ORIGINAL ARITICLE

Evaluation of Farmers-Researcher-Extension Workers Linkages in Irrigated Maize Farm Management in Dera Woreda, Northwestern Ethiopia

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Abstract

Supporting service in irrigated maize farm management through linking farmers with researchers and extension workers characterized farmers as passive recipients of technology. This has brought about weak link and fragmentation. The study is evaluating the performance of researchers, extension workers and farmers linkages in irrigated maize agriculture in Dera Wereda, North-Western Ethiopia. Simple random sampling technique was used to select researchers, extension workers, and farmers. Their responses were elicited through unstructured questionnaire. Activities under evaluations includes farmer participation in identification of problem; centrality of research trial to low producers; link low producers to formal credit institution and cooperative association, training access, appropriateness of training advice, integration of joint activities to women groups; farmers connection to market; and sustainability of using on-farm research trial sites. Researchers, extension workers and farmers' involvement on average statistically varied as computed using one-way ANOVA. Such finding underlined the high importance of setting appropriate integration strategy to offset the loose working relationships among researchers, extension workers, and farmers in Dera woreda.

Keywords: *Irrigated Maize farm management, linkages, one way ANOVA, Dera, Ethiopia*

Introduction

Several research-extension linkage initiatives have been tried out in SSA at different times towards facilitating learning and encouraging exchange of knowledge about innovations in agriculture. This was done to cultivate greater and more effective interaction among the stakeholders in the agricultural sector (Sulaiman and Hall, 2002). Notwithstanding researchers and extension workers did not adequately understand constraints and potentials of the different farming systems to determine technology need (Anderson and Feder 2004). This has brought obstacle to access relevant technology in a large proportion (Hounkonnou, Kossou *et al.*, 2012) and ultimately made farmers' link with researchers and extension workers minimal. Added to these, lack of incentives for extension workers, and weak linkages among extension workers, researchers, and farmers letdown SSA agricultural extension systems (Davis 2008).

In Ethiopia, production of maize ranks first among cereals. Ethiopian families increasingly rely on maize as a staple food crop. It is increasingly known among Ethiopian families for its higher productivity and lower production costs as compared to other cereals such as wheat and barley (Spielman, Byerlee *et al.,* 2010). Maize productivity, however, has either remained constant or shown a declining trend in the recent years. The decline in maize productivity is partly attributed to farmers' disadoption of new agricultural technologies (Kassie, Van Ittersum *et al.,* 2014). Ethiopian research institutes together with the extension system expected to confront these challenges. The institute focus was largely on increasing production. However, there was poor understanding of the farming system

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and farmer's needs. The successes are largely measured by orienting towards farmland coverage instead of output gained (Anandajayasekeram, 2008)

Agricultural research and extension workers in Ethiopia attempted to play roles in increasing and stabilizing agricultural productivity (Belay, 2003). An effective technological development and delivery system requires a good linkage mechanism, among research, extension workers and farmers (Aker, 2011). Nevertheless, the research and extension services became weak and could not generate innovation, disseminate and adopt improved agricultural technologies (Rathore et al., 2008). For these reasons, marketing of agricultural inputs and outputs are not adequately equipped to serve the poor (Lefort, 2010). Also, accepting agricultural technologies before assessing their technical and economical appropriateness for intended users and working on technology transfer with less attention to problem-solving skill further worsened the decrease in maize production in the country (Swanson, 2008).

Moreover, contact among researchers, extension workers and farmers were infrequent. This has laid difficulties in having discussion among farmers on good practices, successes/failures of technology adoption and input delivery. Poor linkage of small farmers to market and inactive and poor coordination has caused further difficulties in input multiplying, dissemination and transfer of technologies (Davis, 2008). Ultimately, these have hindered the flow of improved technology generated in irrigated maize farm management (Ybabe & Asefa, 2014). The provision of such support in the study area created weak links between actors such as researchers and extension workers limiting the flow of knowledge and new technologies. These actors are characterizing farmers as passive recipients of technology. As a result, the farmers function remained largely uncoordinated and fragmented (Deneke and Gulti, 2016).

