the second sample,

R_i = rank of the sample size.

3. Results and Discussion

The results presented the mann-whitney analysis indicating the linkages and linkage mechanisms between research with extension, research with farmers and extension with farmers.

3.1. Demographic and Socio Economic Characteristics of Farmers

Sex: 89.7% of sample farmers were men and 10.3% of farmers' respondents' women (Table 4). In the study area in

most linkage mechanisms men farmers were involved and the women farmers decision dominated by men.

Age: an average sample farmer respondent's age was 41 years old .67 years were the maximum age and 30 years was minimum age of respondents in the study area.

Trainings experience: 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.

Extension service: 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.

Land: The assumptions of researcher on the land variable in this study were 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.

Family size: 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.

Literacy: 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.

Experience: as indicated in the Table 1, 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					
1.	Age	Maximum	67	41.38	8.646
		Minimum	30		
		Average	41.38		
2.	Landholding	Maximum	2.000	0.996	0.436
		Minimum	.250		
		Average	.99697		
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		

3.2. General Background of Extension Workers and Researchers

Sex: 86.7% of researchers and 63.3% extension workers involved on the linkage activities were men where as 13.3% of researchers and 36.7% were women (see Table 2). In all groups of samples, the majority of participants on the linkage mechanisms were men.

Age: Overall, the 30-40 of extension workers and 41-50 researchers' age groups categorized the largest proportion. The higher age expected to more experience on the involvement of linkage mechanisms.

Trainings: 80% of extension workers received trainings from researcher and provide to farmers. 86.7% of researchers also received and provide trainings related to linkage mechanisms. This implies that, the majority of linkage mechanisms between researchers, extension workers and

farmers were training.

Educational level: Regarding the level of education, 90% of extension workers had bachelor degree holders, while the majority of the researchers (80%) had master's degree, and 13.3% of researchers obtained PhD holders. The results on the level of education indicate that researchers were equipped with a higher level of education than extension workers.

Experience: 40% of extension workers and 20% researchers had been involved on linkage activities by 11-15 times respectively. While 13.3% of extension workers experienced on linkage activities 1-5 times but, 16.7% and 53.3% extension workers and researchers respectively implemented linkage activities more than 15 times. As indicated on the Table 5, the researchers were more experienced to implement linkage mechanisms and extension workers and researchers were an average experience of 2.60 and 3.27 times respectively on linkage activities.

Table 2. Backgrounds of Extension workers and researchers.

No.	Variables	Extension workers				Researchers		
		Values	Percent	Mean	Standard deviations	Percent	mean	Standard deviations
1.	Sex	Men	63.3	1.37	.490	86.7	1.13	.352
		Women	36.7			13.3		
		30-40	56.7			26.7		
2.	Age	41-50	30.0	1.57	.728	53.3	1.93	.704
		51-60	13.3			20.0		
		>60	-			-		
3.	Education	Diploma	10.0	1.90	.305	-	3.07	.458
		BSc	90.0			6.7		
		MSc	-			80.0		
4.	Training	PhD	-	1.20	.407	13.3	1.13	.352
		Yes	80.0			86.7		
		No	20.0			13.3		

No.	Variables	Extension workers				Researchers		
		Values	Percent	Mean	Standard deviations	Percent	mean	Standard deviations
5.	Experience	1-5	13.3	2.60	.932	-	3.27	.884
		6-10	30.0			26.7		
		11-15	40.0			20.0		
		>15	16.7			53.3		

Source: own survey, 2021.

3.3. Linkages Between Research-Extension-Farmers

The first objective of this study was analyzed degree of strength of linkages between research, extension and farmers in the process of technology transfer. The linkage participant actors should be awareness about linkage activities before this interview. This objective has an assumption to understand the degree of strength between researchers, extension workers and farmers are important to transfer improved agricultural technologies.

