Determinants of functionality level of farmers training centers in north-west Ethiopia

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ABSTRACT

The Ethiopian agricultural extension system is highly dependent on Farmers/Pastoralists Training Centers (F/PTCs), hereinafter training centers simply. These training centers are established at Kebele level mainly to provide advisory, information, demonstration, and training services to farmers and pastoralists. Nationally, the training centers are categorized into four levels based on their functionality level. The purpose of this study is to assess the determinants of the training centers' level of functionality in North-West Ethiopia. A cross-sectional data were collected from April to June 2020 from 44 training centers. The quantitative data were collected through a survey questionnaire filled by heads of the training centers. The qualitative data were also collected by interviewing key informants, such as Woreda and Kebele level extension workers. The ordered (adjacent-category) logistic model was employed to analyze the determinants of the training centers' level of functionality. Working experience of development agents (DAs), annual internal revenue, availability of water, and linkage with local cooperatives were found to be significant factors affecting the functionality level of FTCs. Thus, arranging experience sharing platforms among development agents, enabling the training centers to generate their revenue, exploit available water sources, and create strong linkages with locally available cooperatives are suggested to make the low performing training centers at equal footing with the higher performing ones. This study contributes to the literature on what determines the functionality level of FTCs in Ethiopia. It has also a methodological contribution by applying the adjacent-category econometric model which is a rarely used variant of the ordered logistic regression model for ordinal response variables.

1. Introduction

Agricultural extension, in many developing countries, is an important public good that demands government’s intervention [1]. Since the mid-2000s, the agricultural extension service has received due political attention by the Ethiopian government [2] as the sole provider of the service to the farming community. Even before such political attention, Ethiopia has introduced Farmers/Pastoralists Training Centers (F/PTCs), hereinafter training centers, since 2002 [3] with a huge investment of more than 50 million USD [4]. Their establishment and organization are one of the directions in the implementation of the Agricultural Development Led-Industrialization (ADLI) strategy which takes agriculture as the engine of national economic growth [5]. They have been established mainly to provide extension, training, demonstration, exhibition, and information services to farmers (hereinafter the word ‘farmers’ also refers to pastoralists) and the rural youth [6, 7]. They provide training to farmers by middle-level professionals (development agents) graduating from the Agriculture Technique Vocational Education and Training (ATVET) colleges. The ATVET program was introduced after taking useful experiences from China, India, and Indonesia and adapting it to the context of Ethiopia [7]. Overall, farmers training centers (FTCs) are training and information centers serving as a focal point for agricultural development activities in a given rural Kebele administration [7]. Their presence, as a local level extension organization, is supposed to solve farmers’ problems through technology demonstration, adaptation, and provision of up to date information about new ways of production that will increase agricultural productivity and income, and ultimately improve their livelihood. Besides, they are supposed to provide demand

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1 ‘Kebele’ is the smallest administrative unit in Ethiopia.

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driven training aimed at building farmers’ problem solving capacity through imparting new knowledge and skills of production.

The Ethiopian agricultural extension system is thus highly dependent on the training centers [8, 9]. According to the existing data [10], to date, about 14,064 training centers are established across the country. However, they are found at different levels of functionality and most are not meeting a minimum level of quality in the services provided to farmers [11, 12]. Nearly, 30% of them are functional in the country [10, 13] though the government’s intention is to see all the training centers perform in a similar capacity regarding the provision of the aforesaid services to farmers. The Ethiopian Ministry of Agriculture has categorized the training centers as Pre-basic, Basic, Intermediate, and Advanced centers based on their actual service provision performance [10]. As to the authors’ knowledge, labeling the local level extension organizations, in this case the training centers, by their functionality level is unique to the agricultural extension system of Ethiopia.

Few studies were conducted related to the performance of the training centers in the country. For instance [14], studied their physical and functional status in the Oromiya region. The focus of the study was identifying the challenges they face and the existing opportunities which can make the same fully functional [15, 16] conducted a study on their performance with a special focus on the provision of modular training and its effectiveness in improving the knowledge and skill level of farmers in the Oromiya and Amhara regions, respectively. Moreover [17], conducted a similar study focusing on their performance concerning the provision of training and dissemination of technologies to farmers in the Tigray region. However, these studies lacked a scientific inquiry of why some training centers perform well and the others not. Put differently, “What determines the performance of these centers at the local level?” is the question not yet answered. In addition, the abovementioned studies, albeit all followed a mixed-methods research approach, employed more of a descriptive than regression analysis.

Furthermore, worldwide, a considerable number of studies were conducted on the determinants of the performance of the agricultural extension system at large. For instance, see [18, 19, 20, 21, 22, 23, 24, 25]. Nonetheless, the literature is deficient in studies on what determines the observed performance variations among the local level extension organizations in a certain district, region, or zone in a given nation. As known, all the extension activities are carried out with the engagement of the frontline extension workers at the grassroots level. Thus, having a clear understanding of the real bottlenecks limiting the performance of the local level extension organizations, with no doubt, will pave the way for the better performance of the whole extension system in a given nation. Thus, to fill the above mentioned gaps, this study employed a mixed-methods research approach to assess the determinants of the level of functionality of the training centers in the Amhara region which shares about 23% of the nationally established centers [10]. This study also contributes to the literature by applying the adjacent-category model which is a rarely used variant of the ordered logistic regression model for ordinal response variables. The scanty application of this model was noted during the literature review period.

This paper is organized into six sections. The second section presents the literature review and the third section that of the research methodology undertaken by the study. The fourth and fifth sections present results and discussion, respectively. The sixth section concludes and recommends.

