Econometric Analysis of Access to Agricultural Extension Workers' Service and its Implication on Crop Yield in Tigray Region, Ethiopia

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Agricultural extension workers' service has been placed as the central pattern of agricultural transformation in general and smallholder farmers in particular. Due largely to this commensurately known trend, identifying factors that determine farmers' access to extension workers' service and the effect of the service on crop yield was found to be imperative. Cross sectional data was collected through semi-structured questionnaire administered on 270 randomly selected smallholder farmers. While analyzing the data, descriptive statistics and econometric models basically Binary logistic and Ordinary Least Square (OLS) regression models were employed. Regression results revealed that access to agricultural extension workers' service was determined positively by irrigation use, fertilizer use, off-farm activities participation, membership to a certain association, education and tropical livestock unit; whereas gender, age and land size carried a negative sign. The regression result also revealed that agricultural extension workers' service has a positive but insignificant effect on crop yield where no significant crop yield difference have been seen between the visited and non-visited farm households. As per the findings, it is recommended that extension workers need to be financed jointly by the regional government and farmers themselves; thereby extending their roles and responsibilities to the extent of checking farmers at their farm land; and there is a need to solve the fusion of political and agricultural tasks that extension worker are doing.

Keywords: Agriculture, Extension workers**,** Smallholder farmers, Ordinary Least Square, Logit.

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1. Introduction

In developing countries, according to Wanga (1999); Tsakok and Gardner (2007) agriculture is the most viable economic sector basically to generate economic growth of the nation. Given this commensurately known fact, Mbo'o-Tchouawou and Colverson (2014) purported as if agricultural extension is the primary way-out that governments of developing countries need to use mainly to support smallholder farmers to adopt and implement new agricultural methods. Despite its strong importance, in developing countries, agricultural information is not yet been shared freely from extension workers to smallholder farmers (Tollefson, 1995). As a witness for this generalization, in Indonesia, Kadir et al (2002) have had acclaimed as if agricultural extension and the service being delivered was not effective due to weak linkages between the government and extension workers who work in the field. Agricultural extension and advisory service is pertinent to provide access to information and technologies as well as to enhance agricultural skills, practices, capacity to innovate, and address varied rural development challenges through training programs, improved management and organizational techniques (Birner et al, 2009; Christoplos, 2010). Furthermore, Agricultural extension and advisory services can also play a significant role in linking farmer-based organizations with other stakeholders like government agencies, private sector, non-governmental organizations, research institutes and education centers (Davis and Heemskerk 2012). Linking smallholder farmers with these stakeholders, according to GFRAS (2010) and Meinzen-Dick et al (2012), is paramount importance for increasing agricultural sustainability, rural livelihood and well-being.

Extension Workers (EWs) are too nearer to farmers; as a result they are key role players who could instigate farmers to use and disseminate the required information and agricultural inputs. Adebiyi and Okunlola (2013); Genius et al (2013) and Chiputwa et al (2011) and Anderson and Feder (2004) infer that the role of EWs is transferring information from the global or local knowledge base to farmers and thereby shaping their activities. Moreover, they are also agents in guiding smallholder farmers how, where and when to use inputs. In addition, Genius et al (2013) also allege that extension services and farmer-farmer contact are

basic points that determine technology adoption and diffusion; and both are mutually supportive.

Indeed, more than any other developing region, Africa's economic development highly relies on agriculture and agro-industry sectors; and determined by the production potential of the land under cultivation (Mugera & Ojede, 2011; Arega, 2010; Nin-Pratt & Yu, 2008; Henao & Baanante, 2006). As an important breakthrough, under the umbrella of New Partnership for Africa's Development (NEPAD), the Comprehensive Africa Agricultural Development Program (CAADP) has had distinguished the priceless importance of smallholder agriculture in accelerating African overall economic growth and development (Tesfaye et al, 2012). Although agriculture is being advocating as the main stay of the majority, in Africa, according to Dejene (1989) and Gautam (2000) agricultural extension services are ineffective that actually adds almost nothing to agricultural production and productivity of smallholder farmers.

One challenge of agricultural technology adoption in developing countries is poor contact between extension agents and farmers; as a result of this farmer-farmer contact is serving as source of information and agents of technology transfer (Adesina and Baidu-Forson, 1995). Worse than this, Idrisa et al (2008) and Anderson and Feder (2004) purport that extension agents tend to select farmers with large farm size, better income and socially privileged with the assumption that these people could better adopt inputs and could also subsidize them with some incentives. According to Hu et al (2012); Tewodaj et al (2009) and Ozor et al (2007) unsatisfactory contact between DAs and farmers is due largely to unstable source of financing agricultural technologies; where cost-sharing financing system is advocated by Ozor and Madukwe (2004) cited in Ozor et al (2007).