The measurement of degree of linkages between researchers, extension workers and farmers are uses the parameter of planning, implementation and evaluation of linkage activities [6]. It is naturally intangible which measuring is difficult. Based on this, the strength of linkage between researchers with extension, researcher with farmers and extension workers with farmers measured as follows; planning (review meetings, and ADPLAC, implementation (training, on-farm trail, method demonstration, FRG, use of extension materials) and evaluations (field day, farm visit, ADPLAC).

When the actors participated or implemented in all parameters respondents rate strong, that involved at two rate moderate, participate only one of the above rate weak and while the respondents not participated at all of research and extension activities give absent. The actors were asked to rate the level of strength (strong (3), moderate (2), weak (1) and absent (0)) of each other based on the above parameter.

Accordingly, the mann-whitney U test result analysis indicated that, there is statistically significant on the ratings of strength of extension workers linkage with farmers. The

findings of the strength of linkage show that, extension workers had highly strong collaboration with farmers in the study area. This shows that farmers have accessed extension advisory service regularly. The finding was in agreement with the work of [16] in his study in South Africa.

3.3.1. Linkages Between Researchers with Extension Workers

The descriptive analysis result indicated that, 53.3% of researchers rated moderate their degree of linkage with extension workers and 50% of extension workers also rated as moderate on the degree of linkages with researchers. The interaction of research with extension is based on technical information exchange and feedbacks on the technology.

The result of mann-whitney U test analysis result showed that, there is no significant difference between researchers (mean rank of 21.60) with extension workers (mean rank 23.70). Based on the results indicated Table 6, it needs improvement on their communication and coordination to generate and transfer agricultural technologies. In most cases extension workers desire to get incentives to work with researchers which were they think the collaborative activities were not their obligation.

In time of FGD, the participant extension workers reflect the means of communication with researchers were personal contacts and cell phone and their collaboration based on the researchers need. This finding is mentioned by [5] personal communication and phone calls were used as information exchange between researchers, extension workers and farmers.

Table 3. Mann-whitney U-test result of linkages between research with extension.

Linkages	Actor	Strength of linkages between researchers with extension workers				N	Mean rank	Mann Whitney U test	Exact sig. (2-tailed)
		Strong	Moderate	Weak	Absent				
Researcher with extension	R	13.3	53.3	26.7	6.7	15	21.60	204.000	.577 ^{NS}
Extension with research	E	20.0	50.0	30.0		30	23.70		

Source: own survey, 2021, Note: NS- not significant at P<0.05.

3.3.2. Linkages Between Researchers with Farmers

Researchers support farmers in the form of capacity building and technology supply whereas the farmers also provide land to demonstration, labor for agronomic practice and give feedbacks on the technology.

The findings on the Table 7 confirmed that, 66.7% researchers rated their degree of linkage with farmers as weak and 40% farmers also rated as weak their degree of linkage with researchers. The mann-whitney result indicated there was no significant difference between researchers with farmers and farmers with researchers with mean rank of

researcher (106.00) and extension (89.09).

The reasons for weak linkage and insignificance between researchers and farmers were as follows; limited resources to research organizations to address the mandate districts of the surroundings [9]. Another reason was insufficient number of researchers to mobilize large number of farmers; this was in line with the findings of ([4, 2]) and Farmers not participate on the on-station research process which researchers conduct the research separately [17].

One focus group discussion was conducted within researchers. During FGD, researchers discuss about how was

communicate with farmers. Hence they were communicating only when researchers had new technologies to transfer.

Table 4. Mann-whitney U-test result of linkage between research with farmers.

Linkages	Actor	Strength of linkage				N	Mean rank	Mann Whitney U test	Exact sig. (2-tailed)
		Strong	Moderate	Weak	Absent				
Researchers	R	-	33.3	66.7	-	15	106.00	1005.000	.198 ^{NS}
Farmers	F	-	32.7	40.0	27.3	165	89.09		

Source: own survey, 2021, Note: NS- not significant at $P < 0.05$.