2. Literature review

2.1. The functionality status of F/PTCs in Ethiopia

The training centers in Ethiopia are found at different levels of development, based on the Kebele administration and community commitment as well as the availability of government/donor resources to cover capital expenditures (for example, building materials, equipment, animals) and operating costs (such as seeds, fertilizers, chemicals, etc) [8]. As a result, as illustrated in Figure 1, FTCs are classified as Pre-basic, Basic, Intermediate, and Advanced level based on their functionality status with a minimum criteria set by the Ministry of Agriculture [9, 26]. According to [10], among the total training centers established nationally, the relative majority (38.38%) were yet Pre-basic, implying that they are not in a position to provide modular trainings, demonstrate new technologies and provide up-to-date information of various type to farmers. Meaning, these centers lacked either the minimum required number of DAs, had poorly furnished buildings or had no demonstration plots at all. About 33.43% of them were found at a Basic level of functionality which had a capacity to the opposite of the Pre-basic ones. Nearly, 26% of the centers were in the Intermediate level of functionality with adequate physical resources and facilities enabling them to provide practical trainings to farmers. Only 2.4% of the entire centers were found at the Advanced level of functionality with a capacity of generating their own revenue, linking with other development institutions, handling advanced trainings (level-I and level-II) to the farming community. Generally, it is the Intermediate and Advanced level centers (nearly 30%) which are said to be providing the intended services to farmers. In other words, about 70% of them are not in a position to provide the expected services to the farming community and the rural youths in Ethiopia.

2.2. The major challenges of F/PTCs in Ethiopia

While F/PTCs and the assignment of thousands of graduates as staff in these centers represent huge resource and opportunity to move forward, making these centers functional, responsive, effective and dynamic remains a real challenge [27]. Most of the F/PTCs are not capable of providing the expected services to farmers [9]. According to the existing literature, the key challenges leading to the poor delivery of services in these training centers are summarized as follows:

2.2.1. Lack of physical resources and facilities (operating equipment, inputs, training materials, demonstration plots)

F/PTCs often lack adequate basic infrastructure and facilities to offer the desired training and extension service to farmers [8, 9, 12, 14, 19, 27, 28, 29, 30, 31, 32, 33]. The infrastructure and resource levels of the training centers differ substantially across the country. Many of the better-developed centers are donor-financed [8], like IPMS Ethiopia, Rural Capacity Building Project (RCBP) of the World Bank, Oxfam America. For instance, RCBP had supported 2,504 training centers in 138 Woredas throughout the country [34]. Oxfam America and Sassakawa Africa Association (SAA), with the grant from Bill and Melinda Gates Foundation, capacitated 214 centers to effectively function [32] during its intervention from 2010-2015 in all regions of Ethiopia. IPMS Ethiopia supported 40 training centers in Oromiya, Amhara, SNNPR and Tigray regions [27]. As a result, project supported training centers showed much improvement in access to technologies, inputs, services and advices [32]. According to [19], donor funding significantly affected the performance of the agricultural extension service in Ethiopia.

2.2.2. Budget constraint

The F/PTCs lack adequate budget to cover their operating costs; costs for modern input purchasing for technology demonstration [8, 12, 14, 27, 30, 35]. F/PTCs, instead of depending on the government and other donor agencies, are expected to generate their own income through the sale of farm outputs after the demonstration is over. The Demonstration Farms (DFs) have great potential to be run as effective revenue-generating and teaching tools to demonstrate to different types of farmers on how they can increase their farm household income [8]. However, their ability to do so depends heavily on the abilities of the management committee and the extension agents [35] and the availability of resources and facilities [8].

2.2.3. Development agent related factors

Development agents (DAs) assigned at F/PTCs lack practical knowledge and skills to train and skillfully demonstrate technologies to
This contributes to the low interest of farmers to work with DAs and to use F/PTCs as farmers are pragmatic by nature—they need problem solving interventions than those full of theories.

Lack of housing to DAs is another challenge in many of the F/PTCs. Only few F/PTCs that have received sufficient government or donor support provide DAs with a suitable place to live at or near the F/PTC [8]. Besides, the frequent turnover of DAs is another headache for F/PTCs. Several of the centers are either unstaffed or abandoned [37]. According to [9], roughly out of the 83,000 DAs graduated from ATVET colleges, only 56,000 were on duty. Inadequate incentives to motivate and retain DAs [8, 31, 33, 35], DA promotion to higher positions [35] and DAs involvement in non-extension activities [14, 38, 39] are important reasons for the staff turnover. This frequent DAs turnover hampers the development of strong relations between the centers and the community [35].

To culminate the DAs' incentive claim, for instance, the government of the southern Nations, Nationalities, and Peoples (SNNP) regional state has adopted a proclamation that shares 40% of the net F/PTC income to DAs to improve their motivation [32] even if it was promised to be 60% according to the previous F/PTC guideline [6]. However, this incentive mechanism is invalidated by the new DAs' incentive system guideline issued in July 2013 [6].
According to the newly issued DAs' incentive system guideline, the special incentive package includes scholarship, experience sharing in home country or abroad, financial (bonus) incentives, various in kind gifts, and some share from the F/PTCs' net revenue generated. The implementation of this incentive package is based on the DAs' performance [6]. Nonetheless, DAs' incentive system has not been fully implemented and where implemented, it lacks consistency over time and across regions and Woredas [32].

2.2.4. Poor linkage with other institutions (research, service providers, input suppliers, universities, etc)

The linkage that F/PTCs have with other research and development institutions is weak [27, 29, 31, 32, 34, 35, 37].

2.2.5. Poor community participation

The community participation to utilize the services of F/PTCs is minimal [37, 40] and the community simply expects much benefit from the centers. There is a low women participation [29, 30] and high dropout rate [14] in modular trainings. Many of the farmers who attended the FTCs are often heads of households and not grouped by age or gender [37]. These problems will lead to limited training to and involvement of farmers in managing and sustainably using F/PTCs [9] which will further lead to the poor performance of the agricultural extension service in the country.