Being a member of Sub-Saharan African countries, Ethiopia has had relied on agriculture. According to Tesfaye et al (2012) and Ministry of Finance and Economic Development (2003), following the coming to power of Ethiopian People's Revolutionary Democratic Front (EPRDF), since 1990s, Agricultural Development-Led Industrialization (ADLI) is been in place as a national economic development policy that predominantly advocates smallholder agricultural development and transformation. Hence, majority of the country's total production is produced by smallholder farmers (Ministry of Agriculture and Rural Development, 2010).

According to Berihun et al (2014), inside the heart of the main poverty reduction papers of the county particularly Sustainable Development and Poverty Reduction Program (SDPRP), the Plan for Accelerated and Sustained Development to End Poverty (PASDEP) and Growth and Transformation Plan (GTP), expanding advising services and agricultural advisors as well as procurement and distribution of agricultural inputs were the most important strategies so as to increase agricultural production and productivity. Hence, smallholder farmers are expected to be guided by DAs' advice and they are also expected to contact them. In such a scenario, Wondimagegn et al (2011) asserted that, as a risk aversion mechanism, farmers with more extension contacts are more likely to diversify their production intensity.

Despite these policies intensions, in Tigray region, smallholder farmers have been seen reluctant while contacting or visiting agricultural extension workers and employing agricultural inputs (Bureau of Finance and Economic Development, 2011; cited in Berihun et al, 2014). Henceforth, Bureau of Finance and Economic Development have had reported as if the tendency of smallholder farmers to contact agricultural extension workers is lesser and negligible. Besides, although there is a simple voice of using extension workers for doubling agricultural production, its implication on crop yield is not yet been seen and clearly exemplified. Furthermore, in the study area, there is confusion in indentifying the issue: "Who is to be contacted, extension workers or smallholder farmers?"; or do smallholder farmers are expected to visit extension workers at their offices or else are extension workers to go to the field?. Such things are not clear and making these things clear is pertinent for comprehensive and an integrated agricultural development and smallholders transformation. Given these gaps, therefore, the general objective of the study is to identify the determinants of access to agricultural extension workers' service and then examining the implication of their advising services on crop yield.

2. Materials and Methods

2.1 Sampling Method and Data Collection

Multi-stage sampling procedure was followed to select the final sample respondents. As per this procedure, first, two districts (Raya-Azebo and Raya-Alamata) with a total of 29 sub-districts were selected; followed by the randomly selected four sub-districts and eleven villages. Then, on the basis of Yamane (1967) s' sample size determination formula cited in Israel (1992) 270 sample respondents were calculated and considered to collect primary data mainly through semi-structured questionnaire in 2013 cropping year. Data through questionnaire was supported by in-depth interview with experienced farmers, agricultural technology adopters, irrigation users, crop production personnel of the two districts and agricultural extension workers

themselves. Besides, focus group discussion was also been taken from four villages involving participants like female-headed farmers, agricultural technology adopters, off-farm activity participants and irrigation users. To supplement primary data, secondary data was collected from the bureau of agriculture and finance and economic development. Finally, final sample respondents were selected randomly from the list of farm households from each targeted sub-districts and villages; and its proportion is shown in the Table 1.

2.2 Method of Data Analysis and Econometric Model Specification

While analyzing the data descriptive statistics and econometric techniques mainly OLS and binary logit regression models were employed. Descriptive statistics like mean, percentage and standard deviations were used to assess the socio-economic and demographic characteristics of the sample respondents. Besides, to test the relationship between the already taken independent variables and the dependent variable vis-à-vis the two groups of individuals, T-test and Chi-square tests were used, respectively, for continuous and dummy variables. Data collected through interview and focus group discussion was basically analyzed qualitatively or through narration that actually was triangulated with the econometric result.

Regardless of the frequency of contact they made with extension workers either by going to their office or vice versa, a farmer was taken as visited if he/she has been contacted in the most critical times of a cropping year basically during field preparation, sowing and weeding time. Hence, those who got extension advice services in these time interval were taken as visited or contacted and those who did not get advice in these time interval were taken as non-visited or non-contacted ones. Therefore, the dependent variable, agricultural extension workers' service, has a binary nature taking the value of 1 for visited or contacted and 0 for non-visited or non-contacted. Due to this dichotomous nature of the dependent variable, the researcher has used a binomial logit model that shows the likelihood of being visited by extension workers i.e., $\Pr(y_i = 1|x)$ and well specified as follows.

$$\frac{P(y_i = 1|x)}{P(y_i = 0|x)} = \frac{\Pr(y_i = 1|x)}{1 - \Pr(y_i = 1|x)} \quad (1)$$