Studies such as Sewnet (2016) assessed the causes of weak agricultural research, extension and farmers linkage in Ethiopia. Chanie, Y., *et al.* (2014) focused on the contribution of farmers' participation in farmers' research groups on their farm income. However, little or no attention is given to assess the linkages across research-extension-farmer as vital means to check level of disparity in implementing joint activities. The study, thus, aimed at examining the researcher extension workers and farmer joint involvement in the improvement of irrigated maize farm management in Dera woreda.

Conceptual Framework of Researcher-Extension Worker-Farmer Linkages

Linkage implies the communication and working relationship established between two or more organizations pursuing commonly shared objectives to have regular contact and improved productivity (Akinbile 2012). This entails the organization of research and extension programs prioritizing client needs and explore sources of knowledge and new technologies (Mekoya, Oosting et al. 2008). The linkage mechanism such as formal (e.g. liaison services) and informal methods employ both mutual and reciprocal connection among researchers, extension workers and farmer groups (Akinbile, 2012). This is to coordinate the required tasks in the process of making relevant technologies available to farmers to improve resource use (Agbamu, 2000).

As depicted in Figure 1, researcher and extensionists exchange formal agricultural knowledge. This knowledge served as link attribute to accomplish joint activities such as identifying research needs of clients, and participating farmers in problem solving. Formal and informal methods were serving as a way to get linked with the clients.

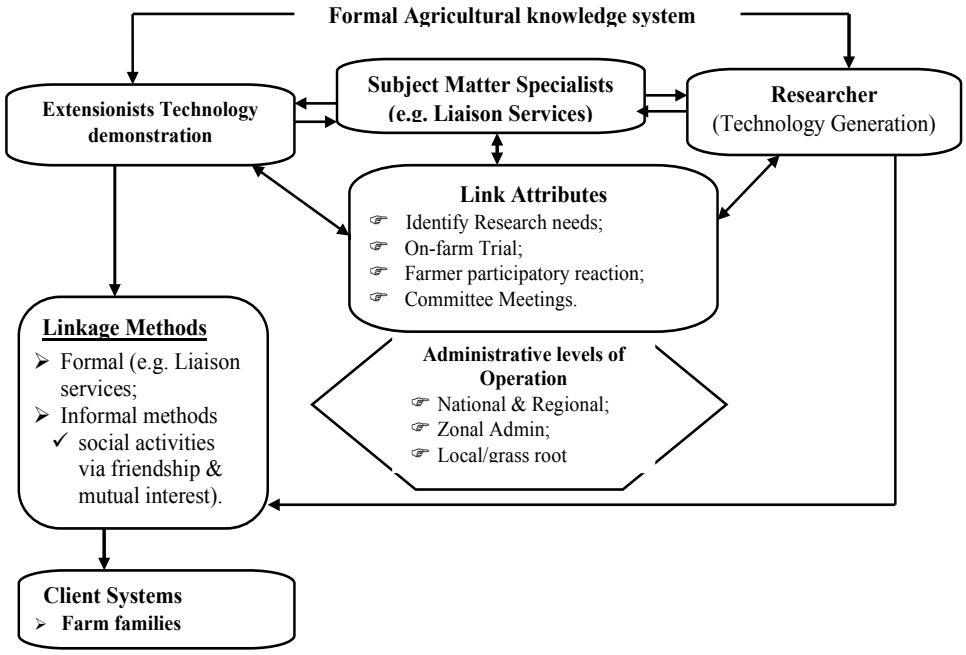

Figure 1: Institutional Framework and Function across Research-Extension-Farmers Linkages
Source: Adapted from Ajzen (2005); Greenhalgh, et al. (2004); Sahin (2006).

Study Area

The study area is Dera woreda which is found in the south Gonder administrative zone of Amhara Region of Ethiopia. It lies between 11017' 52" N to 11054' 03" N latitude 37025'12" E to 37058'02"E longitude. The woreda is bordered by Mirab in the East, Bahir Dar Zuria in the West, Fogera and Lake Tana in the North and North East, and River Abbay in the South. Amba Same, Gebeya, Hamusit, and Qorata are urban centers while twenty-nine kebeles are rural (CSA, 2011).