3.3.3. Linkages Between Extension Workers and Farmers

The table 8, result implies that more of extension workers (50%) rated their strength of linkage with farmers as strong with a mean rank of 120.25 and majority of farmers (36.4%) also rated as strong their link with extension workers with a mean rank of 93.95. The mann-whitney analysis indicated that there is significant difference between extension workers collaboration with farmers and farmers' collaboration with

extension workers. This implies extension workers provide regular and effective extension service and the farmers participated on the linkage mechanisms with extension workers. Hence, farmers are active participants on the extension advisory service in the study area. According to the key informant interviews, the existing form of linkage between extension workers and farmers are appropriate to transfer new technologies. Similar finding was reported by [10] in Ethiopia.

Table 5. Mann-whitney U-test result of linkages between extension with farmers.

Linkages	Actor	Linkages between				N	Mean rank	Mann Whitney U test	Exact sig. (2-tailed)
		Strong	Moderate	Weak	Absent				
Extension with farmers	E	50.0	50.0	-	-	30	120.25	1807.500	.012 ^S
Farmers with extension	F	36.4	37.0	26.7	-	165	93.95		

Source: own survey, 2021, Note: S-significant at $P < 0.05$.

3.4. Linkage Mechanisms Between Research-Extension-Farmers

In this study, Linkage mechanisms which are the major factors of agricultural technology transfer consist of eight linkage mechanisms through which technology disseminates along the research institute to end users. Linkage mechanism referred to as “the specific organizational steps used to continue technology transfer process [8]. The 8 linkage mechanisms selected to this investigation were review meetings (planning), on-farm trails, trainings, method demonstrations, field visits, membership of farmer research groups, use of extension materials and active participation of actors on ADPLAC (joint problem identification and activity evaluation). It allows actors (i.e. researchers, extension workers and farmers) to disseminate improved agricultural technology to end users. The linkage mechanisms that actors come together should be identified to enhance exchange of ideas, technology and information about farming. The farmers concerned in the linkage were interviewed to identify which linkage mechanisms were more used to exchange information to the researchers and extension workers and capacitate them in the process of technology transfer.

The assumption is there are differences on the use of linkage mechanisms. The criterion is based on the researcher's assumption that the research variable linkage mechanisms between research-extension and farmers was operationalized and measured as the degree to which those personnel's were using linkage mechanisms to communicate with one another, and also as the degree of their mutual participation in planning, implementation and evaluation

of research and extension activities.. On the basis of these criteria's, frequently implemented and involved linkage mechanisms was rated as very much use. To analyze the degree of use of linkage mechanisms between research institute, agricultural offices (extension) and farmers and the study used eight well-known linkage mechanisms which were frequently implemented by the actors (researchers, extension workers and farmers) to develop, transfer and adopt improved agricultural technologies.

To analyze the actors have frequently applied linkage mechanisms given to score in 5-point Likert scale: (not use at all (0), very little use (1), little use (2), much use (3) and very much use (4)) on each linkage mechanisms. As findings indicated that, training, method demonstration and field visit linkage mechanisms were frequently and commonly used by majority of the respondents which supports the work of [11] in Ethiopia.

3.4.1. Linkage Mechanisms Between Researchers and Extension Workers

The findings of linkage mechanisms between researchers with extension workers indicated that, 46.7% of researcher confirmed the use of method demonstrations and field visits on their research system with extension workers, as very much use and trainings (20%), extension materials (13.3%). The mann-whitney U test result implies that, there was statistically significant between use of trainings, field days, method demonstrations and use extension materials as technology transfer techniques.

Training: 20% of linkage mechanisms between researchers with extension workers confirmed, trainings as very much use and 50% of extension workers also linked with

researchers by trainings as very much use. Most of extension workers get trainings from researchers about characteristics of improved technologies in the study area. Training is one of the most important methods of transferring technology to extension workers and farmers regarding the characteristics of technology, and facilitates scaling up of technology dissemination. Extension workers had received two days theoretical training from researchers. Similar findings reported by [3] in Tanzania.