The odds indicates the extent to which farm households' got agricultural extension workers' service $(y = 1)$ relative to those who does not got $(y = 0)$. The log of the odds specified in Equation 2 below suggests that it is linear in the logit.

$$\ln\left[\frac{P(y_i = 1|x)}{1 - P(y_i = 1|x)}\right] = x\beta_i \quad (2)$$

Which is equivalent to the logit model derived as:

$$P(y_i = 1|x) = \frac{\exp(x\beta_i)}{1 + \exp(x\beta_i)} \quad (3)$$

where P denotes the probability that the i^{th} farmer has got extension workers' advice, x_i captures household and farm level characteristics that affect household's probability of being visited, while β_i is a parameter to be estimated. The binary Logit model is pertinent mainly to examine factors that determine farm households' likelihood of being visited by agricultural extension workers. The dependent variable (y) is, therefore, a dichotomous alternative of being visited or not visited; and the parameters are believed to be interpreted as derivatives of the dichotomous dependent variable with respect to the stated independent variables; given below.

EXTVISIT$_=$ β_0 + β_1Gen + β_2Educ + β_3 Age + β_4 TLU + β_5 Landsz + β_6 Irriguse + β_7 Officedist + β_8 Fertuse + β_9HYV + β_{10} Credit + β11Associ + β_{12} Offarm

Where: EXTVISIT is a dependent variable indicating the likelihood of being visited by agricultural extension workers.

Besides, to estimate the magnitude of parameters or variables mainly to put clearly the percentage likelihood of being visited or contacted by agricultural extension workers, marginal effect of variables was calculated. Marginal effect of a variable is the effect of unit change of that variable on the likelihood of being visited or contacted and it can be seen as P(Y = 1|X = x), given that all other variables are constant. The marginal effect is expressed as:

$$\frac{\partial P(Yi=1/Xi)}{\partial Xi} = \frac{\partial E(Yi/Xi)}{\partial Xi} = X_i'\beta\beta \quad (4)$$

Therefore, description of the above variables (used in logit model) and their expected sign or prior hypothesis has shortly been summarized in the Table 2.

On the other hand, to examine the effect of agricultural extension workers' service on crop yield, Ordinary Least Square (OLS) regression model was used. OLS was considered due to the continuous nature of the dependent variable, crop yield measured in Quintal. Furthermore, according to Gujarati (2006), with the assumption of classical linear model, OLS estimators are with unbiased linear estimators with minimum variance and hence they are Best Linear Unbiased Estimators. Hence, its specification is given below using similar independent variables used and described in the binary logit model above.

$Y = \beta 0 + \beta iXi + Ui$ (5)

Where: Y is the dependent variable (crop yield), Xi is a vector of explanatory variables, βi is a vector of estimated coefficient of the explanatory variables (parameters) and Ui indicates disturbance term which is assumed to satisfy all OLS assumptions (Gujarati, 2006).

$Cropyield = \beta_0 + \beta_1 Extcnct + \beta_2 Gen + \beta_3 Educ + \beta_4 Age + \beta_5 TLU + \beta_6 Landsz + \beta_6 Irriguse + \beta_8 Officedist + \beta_9 Fertuse + \beta_{10} HYV + \beta_{11} Credit + \beta 12 Associ + \beta_{13} Offarm + ui$

In this case, the prior hypothesis states the positive contribution of agricultural extension workers' advice on crop yield measured in quintal.

3. Results and Discussion

3.1 Socio-Economic and Demographic Characteristics of Sample Households

Examining and identifying the socio-economic and demographic characteristics of the sample respondents under study were imperative to have a look on the determinants of access to agricultural extension workers' service and for policy implication as far as crop production is concerned. These characteristics were summarized in the Table 3.

The Table 3, clearly alleges that, only 27.41% of the sample respondents were contacted or visited by extension workers basically in critical times of farming- especially during plot preparation, sowing and weeding time. The remaining sample respondents have been categorized either non-contacted or contacted in non-critical time period. Compared with those non-contacted (non-contacted at all and contacted in non-critical time), visited or contacted sample households had owned a flock of animals and were better irrigation users. From this, the researcher come to deduce as if critical time visited farm households were those with better farm income, irrigation users, off-farm participants as well as association members.