As indicted above, the existing literature clearly pinpoints the challenges that FTCs are generally facing in an effort being made to provide extension, training, information, and demonstration services to farmers. However, it is assumed that all these challenges would not be the same to all FTCs functioning at different levels. In other words, knowing which of these challenges are more sensible to which level of FTCs by function is crucial, that is not yet investigated. A clear knowledge of this is helpful to government and other stakeholders to take appropriate measures specific to FTCs found at a certain functionality level to further improve their performance. Therefore, investigating what determines the functionality level of FTCs is the salient objective of this paper.

3. Materials and methods

In this section, study area description, sampling technique and sample size, data collection and data analysis methods, and summary of variables hypothesized for the study are presented.

3.1. Description of the study areas

The study was conducted in Machakil and Bure Zuria2 Woredas in the Amhara region (Figure 2). Machakil is one of the 18 Woredas in the East Gojjam Zone consisting of 25 rural Kebeles. Its capital, Amanuel, is located 328 km North-West of Addis Ababa and 240 km from Bahirdar, the capital of the Amhara region. The Woreda has a total area of 727.4 km2 with an elevation ranging from 713 masl in the South near the Abay gorge to 2604 masl. Agro-ecologically, Bure is mainly mid-highland (82%) followed by moist and wet low land (10%), and wet highland (8%) climatic conditions. The annual mean temperature of the Woreda ranges from 14°C to 24°C with rainfall ranging from 1386 mm to 1757 mm annually [42, 43]. The Woreda follows a mixed farming system. According to the Woreda’s office of agriculture, the major crops being produced include wheat, teff, maize, and finger millet. Fruits such as papaya, avocado, and orange are also produced. From the livestock component, cattle, small ruminants, and poultry are also reared in the area.

2 ‘Woreda’ is the fourth level administrative unit in Ethiopia equivalent to a district.

3.2. Sampling technique and sample size

Machakil and Bure Zuria Woredas were purposively selected from the Amhara region. The two Woredas were selected mainly to capture all levels (Pre-basic, Basic, Intermediate and Advanced levels) of the training centers by function existing in the region. The selection also considered a locational representation and accessibility. The Pre-basic level FTCs were available in Machakil Woreda in the East Gojjam Zone. But, no advanced level FTCs were found in this zone. The Advanced level FTCs were available in Bure Zuria Woreda in the West Gojjam Zone. Thus, a total of 44 training centers established in the sample Woredas (25 in Machakil and 19 in Bure Zuria) were selected for the study. Four Woreda extension experts (two from each Woreda) and twelve Kebele extension workers (six from each Woreda) were purposively selected as key informants. The Woreda extension experts included extension team leaders and extension training experts. These experts were selected as they have adequate and valuable information about FTCs being responsible for managing, guiding, and evaluating their performance in collaboration with heads of the centers positioned at the kebele level. In addition, the Kebele level extension workers situated at each FTC have full-fledged information about the centers’ day to day performance and their weaknesses and strengths in light of their areas of specialization. Thus, the selection of these workers considered Animal Science, Plant Science, and Natural Resources Management backgrounds by specialization to capture the full picture of the status of the training centers in terms of livestock production, crop production, and natural resources management.

3.3. Methods of data collection

Employing a mixed-methods research approach, the quantitative and qualitative data were concurrently collected for the study. This approach, along with the quantitative data, is valuable to qualitatively capture the views of Woreda and village level agricultural extension workers about the functionality status of the training centers and their determinants to provide the expected services at their full capacity. Thus, the integration of the quantitative and qualitative method for this study is helpful due to the nature of the research problem per se and to fill the weaknesses of the separate application of the two methods. The quantitative data were collected through a semi-structured questionnaire after making a pre-test to include relevant variables and avoid unnecessary ones. The FTC heads were taken as institutional representatives for FTCs. Thus, the questionnaires were distributed to 44 heads of the training centers at the Kebele level. The FTC heads, mandated to manage the centers, were found to be appropriate personalities to fill the questionnaire believing that they would provide relevant and accurate data reflecting the true image of the FTCs in terms of their success and failure stories. The researchers with the help of Woreda level extension team leaders and training experts managed the data collection process. As a result, all the distributed questionnaires were filled and collected back from each FTC to researchers. Moreover, the qualitative data were collected by interviewing four Woreda and twelve Kebele level extension experts, 16 in total, to complement the quantitative data. Two Basic and two Intermediate level FTCs were also observed. No Pre-basic and Advanced level FTCs were part of the observation due to remoteness and movement restriction due to the Covid-19 pandemic, respectively.
3.4. Methods of data analysis

The quantitative data were first cleaned and organized, and made ready for analysis. Then, descriptive and econometric analyses were made by using STATA (14.2) analysis software. The ordered logit (adjacent category) model was employed to analyze the determinants of the training centers’ level of functionality. The qualitative data were transcribed from the local language into English verbatim. Then, they were organized, coded, and categorized into themes, and interpreted by employing the thematic analysis method.

3.4.1. The ordered logit (adjacent category) model specification

The Ethiopian Ministry of Agriculture categorizes the training centers into four levels, namely Pre-basic, Basic, Intermediate and Advanced, according to their level of performance [9, 26]. Thus, the dependent variable (Y), i.e. the training centers’ functionality level, is a four-level ordinal response variable. The ordered logit model (proportional odds model) is commonly used for the analysis of ordinal categorical data when the response variable has more than two ordinal categories [44].

Among the three approaches of the ordered logit models (cumulative, stage, and adjacent), the adjacent approach is applied for this study. The adjacent approach is chosen over the cumulative and the stage approaches as the ordinal response (i.e. the functionality level of training centers) indicates no underlying (latent) continuous variable and it doesn’t occur in a sequence of mandatory stages (i.e., a given center does not have to go through categories 1, 2 and 3 to reach category 4), respectively [45]. In the adjacent approach, “... the probability of being at a given point is compared to the probability of being at the next highest point (i.e., pr[y = m]/pr[y = m + 1])” [45]. So, the probability of interest here is the adjacent probability. That is, the probability of being a “Basic level training center” is compared to the probability of being an “Intermediate level training center,” the probability of being an “Intermediate level training center” is compared to the probability of being a “Basic level training center”, and the probability of being an “Advanced level training center” is compared to the probability of being an “Intermediate level training center”.