Field day: 46.7% of researchers rated field days as very much use with extension workers whereas 63.3% extension workers rate field days as much use with researchers. Joint field trials play a major role in research-extension relations in the more advanced systems.

Method demonstrations: 46.7% of researchers use demonstrations as very much use with extension workers and linkage mechanisms of 80% of extension workers was also

demonstrations rated as very much use. This result is support the work of [14] in Nigeria on joint field demonstration and field trips/visits were major linkage mechanisms between researchers with extension workers.

Use of extension materials: 13.3% of researchers rated use of extension materials as very much use with extension workers whereas 30% extension workers rate use of extension materials as much use with researchers.

There was no significant difference between researchers communicate with extension workers in the conduct of review meetings, on-farm trails, formation of farmer research groups, involvement of in ADPLAC as tool to transfer the technologies and participation of in the ADPLAC meetings by their technology experiment and extension advisory service applied as linkage mechanism. Qualitative results: So far, researchers not invite extension workers and farmers on review and ADPLAC meetings and on technology trails [15].

Table 6. Mann-whitney U-test results of linkage mechanisms between research with extension.

Linkage mechanisms	Actors	Degree of use of linkage mechanisms					Mean rank	Mann Whitney U test	Exact sig. (2-tailed)
		4	3	2	1	0			
Review meetings	1	-	-	33.3	40.0	26.7	25.87	182.00	0.284 ^{NS}
	2	-	-	20.0	26.7	53.3	21.57		
Trainings	1	20.0	33.3	33.3	13.3	-	17.60	158.500	0.002 ^S
	2	50	50	-	-	-	25.70		
on-farm trail	1	-	-	20	40	40	30.40	114.000	0.068 ^{NS}
	2	-	-	-	20	80	19.30		
Demonstrations	1	46.7	40.0	13.3	-	-	16.00	144.000	0.022 ^S
	2	80	20	-	-	-	26.50		
Field visits	1	46.7	40.0	13.3	-	-	27.43	120.000	0.005 ^S
	2	16.7	63.3	20	-	-	20.78		
FRG	1	-	13.3	33.3	40.0	13.3	22.50	217.500	0.855 ^{NS}
	2	-	10.0	40	26.7	23.3	23.25		
Extension Materials	1	13.3	26.7	33.3	13.3	13.3	28.67	140.00	0.034 ^S
	2	-	30.0	30.0	26.7	13.3	20.17		
ADPLAC	1	13.3	13.3	26.7	33.3	13.3	27.43	158.500	0.100 ^{NS}
	2	-	16.7	26.7	43.3	13.3	20.78		

Source: own survey, 2021. Note: NS- not significant at $P < 0.05$ and S-significant at $P < 0.05$.

*1=researcher and 2= extension worker.

*very much use (4), much use (3), little use (2), very little use (1) and not use at all (0).

3.4.2. Linkage Mechanisms Between Researchers and Farmers

The mann-whitney U test result indicated there was no significance difference between means ranks of researchers and farmers on six linkage mechanisms but, there is statistically significant on the field visits and demonstrations between researchers with farmers. The finding is similar with the work of [7] in Nigeria. Majority of farmers also pointed out field days and demonstrations were most frequent means of collaboration with researchers. The farmers were rated as little use on, membership of FRG and use of extension materials and they were not participated at all on-farm trails, review meetings and ADPLAC with researchers.

Field visit: 46.7% of researchers use field days as linkage mechanism with farmers. Extension workers involved on field visits to seek more information and strength their linkage with researchers. The field days in the study area was prepared by research center and by financial support of IFAD

project. After demonstration and continuous follow up one day field visit and variety evaluation were conducted at vegetative stage. The institutions which was initiated the existing technology was Adiet agricultural research center specially Woramit sub fruit research center.