Table 1. Targeted Sub-Districts and villages with their total population and sample size taken

No	Name of sub-district	Villages	Population size (N)	Sample size (n)
1	Bala-Ulaga	1. Buta	2164	63
		2. Kulqual Kebele		
		3. Merfeta		
2	Kukufito	1. Marsa-Danisa	3784	109
		2. Qalina		
		3. Telle		
3	Lemeat	1. Adibo-Gulja	1697	49
		2. Adi-Hagos Tsegay		
		3. Kutiche		
4	Tao	1. Gendera	1697	49
		2. Maikel-adi		
	Total		9342	270

Source: CSA, 2007 and Own Computation, 2014

Table 2. Variable Description and Expected Signs

Variable Type	Variable Nature	Unit of Measurement	Expected Sign
Gender (Gen)	Dummy	1 if Male and 0 if Female	-
Age (Age)	Continuous	Years	-
Education (Educ)	Continuous	Years of schooling	+
Land Size (Landsz)	Continuous	Tsimad[1]	-/+
Home distance from office(Officedist)	Continuous	Kilometer	-
Off-farm participation (Offarm)	Dummy	1 if Participate, 0 otherwise	-
Irrigation use (Irriguse)	Dummy	1 if Yes, 0 otherwise	+
Access to credit (Credit)	Dummy	1 if Yes, 0 otherwise	+
Membership to an association(Associ)	Dummy	1 if Yes, 0 otherwise	+
Tropical Livestock Unit (TLU)	Continuous	Numbers	+
Using High Yielding Varieties (HYV)	Dummy	1 if Yes, 0 otherwise	+
Fertilizer use (Fertuse)	Dummy	1 if Yes, 0 otherwise	+

+, Positive effect; -, Negative effect

[1]- One Tsimad=0.25 hectares

Table 3. Descriptive Statistics of Variables Used in Regression Analysis

Variables	Extension non-Visited (N= 196)		Extension Visited (N= 74)		T and Chi2 tests (P-Value)
	Mean	Std.dev	Mean	Std.dev	
Gender (1=Male)	0.821	0.384	0.622	0.488	0.065*
Age	46.515	10.340	39.757	9.187	0.000***
Education	0.485	1.102	2.338	2.751	0.000***
Land Size	6.184	2.730	5.432	2.511	0.020**
Home Distance from office	9.091	3.973	8.311	4.875	0.089*
Off-farm participation (1=Yes)	0.704	0.458	0.838	0.371	0.051*
Irrigation use (1=Yes)	0.235	0.425	0.418	0.497	0.073*
Access to credit (1=Yes)	0.321	0.468	0.500	0.503	0.073*
Membership to an association(1=Yes)	0.592	0.561	0.649	0.584	0.811
Tropical Livestock Unit	5.281	3.517	6.149	5.032	0.111
Using High Yielding Varieties (1= Yes)	0.316	0.466	0.419	0.497	0.282
Fertilizer use (1= Yes)	0.245	0.431	0.378	0.488	0.170

Source: Own Survey Result, 2014 Std.dev; Standard deviations; asterisks ***, ** and * is significance at 1%, 5% and 10% significance level

3.2 Place, Season and Frequency of Contact between EWs and Farmers

Assessing and answering a big question: who-extension workers or farmers are to be contacted? was considered as an important breakthrough to deal with determinants of access to agricultural extension workers' service. As per this priority, place where contact is made, season where farmers got advice and frequency of contact they made as well as farmers' response on their satisfaction of contact (as enough and not enough) were the main issues raised and responded as it has been shown in Table 4.

As it can vividly be seen above, it is believed that, 81.48% of the sample households were visited by EWs and farmers themselves have also visited extension workers. It is believed that, these days, EWs are providing agronomic oriented advisory services like proper land preparation, application of chemical fertilizer and high yielding varieties, soil and water conservation practices, on how to manage post harvest practices and the like. As per this expectation, hence, these all populations had a chance of bequeathing these all indispensable advices that could potentially increase crop production. Unfortunately, only 27.78% of the sample respondents have either been visited by EWs or do visit EWs by themselves in most critical times basically during plot preparation, sowing and weeding seasons. Contrary to this, majority of the respondents have had assumed as if EWs do visit them in non-critical farming time, that actually is after harvesting. Normally, EWs can convince smallholder farmers to adopt new agricultural technologies for the coming cropping year; but the time after harvest is considered as a comfort time whereby smallholders do think of off-farm activities participation and then income diversification.

Inherently, one can ask a strong, actually complex question- who is going to visit to whom? This basically was answered through the analysis of place of contact that EWs made with smallholder farmers and vice versa. Given this, of the total 27.78% of critical time visited households, only 2.96% had been visited by EWs at their own field or farm land. The remaining 24.81% of the sample respondents have had visited EWs at their office. From this analysis one can deduce that smallholder farmers are obliged to visit EWs at their office. Hence, from the real experience of the study districts (Raya-Azebo and Raya-Alamata), smallholder farmers were found to be responsible to visit EWs at their office. This finding is unlike the policy dictation as well as the responsibility of EWs that clearly stipulates as if EWs are responsible and accountable to visit smallholder farmers at their field and show how to double their crop production potential. In supporting this finding, the overall mean summary of contact days per month and year was 0.8 and 9.6 respectively.