The proportional odds assumption is required for the adjacent category model. The proportional odds model assumes equal βs across the logit equations for the different cut points or intercepts [45]. The equation for the adjacent category model is [46, 47, 48] (Equation 1):

$$\log \left( \frac{Pr(y = m/x)}{Pr(y = m + 1/x)} \right) = T_m - x\beta_{m+1} \left[ 1 \leq m < M \right],$$

where m is a category, x is a vector of independent variables, T is a cut point or intercept, and \( \beta \) is a vector of logit coefficients.

The equation for the probability of any given outcome category (m) in the adjacent category model [48] is (Equation 2):

$$Pr(y = m/x) = \begin{cases} \frac{\exp \left( \sum_{r=1}^{M-1} \left[ T_r - x\beta_r \right] \right)}{1 + \sum_{q=1}^{M-1} \exp \left( \sum_{r=1}^{q-1} \left[ T_r - x\beta_r \right] \right)} & 1 \leq m < M-1 \\ 1 - \sum_{r=1}^{M-1} Pr(y = q/x) & m = M. \end{cases}$$

where \( T \) is a cut point, x is a vector of independent variables, \( \beta \) is a vector of logit coefficients that do not vary across adjacent comparisons, and m is the category and its corresponding logit equation.

Since the outcome variable has four categories, the model estimates three binary logit models simultaneously. However, in this analysis, the outcome variable is made to have three categories due to the exclusion of the Pre-basic level training centers as they were small in number. Thus, the model estimates two binary logit models (See section 4.1.2). Finally, “… the choice between the ordered logit and ordered probit model is mainly one of computational convenience. Moreover, interpretation of the parameters in terms of odds requires the ordered logit model” [49] than the ordered probit model.
3.5. Variables hypothesized to determine FTCs’ level of functionality

Based on the literature review, personal experience of the investigator, and formal discussion with experts of the study areas, the independent variables hypothesized to influence the functionality level of training centers are presented in the below table (Table 1).

Before conducting an econometric analysis, a multicollinearity test was made for the predictor variables. Variance inflation factor (VIF) is one of the indicators of collinearity. Hence, the values of VIF for each predictor (i.e. VIF values less than 10) and the mean VIF (1.23) were found to be small indicating that the data had no serious problem of multicollinearity. Besides, the endogeneity test was conducted for the variable ‘revenue’ generated by demonstration farms as it is suspected to be related to the size of demonstration farms. Following, the regression-based test indicated that the t-value (−0.56) for the included residual (v) is not significant (p = 0.576) to reject the null hypothesis that its coefficient is zero (See Appendix A Table A1). Thus, it is concluded that the suspected variable is not endogenous. Based on the two tests made above, all the predictor variables, therefore, were kept and entered into the ordered (adjacent-category) logistic analysis.

4. Results

In this section, the findings of the study are presented in the consecutive sub-sections with descriptive and econometric analyses of the data, respectively.

4.1. Descriptive analysis

4.1.1. Distribution of FTCs by the level of functionality in the study areas

As depicted in Table 2 below, among the total training centers, the Intermediate (50%) followed by the Basic level (48%) dominated over others in the study Woredas. Location-wise, the Basic and Intermediate level training centers (48%) had shared equal proportions in Machakil Woreda. However, training centers at the Intermediate level (53%) dominated over others in Bure Zuria Woreda. In addition, it was only in this Woreda where training centers at the Advanced level (14%) were found.

4.1.2. Characteristics of FTCs by levels of functionality

Description for the characteristics of training centers is done based on the 41 FTCs by excluding the Pre-basic ones. This was done because of the convergence failure that happened in the ordered logit regression. The convergence failure is fixed when training centers at the Pre-basic category are dropped. It is suspected that the convergence failure occurred since training centers at the Pre-basic level were few as a case compared to other categories (See Table 2).

As indicated in Table 3, the F-test was used to compare the means of the continuous predictors (DAs’ experience, Demonstration farm size, and Revenue generated) among the Basic, Intermediate, and Advanced levels of FTCs. But, the Chi-square test was used to see whether there was an association between the FTCs’ level of functionality and the categorical predictors (Water availability and Linkage with cooperatives).

Table 2 portrays that, in relative terms, on average, training centers at the Intermediate level had better experienced DAs than the Basic and Intermediate level ones (6.45 years) and the Basic and Advanced level training centers (6.45 years) had better experienced DAs than the Basic and Intermediate level ones. The minimum and maximum working experience of DAs was found in the Basic (0.5 years) and Advanced (10.67 years) level training centers, respectively. The F-test using one-way ANOVA (Analysis of Variance) shows that the mean working experience of DAs significantly varied among the three levels of training centers at 5%. The implication

Table 1. Summary of variables with their hypothesized sign to explain the functionality level of FTCs in the study areas.

| Variables | Descriptions | Hypothesized relationship |
|-----------|--------------|--------------------------|
| Dependent variable: | | |
| FTCs’ functionality level | Functionality level of FTCs (1 – Pre-basic; 2 – Basic; 3 – Intermediate; 4 – Advanced) |  |
| Independent variables: | | |
| DAs’ experience | Average working experience of development agents (DAs) (years) | +ve |
| Demonstration farm size | Size of demonstration farms (hectare) | +ve |
| Revenue | Annual revenue generated by the demonstration farms (birr/year) | +ve |
| Water availability | Availability of water to demonstration farms (1 – if Yes and 0, otherwise) | +ve |
| Linkage with cooperatives | Linkage with local cooperatives (1 – if Yes, and 0, otherwise) | +ve |