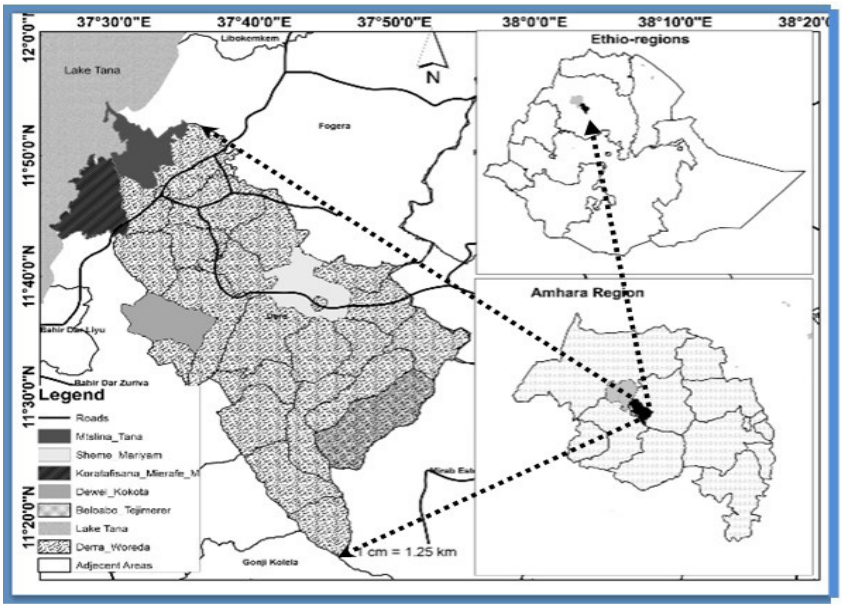

Figure2: Location Map of the Study Area
Source: Central Statistical Agency (2011).

Based on data obtained from Bureau of Finance and Economic Development of Amhara Region (2016), Dera woreda population projected to be about 313,315. Of these, 160,099 and 153, 217 were men and women, respectively. Twenty-one thousand one hundred forty eight (6.75%) people inhabited an area of 1,525.24 square kilometers were living in urban centers. Dera woreda has a population density of 162.90, which is greater than the Zonal average of 145.56 persons per square kilometer. A total of 62,663 households were counted in the woreda. The majority of the inhabitants (98.05%) reporting that their religion is orthodox Christianity, while 1.92% of the population were follower of Muslim (CSA, 2011).

Sampling Strategies

The study area is delimited to Dera Woreda. Based on the data obtained in Dera Woreda Agricultural Office, 15 Rural Kebele Administration Units (RKAUs) get involved in joint activities to improve irrigated maize agriculture. Of these, five kebeles namely, Beloabo Tejimerer, Dewel Kokota, Koratafisana Mierafe Mariyam, Sheme Mariyam, and Mtslina Tana, were selected randomly. According to data obtained from annual reports of Dera Wereda Agricultural and Rural Development office, these kebeles were knowm for different trials and demonstrations intensively undertaken to increase and stabilize maize productivity(DWARDO, 2015).

Based on data available in Woreda agricultural office, seventy-five farmers were involved in joint activities on regular basis. Fifty researchers were identified as target population. These were working at national agricultural research institutions and Agricultural Research at regional and zonal level in setting research agenda, conducting surveys, identifying existing practices and research priorities, conducting on-farm experiments, and offering training to farmers. Sixty-five extension workers who were working at rural kebele

and Woreda levels were identified as target population.

The number of populations targeted with respect to researchers, extension workers and farmers groups is smaller than 100 implying that determining sample size using the formula is un realistic. This allows to use principle of large sample size ($n \geq 30$) which allows drawing at least 30 respondents (Fritz and MacKinnon 2007). Therefore, thirty researchers and extension workers each and forty farmers that gave a total 100 respondents were drawn randomly from identified target population.

