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Economic Benefit Farmers Gained from Demonstration Trials

Factors Affecting Farmers' Hiring Decision on Agricultural Mechanization Services: A Case Study of Debre Elias Woreda, East Gojam Zone, Ethiopia

Effect of Salary and Staff Loan on Employees' Saving Deposit Status: Case Study of Oromia International Bank

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Agriculture is the most important sector in the Ethiopian economy, contributing the lion's share of the GDP. Nearly 80% of the population live in the rural areas and derive their livelihoods directly or indirectly from agriculture. Given its importance, the performance of the sector is therefore reflected in the performance of the whole economy. With this background, the Journal of Agriculture and Development aims to stimulate research and thinking on agriculture and development studies in Ethiopia. The articles contained in the journal reflect the views of their authors and do not necessarily coincide with those of the Editorial Committee, Institute of Agriculture and Development Studies, JADS or of SMU.

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Economic Benefit Farmers Gained from Tef Demonstration Trials

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Abstract

Sixty-eight lead farmers were randomly selected from a shortlist of 120 lead farmers, and they were provided with quality seed of tef varieties released recently to plant on one-fourth of a hectare on the same farmers' fields, The grain yield means from the two tef varieties were comparable amounting to 2.54 and 2.48 t ha^{-1} for Dagim and Bora, respectively. Given the input and output prices that prevailed in the selected districts, the mean production costs (variable and fixed) and the gross income were estimated at 35,504.30 and 83,445.62 Birr ha^{-1}, respectively. The study also revealed that labor accounted for about 53% of the total costs. It is, therefore, recommended to introduce seed-oriented demonstration trials accounting the costs and revenue to determine the economic benefit farmers gained from seed sales to fellow-farmers.

Key words: Farmers' access, Host farmers, Seed oriented, Tef varieties, Grain yield, Economic benefit

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Introduction

Background

Seed-oriented demonstrations (demos) are one of the most common features of agricultural extension. They are an important tool for enabling farmers to acquire first-hand information about improved agricultural production practices. Just as a picture speaks a thousand words, demos can communicate a rich spectrum of messages for farmers (Hancock, 2017; Bell and Rickman, 2013).

Physical and economic information on the demonstration trials, as a resource, for development is only just beginning to gain ground in Ethiopia. Policy makers, planners, researchers and extension agents are increasingly recognizing the fact that physical and economic information is indispensable to the development process. One serious constraint to agricultural development is the limited access to financial information on the demonstration trials/plots so far done for a number of years. The current study attempted to collect both physical and economic data on the demonstration trials as well as to express the results in both physical and monetary terms

The majority of the food security programs implemented in different countries are attributes of demo sites. Demos are also common with other practitioners because they provide a platform to introduce new ideas and allow farmers to experience innovative practices first hand. Despite their popularity, implementation of demos is not always successful, and there are many instances where demos fail to convince farmers to adopt new practices (Martin, 2008; CARE, 2015).

Demos have been around us for so long that they were and are implemented almost by default. Demonstrations, in Ethiopia, may not always be picture-prefect because there is limited literature to guide how to implement them effectively. We, therefore, should embark on a journey to explore how program staff and extension agents can be effective in implementing demonstrations using a correct guide (Corps, 2014).

Well-presented demos can play a critical role in hastening technology adoption. When farmers can see for themselves that a technology works, they are more likely to try it. Conversely, poorly presented demos can negatively affect the learning process and discourage farmers from adopting a new practice. There is a wealth of information on demonstrations in other countries where we can learn from. There are outlined guiding principles across key factors influencing the effectiveness of demos. There is only one effective way to reach and influence the farming classes, and that is by object lessons (Knapp, 1906; Martin, 2008). The objectives of a demo should be cultivated together with farmers; they should be clear to allow objective measurement of results. Most importantly, demos should enable farmers appreciate how to experiment and try out new ideas for themselves on a piece of land.

The objectives of the demonstration trials were**:** 1) to promote newly released tef varieties through demonstration trials; 2) to determine the yield level and production cost of newly released varieties under farmers' conditions; and 3) to demonstrate to farmers the commercial potential of improved variety of tef in order to strengthen the farm-saved seed system.

Methodology

Guiding principles for demonstration work

The overall agreement principles between the researcher and the lead farmers are in indicated in Table 1. The lead farmers entered into an agreement with the researcher to manage the demonstration plots of his/her own and fellow farmers; assist the researcher in selecting suitable land for the demonstration trials; prepare the land according to research directives; sowing seeds on time as advised by the researcher; follow up of the crop management practices such as planting, fertilizer application, weeding, rouging, harvesting and so on as per the research advisories; visit the demo plots regularly, and help fellow farmers when faced with problems especially in harvesting, threshing, cleaning, sorting, grading and in the drying process of crops. The lead farmers were also obliged to assist the researcher in recording production and cost data.