Quite surprisingly, having the above mentioned contact days, 70.37% of the visited sample households do believe as contact frequency was enough. As a regional policy, in the region, giving twenty days free labor service is one of the strategies designed to implement soil and water conservation practices. In such scenario, EWs are expected to avail themselves in an area where conservation is being done thereby give their professional guidance and advice as far as employing agricultural technologies typically chemical fertilizer and high yielding varieties were concerned. As a result of this, 56.67%

of sample respondents have been contacted by EWs in areas where 20 day of free labor service and productive safety net programs were given. Hence, the mean yearly extension contact (9.6 days) vis-à-vis 20 days of free labor service paves the way to conclude as if extension contact was negligible or zero. While analyzing the reason behind smallholder farmers' reflection on contact time that had been considered as "enough" was mainly to be free from frequent nagging and convincing trials made by EWs to take chemical fertilizer and high yielding varieties. In relation to this, focus group discussants had acclaim that, districts' soil quality can best be taken as fertile enough that simply requires rain or irrigated water. Hence, any governmental intervention that intends to improve soil quality of the region is wholly unacceptable.

Typically, the case of chemical fertilizer is one of the basic and hottest issues that the society is unspeakably dealing, opposing it and facing the challenge. It is believed that fertilizer is sought to be employed in areas where rainfall and irrigation practices are abundant. Hence, inference can be made as their argument basically seems logical; fertilizer is not something that could be used in areas where there is no abundant rainfall and irrigation water. Due to erratic rainfall nature and districts' fertile soil endowment, according to discussants voice, the intervention being made could not be seen in effect. What it seem justifiable, practitioners (EWs in collaboration with districts', sub-districts' and village leaders) have been forcing the society to take chemical fertilizer and high yielding varieties as per their respective land acreage with the pre-text of doubling production and increase productivity. The result is consistent with the empirical findings of Shumet (2011) and Umar et al (2011).

EWs themselves were considered as key informants; as a result of this, EWs in Kukufito, Tao and Lemeat sub-districts were asked about their typical roles and responsibilities in serving the community. Almost all of them have had responded and confessed as if their role was convincing farmers to take agricultural inputs alone; far beyond convincing farmers, checking each and every farmer whether they use chemical fertilizer and high yielding varieties or not was the most cumbersome task. Hence, inference can be made as EWs had limited their roles and responsibilities; hence, they could not demonstrate and show farmers how to use fertilizer and thereby increase crop production. Making poverty history could not be done by convincing farmers to take chemical fertilizer and high yielding varieties; rather since farmers were illiterate, showing how to use inputs, serious and series follow up and frequent contact could have been taken as the best mechanism. Surprisingly, one of an experienced and 59 years old farmer from Kukufito sub-district particularly in Qalina village had responded that:

Farm and farming practices are not things that can be done keeping your neatness; hence if extension workers want to serve the community heartedly and intended to see a grown farmer, they should travel on foot rather than wasting time waiting for motor bicycle; show us how to double our production potential and how to employ the needed inputs if necessary. The already confessed limited responsibility of EWs coupled with the voice of the above experienced and old aged farmer, has had aroused the need to assess the reason for limited responsibility and reluctant nature of EWs. In doing so, the 12th grade completed student and 37 years old youngster from Lemeat sub-district particularly from Adi-Hagos Tsegay village had responded as follows:

Although I am the one among those who frequently visited them in their office, there is a tendency of freeing themselves from field demonstration and checking application of agricultural inputs. In such a scenario, I saw them while doing unrelated tasks that have been dictated from their bosses. These activities are of politics mainly collecting money from the community on the name of membership to the regional political party, Tigray Peoples' Liberation Front (TPLF). They do these things basically as a response to their bosses. Unless they do these things, they will automatically be dismissed from their position and loss their meager monthly salary since it is directly paid from the government side alone. Hence, extension workers do limit their responsibility due to a discouraging monthly salary and top-down financing system. As a response for such things, they prefer to be obeying orders of bosses since they want to upgrade their educational status and then be paid better. As a conclusive remark, these days, extension workers are being confused due to the fusion of politics and agriculture issues where the former is being practiced well on the expense of the latter. In this case, they simply become responsible for their bosses and top officials by rejecting farmers since they could not subsidize them. The finding is in line with the findings of Tewodaj et al. (2009) in Tigray, Amhara, Oromia, SNNP and Gambella regions of Ethiopia; and Ozor et al. (2007) in Katsina, Bauchi, Kogi, Ondo, Enugu and Rivers states of Nigeria; Adesina and Baidu-Forson (1995) in Burkina Faso and Guinea.