Data Sources and Methods of Acquisition

Initially, Ethiopia Agricultural Research Institute's research-extension-farmer linkages platform and the different institutional linkage arrangements were reviewed (Kassa and Alemu 2016). Relevant books, journals, proceedings, minutes and official reports of research and extension agencies in the areas of research-extension linkage too were assessed

The study employed cross sectional design which examines observation of sampled stakeholders, towards joint activities at a single point in time (Lindell and Whitney 2001). Primary data collected from researchers, agricultural extension staff, and farmers using key informant interviews, focus group discussions, and questionnaires. Three separate sets of questionnaires, closed and open ended questions, were prepared, pre-tested to obtain data from researchers, extensionists and farmers (Kuehne, Llewellyn et al. 2017). Corrections were made accordingly. In depth interviews were conducted with ten key informants composed of two farmers from each sample kebele incorporated leaders, women's, and progressive farmers. Five experienced researchers and six extension workers too took part as key informants. Informal conversations were also conducted with the intention to explore ideas and check whether joint activities in strategic linkage document are in conformity with field practice in Dera Woreda.

Moreover, three focus group discussions each with researchers and extension workers, and farmers were also conducted. This was done with the intention to verify joint activities stated in strategic platform. These activities were further checked for being comprehensive to address stakeholder joint involvement in consultation with woreda agricultural experts and DAs. Thirteen out of twenty-one joint activities stated in strategic document are found well-matched in the study area.

Structured questionnaire was developed in English and then translated into Amharic and then back to English before data collection for checking the consistency of translation. The questions were organized to obtain stakeholders response of involvement using the scale of five point type response (1= Not done at All, 2 = Almost Not done, 3 = Stayed neutral, 4 = Done well, 5 = Done Very well) (Lewis, 2015). The data were coded, cleaned, entered and analyzed using Stata, version 14. Two data enumerators who have know-how of collecting data were involved in gathering primary data. Prior to administering structured and semi-structured interviews, they were trained on the contents of the questionnaire. They were also oriented to collect the data after obtaining verbal consent from the study participant. Field trips were made before the actual survey to observe the overall features of the selected rural kebeles and farming communities to undertake the preliminary assessment of characteristics of the study area and the study population.

Data Analysis

The study set one way Analysis of variance proved useful in determining differences in the means of three or more independent/unrelated groups (Ogunremi, Faturoti *et al.* 2011; Ogunremi and Olaniran 2012). The analysis used to evaluate the difference in mean scores of involvements in linkage activities among researchers, extension workers and farmers (Vijayvargiya, 2009). For solving one way Analysis of Variance (ANOVA), one needs to find out the mean of the total sample by adding the values of all the components and dividing the total sum by total number of components (Jolliffe, 2011).

Prior to estimating data using One Way ANOVA, the nature of the data checked for its three major assumptions, namely: normality, homogeneity of variance and independence of error (Pallant, 2013). As indicated in Annex Table 2, there is no evidence of departure from normality statistically. Therefore, null hypothesis can't be rejected ($p > 0.05$). The test of the equality of variance among groups indicated in Annex Table 3, defined by using methods of Levene (1960) and Brown and Forsythe (1974) as cited in Anderson, Ellingsen et al. (2006) are independent of each other. This implies that respondents were drawn randomly and independently from the population. This makes the tests less sensitive to departures from normality.

Principal Component Analysis (PCA) is employed as multivariate analyses and data reductionist method to reveal the internal structure of the data. Prior to conducting the PCA, two statistical tests: the Kaiser-Meyer-Olkin (KMO) of sampling adequacy and the Bartlett's Test of Sphericity, were checked(Williams, Onsman *et al.* 2010). Bartlett's test of Sphericity was significant ($x^2(45) = 234.95$ at $P < 0.000$, supporting the factorability of the correlation matrix. The Kaiser criterion (eigenvalues > 1) was applied for the component selection(Brown and Forsythe 1974 as cited in Savin(2005). The overall KMO tested at 0.66 is a bit higher than the recommended value of 0.6 (Pallant, 2013). This stepwise exclusion approach was repeated until the variables and components were stable and statistically robust.

Once the KMO and the Bartlett's Sphericity test passed with the given standard, PCA run to condense an original set of variables (joint activities) into a smaller number of linear varieties. This was made by identifying patterns in high-dimensional data that best describe variations in the data through identification and clustering of variables that measure the same theme (Donoho 2000). The technique has allowed for a robust and consistent set of variables that can best explains the variance in the data using Eigen value decomposition of a data covariance matrix.