Table 2. Distribution of FTCs by level of functionality by Woreda (N = 44).

| Functionality level of FTCs | Machakil | Bure Zuria | Total |
|----------------------------|---------|-----------|-------|
| Pre-basic                  | 1 (4)   | 2 (10.33) | 3 (6.82) |
| Basic                      | 12 (48) | 1 (5.26)  | 13 (29.55) |
| Intermediate               | 12 (48) | 10 (52.63)| 22 (50) |
| Advanced                   | -       | 6 (31.58)| 6 (13.64) |
| Total                      | 25 (100)| 19 (100) | 44 (100) |

Table 3. Characteristics of FTCs by functionality levels (N = 41).

| Variables | Basic (13) | Intermediate (22) | Advanced (6) | Total (41) |
|-----------|------------|-------------------|--------------|------------|
| DAs’ working experience (years) | Mean (SD) | 3.71 (1.97) | 5.76 (2.36) | 6.45 (2.35) | 5.21 (2.43) |
| Min.      | 0.5        | 2.5               | 4.5          | 0.5        |
| Max.      | 7.5        | 9.64              | 10.67       | 10.67      |
| F (2, 38) = 4.46; p-value = 0.0181** |
| Demonstration farm size (ha) | Mean (SD) | 1.18 (0.68) | 1.59 (0.60) | 1.66 (0.23) | 1.47 (0.61) |
| Min.      | 0.13       | 0.13              | 1.25         | 0.13       |
| Max.      | 2.73       | 2.86              | 1.88         | 2.86       |
| F (2, 38) = 2.37; p-value = 0.1073 |
| Revenue generated (birr) | Mean (SD) | 6959.038 (7987.19) | 16517.7 (12734.22) | 37883.33 (6635.79) | 16613.59 (14419.98) |
| Min.      | 0          | 0                 | 26100        | 0          |
| Max.      | 24000      | 37000             | 45000        | 45000      |
| F (2, 38) = 16.99; p-value = 0.0000*** |
| Water availability | Yes (%) | 23.08 | 63.64 | 66.67 | 51.22 |
| No (%)    | 76.92     | 36.36 | 33.33 | 48.78 |
| χ² (2) = 6.05; p-value = 0.049** |
| Linkage with cooperatives | Yes (%) | 38.46 | 72.73 | 83.33 | 63.41 |
| No (%)    | 61.54     | 27.27 | 16.67 | 36.59 |
| χ² (2) = 5.34; p-value = 0.069* |

* * * p < 0.01; * * p < 0.05; * p < 0.1.

Source: Field survey result, 2020.
is that training centers at a higher level of functionality were those where more experienced DAs are working in than the lower-level ones.

The mean size of demonstration farms seemed also to have an increasing trend from the Basic to the Advanced level training centers. That is, on average, the Intermediate level training centers had a larger farm size (1.59 ha) than the Basic level (1.18 ha) ones, and the Advanced level training centers had a larger farm size (1.66 ha) compared to those at the Basic and Intermediate levels. However, the F-test shows that there was no significant variation of mean farm size among the three levels (Table 3). According to the key informants, in the study areas, the minimum recommended farm size for each center is 2.5 ha. However, there were variations from one training center to the other depending on the availability of communal lands in each Kebele to allot for them. As a result, the size of the demonstration farms ranged from 0.13 ha to 2.86 ha (See Table 3). Nationally, training centers are recommended to have 3–5 ha of land to be allotted for the demonstration of new practices and technologies to farmers mainly on crop and livestock production and natural resources management [52]. However, in this study, the result of the F-test shows that farm size has nothing to do with the FTCs level of functionality. This implies that what matters is not the demonstration plot size but the effective and efficient utilization of the available plots in exhibiting the intended modern farm production techniques and practices to farmers.

The annual revenue generated by training centers through their demonstration farms was found increasing when they promote from Basic (6,959.04 birr year-1) to Intermediate (16,517.7 birr year-1) and Advanced (37,883.33 birr year-1) levels of functionality. The F-test shows that the mean annual revenue which the training centers generated varied significantly among the three levels at a 1% level of significance. The interview made with Woreda and Kebele level extension experts confirmed that training centers generating a considerable amount of annual revenue were found in the Intermediate and Advanced levels of functionality. This is because, according to the experts, the generated revenue enables them to purchase modern inputs (improved seeds, fertilizers, bee hives, etc.) required to conduct demonstrations for farmers to learn from. The revenue generated by training centers was found to be the main source of a revolving budget to fulfill inputs needed for demonstrations.

The large majority of the Intermediate (=64%) and Advanced (=67%) level training centers had water to irrigate their demonstration farms during the dry season. However, the great majority (=77%) of the Basic level ones were found to have no water to irrigate the same. The chi-square test shows that the training centers’ functionality level was associated with the availability of water at a significance level of 5% (Table 3). This implies that training centers at the higher levels of functionality were those which had access to water compared to those at the lower functionality levels.

For training centers with access to water, rainwater harvested in a pond layered with geo-membrane (to manage water loss due to seepage) (47.62%) and groundwater with a rope pump (also known as washer pump) (33.33%) were found to be the main sources of water (Table 4).

About linkage with cooperatives, nearly 73% of the Intermediate and 83% of the Advanced level training centers had a link with local cooperatives. However, the large majority of the Basic level ones (≈62%) had no linkage with the same being operational in their localities. The chi-square test shows that the centers’ functionality level was associated with linkage with cooperatives at a 10% significance level (Table 3). This implies that training centers at the higher level of functionality were those which had a linkage with local-level cooperatives compared to their counterparts.