Demonstrations: 60% of researchers' linkage mechanisms with farmers were method demonstrations that rated as very much use. All selected and trained farmers were planted on their filed through practical support of researchers' and regular monitoring of development agents. Woramit sub research centers should carry out a number of method demonstrations on farmers' fields to show the potential of new technology and train extension workers and chosen farmers step-by-step in how to apply it. Crop types demonstrated in the study area were onion, tomato and Banana new improved varieties. Researchers indicated all the linkage mechanisms as major methods for improve linkages with extension workers and farmers except ADPLAC. This linkage mechanism is dominated by politicians and not

reflects the problems of farming.

Table 7. Mann-whitney U-test result of linkage mechanisms between research with farmers.

Linkage mechanisms	Actors	Degree of use of linkage mechanisms					Mean rank	Mann Whitney U test	Exact sig. (2-tailed)
		4	3	2	1	0			
Review meetings	1	-	13.3	20.0	26.7	40.0	93.30	1195.500	0.818 ^{NS}
	3	-	1.8	24.8	35.2	38.2	90.25		
Trainings	1	40	40	20	-	-	87.70	1195.500	0.814 ^{NS}
	3	40.6	41.2	16.4	1.8	-	90.75		
on-farm trail	1	-	-	6.7	26.7	66.7	75.47	1012.000	0.198 ^{NS}
	3	-	-	21.2	26.1	52.7	91.87		
Demonstrations	1	60.0	33.3	6.7	-	-	100.63	815.000	0.017 ^S
	3	46.7	37.0	14.5	1.8	-	89.58		
Field visits	1	46.7	40.0	13.3	-	-	137.17	537.500	0.000 ^S
	3	7.3	38.2	35.2	19.4	-	86.26		
FRG	1	13.3	46.7	40.0	-	-	92.33	1210.000	0.883 ^{NS}
	3	-	24.2	32.1	25.5	18.2	90.33		
Extension Materials	1	13.3	13.3	53.3	20.0	-	106.93	991.000	0.182 ^{NS}
	3	4.2	18.8	35.8	23.0	18.2	89.01		
ADPLAC	1	-	6.7	33.3	33.3	26.7	118.67	1085.500	0.385 ^{NS}
	3	-	-	17.6	31.5	50.9	87.94		

Source: own survey, 2021, Note: NS=not significant at $P<0.05$ and S=significant at $P<0.05$.

*Actors: 1=researcher and 3= farmers

*very much use (4), much use (3), little use (2), very little use (1) and not use at all (0).

3.4.3. Linkage Mechanisms Between Extension Workers and Farmers

The mann-Whitney result indicated that, there was significant difference on the meetings/planning, trainings, field visit and demonstrations, whereas there was no statistically difference on the on farm trail, ADPLAC, use of extension materials and FRG of extension workers with farmer and farmers with extension workers. This shows that majority of extension workers had not been invite the farmers on the linkage activities without researchers need and horticultural technologies were transferred to the farmers through regular contact of researchers. The high connection of extension workers with farmers in linkage indicates that when extension services are the center and directive, funds are expected to be used successfully in conducting demonstration and scaling up.

Qualitative findings by focus group discussion: Approaches extension workers use to share and transfer the technologies to the farmers are by training, demonstrations at FTC and at model farmers' farm, teaching the farmers orally in the churches and preparing field days to scaling up new technologies. Adiet research center was implemented different linkage mechanisms to transfer newly generated agricultural technologies to the farmers. The key informants agreed a choice of linkage mechanisms in which the research center participates in the process of method demonstration,

trainings and field days. Furthermore, there is little farmer research groups' linkage mechanism. From the choices provided demonstration, trainings and field days were ranked from one to three respectively. Tomato and onion producer farmers were organized in the form of farmer research Group, but it was not functional.

Review meetings (planning): 13.3% of linkage mechanisms between extension workers with farmers confirmed planning's as very much use and 10.9% of farmers also participated with extension workers rated planning's as much use.