PCA results are discussed in terms of component (factor) scores, and the weight by which each standardized original variable multiplied extracts the dominant patterns in the matrix in terms of a complementary set of score (Wold, Esbensen *et al.* 1987). Orthogonal Varimax rotation was used to simplify the structure of the underlying dimensions and produce more independence among the factors. The rotation also minimized the number of variables that loaded high on a single factor, thereby increasing the percentage variation between each factor (Kaiser 1958). Before being extracted in to seven principal components in Annex Table 4 composed of 10 joint activities, thirteen joint activities were considered. PCA reduced the dimensionality of the transformed data and extracted seven components with Eigen value greater than 1 retained for further analysis. The analysis used orthogonal Varimax rotation. Scree test was made to retain seven components (Abdi & Williams, 2010).

Out of 13 variables identified in strategic linkage document, 10 variables namely farmers' participation in identification of problem; centrality of research trial to low producers; linking low producers to formal credit institution; linking farmers to cooperative association; appropriateness of training advice and advisory service on crop management; linking joint activities to women groups; linking farmers to market keeping using demonstration trial up and timely availability of information, retain for further investigation. These variables were grouped in to seven principal components. The former two variables grouped as linking farmers to market. The latter two variables relating to capacity building; and appropriateness of training advice and advisory service on crop management labeled as training access and appropriateness. The last four variables were grouped repetitively as gender integration in joint activities, link farmers to market, sustainability of using on-farm research trial sites, and timely of information accessed, respectively.

These seven components explained 78.27 percent of the variability in total. To identify relatively large loadings easier, correlations above 0.4 were in considered. The first, second, third, fourth, fifth, sixth, seventh component, respectively, explained 19.11, 16.32, 15.04, 7.42, 7.34, 6.53, and 6.51 percent of the variance, respectively. The components are labeled as farmer participation, capacity building, training access and appropriateness, gender integration in joint activities, sustainability of using on-farm research trial sites and information access.

To back this up, focus group discussion and in-depth interview were conducted to assess how each key indicator identified define stakeholders' linkages in supporting farmers' irrigated maize farm management.

All focus group discussants confirmed that

> We were jointly implementing farm activities in our farm plots together with researchers and extension workers to improve our maize yield. We were discussing with them about our problem. Those who were constrained financially among us access formal credit. We were encouraged to be members of cooperative association. This has favored us to jointly take part in research demonstration trial. However, we were ignorant of visiting research institutes, getting incentives and participation in committee meeting to discuss in input supply.

Local men and women interviewed as key and knowledgeable informants who live in Beloabo Tejimerer, Dewel Kokota, Koratafisana Mierafe Mariyam and Sheme Mariyam kebeles gave their own remark about the situation as follows:

> Collaboration with researchers from Amhara research centers and agricultural extension workers in our local administration and woreda agricultural and rural development office facilitated formal credit to access money. We were directed to be members of cooperative association to accesss necessary agricultural inputs and participate in research demonstration trial.

Moreover, discussants who were taking part in three focus group discussion sessions at Sheme Mariyam, and Mtslina Tana kebeles told:

> There were big efforts to offer us training on crop management and we have found it comfortable except our limitations. Women were also encouraged to take part in joint activities. Now is the time for women than previous days. We have also appre-

ciation to researchers and extension workers for linking us to market channels and use of demonstration trial sites for long years. We access information through magazine such as *Bekur* and regional FM radio timely, retain for further investigation. While we were not involved in committee meeting to examine improvements in input supply, access incentives to promote our activities and visiting research institutes. However, we had high participation in identification of problems and the rest joint activities discussed from above.

This verification process led to the conclusion that 10 activities broadly captured opinions of their joint engagement in the field. However, the three joint activities targeting committee meeting as a remedy to duscuss and overcome delay in input supply, incentive and research visit are discarded from analysis.

Moreover, the rreliability of each joint activity was confirmed using overall Cronbach's alpha coefficient for internal consistency reliability of scales. A factor can be assumed to be "reasonably representative" of the variable if the Cronbach's alpha is greater than 0.70 (Rancourt, Lee *et al.* 1994). Accordingly, the study computed value for Cronbach's alpha with reliability measurement scale of 0.70.

Results and Interpretations

Stakeholders get involved in joint activities grouped in to seven most important components were reported with its descriptive statistics summary such as their mean involvement score and standard deviation. One way analysis of variance was employed to test whether significant mean differences exist in their mean involvement scores between researchers, agricultural extension workers, and farmers exist.