4.2. Econometric analysis of determinants of FTCs’ level of functionality

As was mentioned earlier in section one, the purpose of the study was to assess factors influencing the functionality level of training centers. Table 5 shows the descriptive statistics for the dependent and independent variables used in the ordered (adjacent-category) logit model.

The results in Table 6 shows that the log-likelihood ratio Chi-square test, LR $\chi^2 (10) = 48.28, p = 0.0000$, indicated at least one of the logit regression coefficients of the predictors, such as the experience of development agents ($da_{exp}$), size of demonstration farm ($d_{farm}$), revenue (sqrtrev), water availability (water), linkage with cooperatives (cooplnkge) was statistically different from zero. Hence, the full model with all predictors provided a better fit than the null model with no predictor variables in predicting the adjacent probability for the functionality level of FTCs ($fctl$).

To check whether the proportional odds assumption of the adjacent category model is violated or not, a Brant test was used. Hence, the test result (See Appendix A Table A3) indicates that the chi-square test ($\chi^2 = 7.702$) is not significant ($p = 0.173$) to reject the null hypothesis stating the model parameters are equal across the categories confirming that the assumption is not violated.

The result in Table 6 shows that all the predictor variables included in the model had a positive effect on the functionality level of training centers as was priori expected. And, except the variable ($d_{farm}$), all the predictor variables significantly affected the functionality level of training centers.

5. Discussion

This study, as mentioned priori, was aimed at assessing factors determining the functionality level of training centers. Thus, following is a discussion made only on the significant factors based on the regression results illustrated in Table 6.

### Table 4. Sources of water utilized by FTCs.

| Water sources | Freq. | Per cent |
|---------------|-------|----------|
| River         | 7     | 33.33    |
| Pond          | 10    | 47.62    |
| Tap water     | 1     | 4.76     |
| Well          | 2     | 9.52     |
| Rope pump     | 7     | 33.33    |
| Total         | 21    | 100      |

Source: Field survey result, 2020.

### Table 5. Descriptive statistics for variables used in the ordered (adjacent category) logit model (N = 41).

| Variables                      | Variable code in the model | %    | Mean | SD  | Range |
|-------------------------------|----------------------------|------|------|-----|-------|
| Dependent variable            |                            |      |      |     |       |
| FTCs’ functionality level     | fctl                       |      |      |     |       |
| 1 – Basic                     |                            |      |      |     |       |
| 2 – Intermediate              |                            |      |      |     |       |
| 3 – Advanced                  |                            |      |      |     |       |
| Independent variables         |                            |      |      |     |       |
| DAs’ working experience (years)| da_exp                     | 5.21 | 2.43 | 0.5-10.67 |
| Demonstration farm size (ha)  | d_farm                     | 1.47 | 0.61 | 0.13-2.86 |
| Revenue (burr year-1)         | sqrtrev                    | 113.48 | 61.89 | 0-212.13 |
| Water availability            | water                      | 0.51 | 0.51 | 0-1   |
| Linkage with cooperatives     | cooplnkge                  | 0.63 | 0.49 | 0-1   |

Source: Field survey result, 2020.

* The square root of the variable “revenue” was taken as it was non-normally distributed.
Table 6. Summary of ordered (adjacent category) logistic regression results for determinants of FTCs’ level of functionality.

| Model  | Est. (Std. Err.) | z | p > | \( |z| \) |
|--------|-----------------|---|---|---|
| df_exp | 2.587261 (1.028653) | 2.39 | 0.017** |
| d-farm | 2.647388 (3.147819) | 0.82 | 0.413 |
| sqrtrev | 1.025052 (0.014817) | 1.79 | 0.074* |
| water | 25.96945 (42.99981) | 1.97 | 0.049** |
| cooplnkge | 20.44195 (36.86189) | 1.67 | 0.094* |
| Cons 1 | 0.0000213 (0.0000889) | -2.58 | 0.010 |
| Cons 2 | 7.64e-11 (9.12e-10) | -1.95 | 0.051 |
| Log likelihood | -16.01698 | LR chi (10) = 48.28 | Number of obs. | 41 |
| Prob > chi 2 | -- | -- | -- | -- |
| Prob > chi 2 | 0.0000 | Psedo R2 | 0.6012 |

* *** p < 0.01; ** p < 0.05; * p < 0.1.
Source: STATA model output, 2020.

5.1. Working experience of development agents (DAs)

When DAs’ average working experience increases by one year, training centers tend to function by 2.59 times higher at a 5% level of significance, keeping constant the effects of other predictors (Table 6). That means, the odds of the training center being at the Intermediate versus the Basic, and the Advanced versus the Intermediate level was 2.59 times higher in attaining the higher level of functionality in terms of providing advisory, information, training, and demonstration services to farmers. This is in agreement with the prior expectation that DAs’ working experience positively affects the training centers’ functionality level. This implies that experienced DAs are capable of transforming a training center, in relative terms, from lower to higher functionality levels [53] also reported that work experience positively and significantly affected the success of extension work in Nigeria. This is because “experience provides the knowledge and tools necessary for implementing effective extension work, which DAs did not obtain through formal education” [54]. According to [55], years of experience in an extension organization had a positive significant effect on the knowledge level of extension workers. Experience serves extension workers as a source of information on extension service, innovation, and the role of extension [56]. On the contrary, the less experienced workers “…tend to search for academic materials to read more frequently than the experienced ones” [54] to obtain information. Moreover, experienced extension workers are enthusiastic to have technical, social, and market information [57] which are basic elements to better address farmers’ needs and improve the performance of the extension organization. Empirical evidence also indicated that experienced extension workers exploit information communication technologies (ICTs) [58, 59] to disseminate information on improved production techniques, marketing, and climatic conditions to farmers.

In general, experience escalates the competency level of extension workers [60, 61, 62] which helps them make the extension organization and the extension service successful [63, 64]. According to [65], the local level extension services demand time to change the outlook of farmers which calls for the assignment of an experienced extension worker.