3.3 Determinants of Access to Agricultural Extension Workers' Service

Before rushing to econometric estimation result display, different econometric assumptions were tested. Since facing multicollinearity and

hetroscedasticity problems is common mainly in cross sectional data, to check that, pair-wise correlation matrix and robust standard error calculation of the binary logistic model, respectively, was used. In addition to this, while running the Ordinary Least Square regression model, Variance Inflation Factor (VIF) was used to test the presence of multicollinearity problem among independent variables; link and OV (Omitted Variable) tests were used to test the inclusion of irrelevant and exclusion of relevant independent variables respectively. Besides, to test hetroscedasticity problem, robust standard error calculation was used. Estimate of the binary logit model and Marginal effects after binary logit estimation was shown in Table 5.

Table 5 shows factors that determine access to agricultural extension workers' service. Accordingly, education, irrigation use, membership to an association, fertilizer use, TLU and off-farm participation were found to have a positive and significant relationship with access to agricultural extension workers' service; while gender, age and land size carried a significant negative sign. Implication of gender on access to agricultural extension workers' service was found to be negative and statistically significant at 5% significance level. Keeping other things constant, male headed households were found to have 18.3% lesser likelihood of visiting agricultural extension workers and vice versa compared with female headed households. According to Berihun et al. (2014), in the study districts, since women were not that much allowed to be a household head, widowed and divorced women were those who could have been taken as female household heads. Due to their limited number, agricultural extension workers might have preferred these household heads and advising them well. On the other hand, female headed households might have also been visiting extension workers for different purposes since they could face a problem while deciding up on an issue. Thence, the prior hypothesized negative coefficient was not rejected at 5% significance level.

Statistically, while determining farmers' access to agricultural extension workers' service, sample households' age was found to be negative and significant at 1% significance level. Consequently, as age increases by one year, citrus paribus, farmers' likelihood of getting access to extension workers' service would decrease by 0.13%. Possibly, young and middle aged farmers could better be exposed to new information and could open their gate for extension workers' advice. Unlike these age groups, as age increases, farmers could give a deaf ear to hear any advisory service concerning their farming practices; and they could have been also reluctant to visit extension workers at their office. As per this finding, the prior hypothesized coefficient was not rejected at 1% significance level.

Although the prior hypothesized coefficient of land size was indeterminate, it was found to be negatively related with access to agricultural extension workers' service; and it was significant at 10% significance level. As arable land size increases by one tsimad, keeping other things constant, farmers' access to extension workers' service decreases by 0.25%. The possible interpretation is, if farmers do have a large coverage of arable land, they can use fallow system that could maintain and preserve soil fertility and nutrient and thereby increase crop production. Given their rationality in decision making, farmers could have been deciding how to prepare the land, what to sow and what to be followed. In such a scenario, they do not want to visit and to be visited by extension workers and then be convinced to take chemical fertilizer and high yielding varieties.

Farm households' educational level was found to be positive and statistically significant at 1% significance level. Undoubtedly, education is an instrument that let farmers to be keen for new agricultural information and advisory services that could potentially increase their yield. As education increases by one year of schooling, citrus paribus, the likelihood of access to agricultural extension workers' service increases by 1.05%. The prior hypothesized positive coefficient was not rejected at 1% significance level.

Engaging in irrigation practices and using irrigation water was found to be positive and statistically significant at 5% significance level in determining the chance to be visited by extension workers and vice versa. Farmers who have an irrigable land and who use irrigation water, keeping other things constant, have 17.9% higher probability of getting agricultural extension workers' service and higher probability to visit and to be visited unlike irrigation non-users. In the study districts, according to Berihun et al. (2014), irrigation users have had a higher probability of adopting agricultural technologies much better than irrigation non-users. When irrigation users adopt agricultural technologies like chemical fertilizer, high yielding varieties, pesticides and herbicides, they need to have an advice and follow up from agricultural extension workers both at their office as well as in field. Hence, irrigation users were found to have higher probability of getting advisory services unlike irrigation non-users. It was worth to note that membership to a certain association like agricultural cooperatives, has a positive and statistically significant relation with access to agricultural extension workers' service. It

was statistically significant at 5% significance level; favoring association members to have a better access than non-members. Hence, association members, keeping other things constant, have 11.6% higher probability to get advice from agricultural extension workers unlike association non-members. Association members might have been exposed to new agricultural information as well as technologies; and could have also been keen to visit extension workers. Furthermore, as one positive contribution, an association by itself could facilitate and ease the communication between its members and extension workers.