Trainings: 73.3% of linkage mechanisms between extension workers with farmers confirmed trainings as very much use and 52.7% of farmers also linked with extension workers rated trainings as very much use. Extension workers provide trainings to farmers with technical aspects to make sure appropriate implementation of technology demonstrations. Similar report was indicated by [10].

Field visit: 16.7% of linkage mechanisms between extension workers with farmers confirmed field days as very much use and 10.9% of farmers also involved with extension workers confirmed trainings as very much use.

Demonstration: 53.3% of linkage mechanisms between extension workers with farmers confirmed, demonstrations as very much use and 51.5% of farmers also collaborated with extension workers rated demonstrations as very much use.

Table 8. Mann-whitney U-test result of linkage mechanisms between extension with farmers.

Linkage mechanisms	Actors	Degree of use of linkage mechanisms					Mean rank	Mann Whitney U test	Exact sig. (2-tailed)
		4	3	2	1	0			
Review meetings	2	13.3	23.3	36.7	26.7	-	137.42	1292.500	0.000 ^S
	3	-	10.9	32.1	26.1	30.9	90.83		
Trainings	2	73.3	26.7	-	-	-	118.37	1864.000	0.016 ^S
	3	52.7	29.1	17.6	0.6	-	94.30		

Linkage mechanisms	Actors	Degree of use of linkage mechanisms					Mean rank	Mann Whitney U test	Exact sig. (2-tailed)
		4	3	2	1	0			
on-farm trail	2	-	-	-	30.0	70.0	91.40	2277.000	0.404 ^{NS}
	3	-	-	11.5	23.0	65.5	99.20		
Demonstrations	2	53.3	23.3	23.3	-	-	94.53	2371.000	0.024 ^S
	3	51.5	35.2	12.1	1.2	-	98.63		
Field visits	2	16.7	36.7	43.3	3.3	-	104.85	1435.500	0.000 ^S
	3	10.9	38.2	43.6	7.3	-	96.75		
FRG	2	-	10.0	40.0	36.7	13.3	105.60	2247.000	0.398 ^{NS}
	3	0.6	7.9	35.2	35.2	21.2	96.62		
Extension Materials	2	-	26.7	40.0	30.0	3.3	132.65	2269.500	0.436 ^{NS}
	3	1.8	7.3	28.5	27.9	34.5	91.70		
ADPLAC	2	-	-	-	26.7	73.3	79.13	1909.000	0.685 ^{NS}
	3	-	0.6	17.0	27.3	55.2	101.43		

Source: own survey, 2021 Note: NS- not significant at $P < 0.05$ and S-significant at $P < 0.05$, *Actors: 2=extension worker and 3= farmers*very much use (4), much use (3), little use (2), very little use (1) and not use at all (0).

4. Conclusion and Recommendation

4.1. Conclusion

The objectives of the study were identified and describe linkages and linkage mechanisms between research-extension and farmers to transfer improved agricultural technologies. The study used mann-whitney U test to evaluate linkages and linkage mechanisms between research-extension and farmers in the process of technology transfer. The overall findings indicated that, the linkages between researchers, extension workers and farmers were weak and require being strengthened.

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. However, all of these can be reversed if policy makers and programme implementers understand the role of linkage in agriculture and apply them to promote agricultural technology transfer and adoption.

4.2. Recommendation

On the basis of results identified by the research the following recommendations were suggested:

- 1) Researchers in the process of technology generation and demonstration be invite extension workers and farmers effectively to easy technology dissemination and adoption.
- 2) As much as possible, actors involve and implement in all linkage mechanisms identified by this study.
- 3) Regular and frequent contacts 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) To enhancing linkage and role performance for extension delivery, a multidimensional and integrated

approach is recommended to government, agencies and other partners in the agricultural sector.

- 6) In general, researchers consider farmers and extension workers as primary partners in the process of technology generation and transfer. So far, conduct linkage mechanisms and the research process jointly.

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