5.2. Internal revenue generated through demonstration farms

As the annual average (square root) revenue increases by one birr, training centers tend to function by 1.03 times higher at a 10% significance level, keeping constant the effects of the other predictors (Table 6). That is, the odds of the training center being at the Intermediate compared to the Basic level, and being at the Advanced compared to the Intermediate level was 1.03 times higher in attaining a higher level of functionality. This result is in line with the findings of [18, 55, 62] that the availability or non-availability of funds affects the efficient and effective performance of the extension service.

Before, training centers didn’t intend to generate revenues from their demonstration farms [9]. But, currently, they are given the mandate to generate their internal revenue through selling the output obtained from the demonstration farms after serving their purposes. As was understood from the key informant interviews made, they are also allowed to use the generated revenue to fulfill mainly farm inputs (improved seeds, fertilizer, chemicals, beehives, etc.) which they require to conduct demonstrations for farmers to learn from and adopt new technologies and practices. As was clear from the interviews made, the generated revenue is serving as the revolving fund and it is the main source of the training centers’ annual budget to be used to fulfilling necessary farm inputs to conduct demonstrations.

The success of extension service depends on, among others, the allocation of adequate operation funds [66]. However, extension services run by the government in many of the countries in the world lack adequate budgets [67, 68, 69, 70]. This is not an exception for Ethiopia where the government covers the lion’s share in running the extension system [8, 71, 72] with inadequate funds [38]. The budget shortfall becomes worse when it comes to the operational budget [8, 12, 14, 27, 30, 35, 38] at the training center level where the budget is needed to fulfill inputs for demonstration farms and training materials. This budget shortfall thus limits the performance of the frontline extension workers to conduct effective demonstrations and offer technical training to farmers. However, as [8] observed, the demonstration farms of training centers have the potential to generate revenue besides teaching farmers if they are effectively managed and used.

5.3. Availability of water to irrigate demonstration plots

The result in Table 6 indicates that training centers tend to function by 25.97 times higher at a 5% significance level when water is available to irrigate their demonstration farms, especially in the dry season. That is, the odds of the training center being at the Intermediate level compared to the Basic, and at the Advanced compared to the Intermediate level was 25.97 times higher in attaining a higher functionality level. This is to mean training centers having a water function better than those without water. This result is in line with the finding of [73] in Zimbabwe which indicated demonstration farms with access to harvested water around performed better in demonstrating new technologies and practices to farmers.

Water availability, principally in the dry season, is linked to demonstration farms under the possession of each training center at the Kebele level. Thus, water is an important factor to make the farms fully functional. In this regard [74], argued that water availability is the main prerequisite to successfully duplicate yield-enhancing green revolution technologies (high yielding varieties, fertilizer, and agro-chemicals) introduced in developing countries. Demonstration farms potentially increase the persuasion power of development agents to convince farmers to adopt new technologies and practices. This is because demonstrations realize the ‘seeing is believing’ proverb which farmers, especially the smallholders, prefer in the technology adoption process. Therefore, storing water from any possible source is a top priority in periods when water is scarce [75] to make use of the demonstration farms of training centers as effectively and efficiently as possible (Figure 3).

As the key informants interviewed witnessed, mostly the training centers are busy conducting demonstrations in the rainy than the dry season. However, in the rainy season, as they stated:

Farmers strongly resist coming and learning from demonstrations as they are busily engaged in routine farm activities (land preparation, sowing, weeding, etc.). Rather, they are interested to visit and learn from demonstrations during the dry season which they think have enough spare time.
That is why training centers that had water available from any possible source (run-off, river, deep hand-dug wells [Figure 3]) and which were able to conduct demonstrations during the dry season were found to be functioning better. As Table 3 portrays, approximately 67% and 64% of the training centers at the Advanced and Intermediate levels, respectively, had water available to irrigate their demonstration farms. However, the large majority of the Basic level training centers (≈77%) had no water source to irrigate the same. In this regard [14, 76], also observed that water is a critical challenge for the proper functioning of the majority of training centers in their studies in the Oromiya region.

The presence of different water storage structures available at training centers has other advantages besides storing water helpful to conduct demonstrations by which farmers will learn about new technologies and practices during the dry season which is convenient for them to willingly come and learn. First, they can serve as sources of water harvesting technologies for farmers to adopt and conduct small-scale irrigation practices as it would pave the way to persuade farmers about the economic importance of small-scale irrigation in the area. This would further promote market-oriented agricultural development by producing high-value crops, which the Ethiopian government has given due attention, through irrigated agriculture [77]. Second, it could increase the training centers’ internal revenue through selling outputs obtained, at least twice a year, from the demonstration farms after accomplishing their primary objectives, i.e. technology demonstrations and training.

5.4. Linkage with cooperatives

As one of their roles, training centers are expected to create linkages with existing development actors [6], among which cooperatives are one, to collaboratively tackle problems that farmers face. The logistic regression result (Table 6) reveals that training centers tend to function by 20.44 times higher at a 10% significance level when there is a linkage with local cooperatives. That is, the odds of the training center being at the Intermediate level compared to the Basic one, and that being at the Advanced level compared to the Intermediate one is 20.44 times higher in attaining a higher level of functionality when there exists a linkage with local cooperatives.

As the key informant interviews made revealed, local cooperatives are the main sources of farm inputs, mainly fertilizer and improved seeds to both farmers and training centers. That means, training centers could conduct demonstrations timely if and only if they can access the required farm inputs locally.