As indicated in Annex Table 2, respondents had cumulative mean involvement score computed with a minimum and maximum score of 2.71 and 3.95, respectively. Researcher on average had higher involvement scores ($\overline{X}$ = 3.4, SD = 1.031) in joint activities than extension workers and farmers. This does mean, researchers were highly involved in linkage activities with mean value of 3.4 followed by extension workers and farmers with mean value of 3.14 and 3.04, respectively. Thus, it can be represented as: R>EW>FF.

Table 1: Result of One way Analysis of Variance

	Sum of Square	Degrees of freedom	Mean Square	F	Sig
Between Group	12.578	2	6.289	25.498	
Within Group	25.960	97	0.268		
Total	38.538	99			

$\overline{X}$ of Farmer (n=40) = 3.01, $\overline{X}$ of Extension worker (n=30) = 3.65 and Researcher (n=30) = 3.80

As indicated in Table 1, significant difference was indicated in overall involvement of stakeholders in joint farm management of irrigated maize. The difference was observed at less than 1 percent level of significance ($P < 0.001$). The result is in conformity with the study examined the linkage system in coastal and inland states of Nigeria, with a difference in mean involvement score of researchers, extension workers and fish farmers statistically at less than 1 percent level of significance (Ogunremi, Faturoti *et al.* 2011).. Similarly, research, extension and farmers linkage system in the country on average in-

tended to introduce and diffuse innovations found with significance difference in the level of involvement of researchers, extension workers and farmers (Oladele 2008).

Table 2: LSD test scores of Researchers, Extension Workers and Farmers in Joint Activities

(I)Designation	(J) designation	Mean Difference (I-J)	Std. Error	Significance
Farmers	Extension Worker	-0.6433*	.12495	.000
	Researcher	-0.7867*	.12495	.000
Extension Workers	Farmers	-0.6433*	.12495	.000
	Researchers	-0.1433	.13357	.286
Researchers	Farmers	0.7867*	.12495	.000
	Extension Workers	0.1433	.13357	.286

* = the mean difference is significant at or less than 0.05 levels
Source: Own Estimation test, 2016/17

As indicated in Table 2, difference in pairs of means computed using a Post Hoc Multiple Comparison Test of Least Significance Difference (LSD) shows farmers' means involvement scores differed from researchers (I-J = -0.7867) and extension worker (I-J= -0.6433) statistically at less than 1 percent level of significance. This implies that the involvement of farmers' in joint activities on average statistically differ from involvement of researchers and extension workers. However, mean involvement score of extension workers ($\overline{X}$ = 3.143) with the researchers ($\overline{X}$ =3.395) were not statistically different from zero. This implies that there were closer collaboration between extension workers and researchers in implementing joint activities.

Conclusions and Recommendations

The study examines research-extension-farmers linkage in relation to irrigated maize farm management in Dera Woreda, Northwestern Ethiopia. What initiated this study is the fact that the present research-extension-farmers linkage in the country in general, and in the study area in particular, faced loose working relationship between farmers and extension workers, and farmers and researchers. However, researchers and extension worker linkage to farmers to avail relevant technologies and innovation in irrigated maize farm management remained difficult. The prevailing situation in linkage activities in the study area show varying degrees of stakeholders' involvement in joint activities. The degree of farmers' involvement with researcher and extension workers to promote innovation in irrigated maize farm management was statistically low.

Based on the findings and the observations, researchers, extension workers, and farmers should identify the systems linkage needs and choose agreed-up on mechanisms. That is, potential gaps, and alternative solutions need to be identified to close disparity in working relationship between actors. Besides, farmers and researchers' interaction should be organized at village level for better linkages. These would give way to a broader agricultural innovation system. This would ultimately benefit farmers from a more appropriate and productive opportunity to enhance irrigated maize agriculture.

Areas for Future Research

Researchers, extension workers and farmers involvement in joint activities targeted disseminating knowledge of agricultural technology management has been assessed in the present study. However, improved irrigated maize growers' contribution of joint activities in context to their livelihood condition was not analyzed. Hence, potential researcher may focus in examining livelihood benefits of joint activities under implementation.