Adopting chemical fertilizer was found to have a positive and a statistically significant association (5% significance level) with access to agricultural extension workers' service. In fact, since introducing and disseminating agricultural technologies in the region is a recent phenomenon, chemical fertilizer might have been taken almost by all residents of the two districts at large; but taking and using chemical fertilizer are two different things (Berihun, 2014). As a result of this, in this regression analysis, only those who have had used it on their farm land were considered. Hence, fertilizer users, keeping other things constant, have 16.5% higher probability to get advice from agricultural extension workers unlike fertilizer non-users. Fertilizer users have had a better chance to visit agricultural extension workers at their office; and in turn agricultural extension workers could have also been preferred these people to show or advice how, when and where to use chemical fertilizer. Tropical Livestock Unit possessed by sample households has a positive association with access to agricultural extension workers' service; and it was statistically significant at 1% significance level. The magnitude of positive sign indicates that, as Tropical Livestock Unit increases by one unit, keeping other things constant, farm households' likelihood to agricultural extension workers' advice would increase by 0.28%. If farmers do own a flock of animals and if they want to get an advice from extension workers, they can subsidize extension workers thereby show them how to use agricultural inputs at the right time and place basically to increase their yield. The prior hypothesized positive coefficient was not rejected at 1% significance level.

Opposite with the prior hypothesized negative coefficient, participating in different off-farm activities was found to have a positive association with access to agricultural extension workers' service. It was positive and statistically significant at 1% significance level. The hypothesis was, if farmers do participate in off-farm activities their attention would totally be diverted in to non-agricultural activities. As a result of this, their probability of visiting extension workers would be less and they could also give a deaf ear to extension workers while they intend to visit and advice them. By rejecting the null hypotheses or negative coefficient at 1% significance level, the regression result infers a positive and significant result. The magnitude of the positive sign indicates that off-farm participants, citrus paribus, have 18.8% higher likelihood to visit extension workers and vice-versa. This infers that an income earned from off-farm activities is being reinvested on agriculture which is pertinent for agricultural transformation in general and smallholder farmers in particular.

Table 4. Description of place, season and frequency of contact made

Variables	Labels	Frequency	Percentage
Season when contact is made	During field preparation time	19	7.04
	While sowing	26	9.63
	While weeding	30	11.11
	After harvest time	153	56.67
	No contact at all	42	15.56
	Total	270	100.00
Place of contact made	At their own field or arable land	8	2.96
	At Extension workers' office	67	24.81
	At a place where free labor service was given	103	38.15
	At a place where PSNP was done	50	18.52
	No contact at all	42	15.56
	Total	270	100.00
Frequency of contact	Weekly	2	0.74
	Once in every two week	6	2.22
	Once in a month	181	67.04
	Irregular	39	14.44
	No access	42	15.56
	Total	270	100.00
Reflection on contact time	Not-enough	46	17.04
	Enough	190	70.37
	No need to contact them	34	12.59
	Total	270	100.00

Table 5. Determinants of Access to Agricultural Extension Workers' Service Results from logit Model

Explanatory Variables	Coefficient	Standard Error	P>|z|	Marginal Effect
Gender	-0.996	0.410	0.015**	-0.183
Age	-0.083	0.021	0.000***	-0.013
Education	0.655	0.127	0.000***	0.105
Land size	-0.155	0.082	0.059*	-0.025
Home distance from the office	-0.011	0.010	0.265	-0.002
Irrigation Use	0.995	0.389	0.010**	0.179
Access to Credit	-0.159	0.403	0.692	-0.025
Membership to an association	0.724	0.343	0.035***	0.116
Use of High Yielding Varieties	-0.358	0.387	0.355	-0.055
Fertilizer use	0.924	0.389	0.018**	0.165
Tropical Livestock Unit	0.162	0.053	0.002***	0.028
Off-farm participation	1.454	0.514	0.005***	0.188
Constant	0.950	1.016	0.350	
Log likelihood = -104.14703	Number of obs = 270	LR chi2(12) = 110.76		
Prob > chi2 = 0.0000	Pseudo R2 = 0.3472			

Source: Own Estimation Result, 2014 asterisks*, **and*** significant at 10, 5 and 1 % respectively.

Table 6.The Effect of Agricultural Extension Workers' Service on Crop Yield: OLS Result

Variables	Coefficient	Standard Error	t	P>|t|
Access to Extension Workers' Service	2.156	1.793401	1.20	0.230
Gender	2.206	0.766	2.88	0.004***
Age	-0.019	0.032	-0.59	0.555
Education	0.349	0.171	2.05	0.042**
Land size	0.634	0.142	4.45	0.000***
Home distance from the office	-0.004	0.016	-0.25	0.805
Irrigation Use	-0.432	0.773	-0.56	0.576
Access to Credit	1.479	0.709	2.09	0.038**
Membership to an association	0.984	0.603	1.63	0.104
Use of High Yielding Varieties	0.726	0.709	1.02	0.307
Fertilizer use	0.275	0.903	0.30	0.761
Tropical Livestock Unit	0.480	0.091	5.28	0.000***
Off-farm participation	-1.194	0.847	-1.41	0.160
Constant	0.208	1.716	0.12	0.904
Number of obs = 270	R-squared = 0.3339	F(13, 256) = 9.87	Adj R-squared = 0.3000	
Prob> F = 0.0000		Root MSE = 5.0485		

Source: Own Estimation Result, 2014 asterisks **and*** significant at 5 and 1 % significance level respectively.