As can be seen from the findings (Table 6), training centers that were closely working with cooperatives were more likely to be found at a higher level of functionality than those lacking that linkage. This implies that the presence or absence of linkages with local cooperatives affects them to conduct effective demonstrations to farmers through which learning and adoption of new technologies and practices would take place. For instance, a case study by [73] in Niger, Bangladesh, and Zimbabwe revealed that weak institutional linkage with local input suppliers had resulted in the untimely arrival of inputs needed to conduct demonstrations as desired. Thus, creating cooperation with local stakeholders is invaluable to timely access inputs required for farm demonstrations [73, 78]. Moreover, the studies by [18] in the Congo Democratic Republic [55], in Nigeria, and [19] in Ethiopia indicated that linkages and interactions among actors increased the performance of the extension organization which is reflected through technology dissemination, timely input delivery, mutual learning through information exchange and cooperation.

However, the training centers in Ethiopia are generally characterized by their poor linkage among the existing development stakeholders [27, 29, 31, 32, 35, 37, 79, 80] such as cooperatives, Universities, research centers, Agricultural Technical Vocational Education and Training (ATVET) Colleges, to mention few.

6. Conclusions

FTCs, as grassroots level extension organizations, are the heart of the Ethiopian agricultural extension system. As to the knowledge of the authors, it is Ethiopia that categorizes such extension organizations as Pre-basis, Basic, Intermediate, and Advanced based on their service provision performance at the local level. Knowing what determines the performance variation among them is crucial for the government and other stakeholders to systematically address their bottlenecks and enable them to provide the intended services to farmers. Thus, this paper assesses the determinants of the training centers’ level of functionality in North-West Ethiopia.

Training centers at the Pre-basic, Basic, Intermediate, and Advanced levels of functionality were found in the study areas. By coverage,
taking their total in the study areas, those at the Intermediate level dominated over the Advanced and Basic ones. Working experience of development agents, annual internal revenue, availability of water, and linkage with local cooperatives were the determinant factors positively affecting the functionality level of training centers. These findings imply that government intervention in areas of human, financial, and physical resources, and institutional linkage is needed to bridge the performance gap existing among the training centers and make them function on equal footing. This study, therefore, recommends that regular platforms should be arranged for development agents assigned at each training center to share experiences. Besides experience sharing, the government in collaboration with other stakeholders, like non-government organizations (NGOs), should create short-and medium-term training opportunities for development agents to enable them provide effective extension service to farmers. The training centers should also be encouraged and supported to generate their internal revenue needed for fulfilling the necessary inputs, facilities, and other resources to provide a full-fledged extension service to farmers in a sustainable manner. This could be an important loophole and/or strategy for countries adopting a public extension system to address their budget shortfalls to cover the costs of the extension service at local level.

Moreover, letting the training centers have access to water, in any means, to irrigate their demonstration plots, especially in the dry season, should be given due attention by the government, NGOs, and the local community. A FTC-based demonstration of new technologies and best practices in the dry than rainy season should be taken as a good extension strategy to win the full interest and participation of farmers as they have enough spare time in the former season. In addition, the presence of all-season FTC-based demonstration plots is indispensable to generate or adapt, and successfully promote context specific technologies and practices that farmers can easily adopt. It also increases the persuasion power and credibility of DAs among farmers as demonstrations are powerful to increase farmers’ motivation and encourage learning by doing.

Furthermore, the training centers should be empowered to create linkages with cooperatives, NGOs, and other stakeholders available at least locally to easily access resources (financial, material, etc) and services (input provision, training, consultancy, etc) to help them provide the intended services to farmers. Such linkages are helpful to FTCs as the government’s intervention is not adequate to capacitate them at the level of providing services to farmers as desired.

This research is limited to cover a wider geographic space and the respective sample size of FTCs. Thus, further research is needed to identify other determinant factors by increasing the sample size of the training centers at regional or national level to substantiate the findings of this study.

Declarations

Author contribution statement

Ketemaw Melkamu Wonde: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Wrote the paper.
Abrham Seyoum Tsehay; Samson Eshetu Lemma: Conceived and designed the experiments; Performed the experiments; Contributed reagents, materials, analysis tools or data.

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Data availability statement

Data will be made available on request.

Declaration of interest’s statement

The authors declare no conflict of interest.

Additional information

No additional information is available for this paper.

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Appendix A

Table A1. Multicollinearity diagnostics

| Variable  | VIF  | SQRT VIF | Tolerance | R-Squared |
|-----------|------|----------|-----------|-----------|
| da_exp    | 1.08 | 1.04     | 0.9223    | 0.0767    |
| d_farm    | 1.14 | 1.07     | 0.8753    | 0.1247    |
| sqrtrev   | 1.43 | 1.20     | 0.6969    | 0.3031    |
| water     | 1.12 | 1.06     | 0.8896    | 0.1104    |
| cooplnkge | 1.35 | 1.16     | 0.7420    | 0.2580    |
| Mean VIF  | 1.23 |          |           |           |

Source: STATA output.
Table A2. Test of endogeneity for the variable “sqrtrev”

| Variate  | Coef.  | Std. Err. | t    | P > | t  |
|----------|--------|-----------|------|-----|----|
| da.EXP   | 0.766606 | 0.021568  | 3.68 | 0.023 |
| d-farm   | 0.396963 | 1.365075  | 0.28 | 0.492 |
| sqrtrev  | 0.007015 | 0.002557  | 2.76 | 0.009 |
| water    | 0.141076 | 0.255773  | 2.27 | 0.030 |
| coop/lnge | 0 (omitted) |
| v        | -0.001646 | 0.002918  | -0.56 | 0.280 |

| cons     | 0.311537 | 0.283639 | 1.10 | 0.280 |

| Number of obs. | 41       | F (5,35) = 9.91 | Prob > F = 0.0000 |
| R-squared      | 0.5860   | Adj. R-squared = 0.5268 | Root MSE = 0.45893 |

Source: STATA model output. coop/lnge omitted because of collinearity.

Table A3. Test of the proportional odds assumption

| Chi 2 | df | P > Chi 2 |
|-------|----|-----------|
| Brand | 7.02 | 0.173 |

Source: STATA model output.

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