Acknowledgment

Various institution and people have played important roles in this study. My thanks go to collaborative staff of Dera Woreda district Agricultural and Rural Development Office, the respected cabinets, agricultural experts, Development Agents, Local administrators, and the enumerators for facilitating the farm household survey. I also am grateful to farmers who responded to all questions with patience and dedication so as to offer basic information for the research work.

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ANNEXES

Annex Table 1:Statistical Summary of stakeholders' involvement in joint activities

Linkage Activities	Researchers (R)		Extension. Worker (EW)		Farmer (FF)	
	Mean	SD	Mean	SD	Mean	SD
Linking farmers to Market (LinkFarMkt)	3.633	1.098	3.17	1.276	3.10	1.057
Appropriateness of Training Advice (TraAdvicAppr)	3.200	1.031	2.87	1.176	2.60	0.841
On-farm Demonstration trial Sustainability (SusDemonTria)	3.233	1.073	3.0	1.251	3.00	1.132
research Centrality towards Low Producers (CeRTrialsLoP)	3.700	1.022	2.77	1.21	2.78	1.250
Linking Joint Activities to Women Groups (LinkAct2WoG)	2.567	1.194	2.80	1.27	2.75	1.256
Making Problem Identification participatory (PerIdeProPr)	3.933	0.691	3.90	0.54	4.00	0.453
timely availability of information (TiAvaiInfo)	3.500	1.106	3.50	1.092	3.10	1.033
Cumulative Mean involvement Scores	3.195	1.051				
Farmers FF	3.046	1.003				
Extension Workers EW	3.143	1.118				
Researchers R	3.395	1.031				

Source: Field Survey, 2016/17

Annex Table2: Shapiro-Wilk W Test for Normal Data

Linkage Activities	W	V	Z	Prob>z
LinkFarMkt	0.99	0.45	-1.79	0.96
TraAdvicAppr	0.99	0.87	0.31	0.62
SusDemonTria	0.99	0.45	-1.75	0.96
CeRTrialsLoP	0.99	1.05	0.11	0.46
LinkAct2WoG	0.99	0.78	0.56	0.71
PerinIdentProPr	0.99	1.09	0.18	0.43
TiAvaiInfo	0.99	1.02	0.03	0.49

No. of Observation =100

Source: Model Testing Result, 2016/17.

Annex Table 3: Levene Test of Equality of Variance

Joint activities	Respondents					Levene Test	
	Farmers (N=40)	Researchers (N=30)	Ext. Work-ers (N= 30)	Mean	SD	W_0	Pr > F
LinkFarMkt	3.08	3.63	3.50	3.37	1.07	1.37	0.26
TraAdviAppr	3.28	3.60	3.50	3.44	1.14	1.76	0.18
SusDemTria	3.30	3.70	3.70	3.54	1.09	1.99	0.14
CeRTrialsLoP	2.98	3.60	4.07	3.50	1.24	1.16	0.32
LinkAct2WoG	2.68	3.47	4.13	3.35	1.29	2.97	0.06
IdentProPr	2.98	3.33	4.40	3.51	1.22	1.82	0.17
TiAvaiInfo	3.18	3.27	3.87	3.41	1.06	2.94	0.06

No. of Observation = 100; df (2, 97)

Source: Data drawn from household survey, 2016/17

Annex Table4: Principal components (PC) factors

Compo-nent	Principal components/correlation	Eigen value	PC (eigen-vectors)	Alpha
1	Linking farmers to agricultural Market (LinkFarMkt)	1.968	0.5353	0.69
2	Appropriateness of Training Advice (TraAdvicAppr)	1.481	0.4431	0.73
3	On-farm Demonstration Trials Sustainability (SusDemonTria)	1.314	0.4938	0.68
4	Rresearch trial Centrality towards Low Producers (CeRTrialsLoP)	1.219	0.6281	0.69
5	Linking Joint Activities to Women Groups (LinkAct2WoG)	1.171	0.5016	0.71
6	Making Problem Identification participatory (ProIdentPar)	1.096	0.5127	0.73
7	timely availability of information (TiAvaiInfo)	1.020	0.4923	0.71
		Overall Cronbach alpha=0.70		

Source: Own Household Survey Data, 2016/17