3.4 Implication of Access to Agricultural Extension Workers' Service on Crop Yield

Table 6 shows the implication or effect of agricultural extension workers' service on crop yield that was measured in quintal. Ordinary Least Square regression model was considered so as to measure the effect of extension workers' service on crop yield and its estimation result is been shown here under.

The prior hypothesis stating the positive effect of agricultural extension workers' service on crop yield cannot be rejected although the positive sign was not statistically significant. Hence, the positive implication of extension workers' service on crop yield is neither accepted not rejected. Consequently, the positive sign become insignificant due to lack of up to mark effort exertion and unsatisfactory visit extension workers do on to farmers and vice versa. Besides, as it has already been explained above, majority of the sample respondents were visited in areas where free labor service was being given and in areas where Productive Safety Net Program (PSNP) was done. These areas basically were places where extension workers have had tried to convince smallholder farmers to take chemical fertilizer and high yielding varieties. Although they could convince and the fertilizer and yield increasing varieties have been taken, checking whether these technologies come in to effect or not was the forgotten issue.

These days, furthermore, in the study districts, sub-districts and villages, Productive Safety Net Program (PSNP) is becoming the blood stream and guarantee of farmers' life since crops produced could not satisfy annual household consumption needs. As a solution, farmers want to participate in the program mainly in food-for-work activities as per the criteria dictated. These people were paid employees where one person was expected to do five days per month and will be awarded birr 19 in cash and 3 kilogram (0.03 quintal) in food. One among these criteria's is taking chemical fertilizer. Unless they took, therefore, farmers will lose subsidy of their daily bread and their kids will cry in need of bread. Hence, if they want to fulfill their consumption needs, they have to participate and then if they want to participate in the program they need to take chemical fertilizer regardless of sowing it in their farm land. Therefore, once included in the program, farm households do pay due attention for program tasks delaying farm activities like plot preparation, sowing and weeding that ultimately diminishes the productive potential of the farmer. The reason behind, according to focus group discussants, is over burdened and unaffordable penalty that forced them to prefer delaying farm activities and do even after 12 PM or six o'clock local time. Due to these all reasons, production has been compromised; as a result of this the effect of agricultural extension workers' service on crop production was found to be positive but statistically insignificant.

Unlike the effect of agricultural extension workers' service on crop yield, positive and statistically significant relationship was found with gender, education, land size, access to credit and Tropical Livestock Unit. The regression result revealed that male headed households were better crop producers unlike their female counter parts. Similarly, as a means to solve liquidity constraints, farmers who have had credit access were found to be better crop producers unlike their counter parts. Likewise, crop yield was found to be increased with an increase with educational level, arable land size and Tropical Livestock Unit being possessed.

4. Conclusions and Recommendations

This research paper has tried to examine the underlying determinants of access to agricultural extension workers' service by the rural households in Tigray region, Ethiopia. The binary logistic regression model result revealed as if access to agricultural extension workers' service was determined positively by education, irrigation use, membership to an association, fertilizer use, Tropical Livestock Unit and off-farm participation. Besides, it was found to be determined negatively by gender, age and land size. Irrigation users, association members, fertilizer users, off-farm participants and female headed households were found to have had better access to extension workers' service unlike their respective counterparts. Likewise, farmers' likelihood to visit extension workers and vice-versa was found to be increased with an increase in education and Tropical Livestock Unit; while it was decreasing with an increase in age and arable land size.

To increase and instigate smallholder farmers' likelihood of being visitor and visited to and by agricultural extension workers, policy makers should put emphasis on expanding irrigation practices; distribute chemical fertilizer on volunteer motivation of smallholder farmers; and empowering female headed households as the first step to visit and be visited by agricultural extension workers and thereby enhance crop yield. Besides, policy makers need to give due emphasis on the roles and responsibilities of extension workers that actually need to be ranged to the extent of checking farmers at their own farm land basically whether they have used the already taken chemical fertilizer or not. In doing so, still, attention needs to be given for joint financing mechanism whereby extension workers are to be financed both by the regional government and farmers themselves. Solving the financial issue will be an important breakthrough to solve the great fusion of political and agricultural tasks of extension workers.

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