Table 1. Agreement principles between the researcher and farmer to implement agricultural demos

Items	Who typically pays or takes responsibility for	
	Farmer	Researcher
Improved seed		x
Fertilizer	x	
Manure	x	
Pesticides and herbicides	x	
Land	x	
Labor	x	
Fellow-up from end to end	x	x
Technical advice		x
Knowledge & experience	x	x

Study area

Four districts (also known as *Woredas*) in the central highlands of Ethiopia, where tef is the major crop, were selected for the study. These are *Ada'a* and *Gimbichu* districts from East *Shewa* zone in the *Oromia* Regional State, and *Moretna-Jirru* and *Minjar-Shenkora* districts from North *Shewa* zone in the *Amhara* Regional State. All of the four districts have a long history in tef farming. Tef and wheat are the major crops, which occupy 75 percent of the total cropped area. Virtually, all farmlands are cultivated, and farmers use improved varieties to compensate for land scarcity. The locations of the four districts are shown on Figure 1.

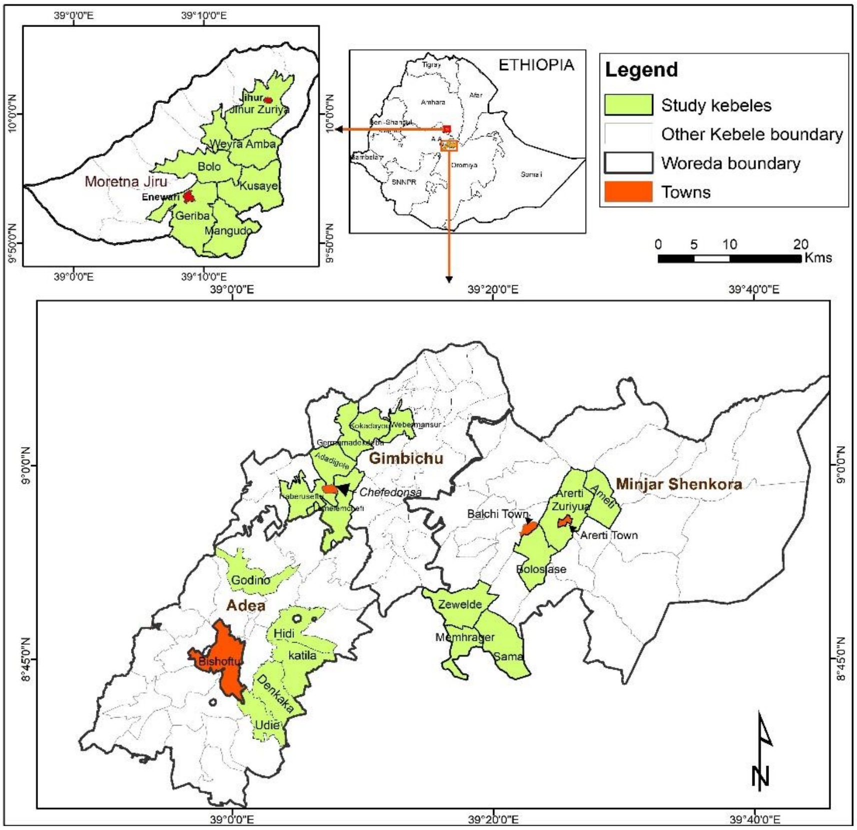

Figure 1. The location map of the study area

Design and sampling

The method applied to select lead farmers was by developing a shortlist of the candidate farmers and present the list to community leaders and the local government agricultural services in the target area. From a shortlist of 120 lead farmers, 68 of them were randomly selected. The term “lead farmers” refers to smallholder farmers who are ready to test new farming technologies including improved varieties in their fields (Martin, 2008; Corps, 2014).

The selected lead farmers entered into an agreement with the researcher to manage the demonstration plots of his/ her own, except for provision by the researchers of improved seeds, regular field supervision and technical advice. Two improved tef varieties were used for the study. These varieties were *Dagim* and *Bora*, which were released by *Debre Zeit* Agricultural Research Center in 2016 and 2018, respectively (MoA, 2020). Each lead farmer was given the two varieties to plant them side-by-side on the same farmers’ field and at the same sowing date each on about 0.25 ha land in order to compare the results. The seed rate used for the varieties was 16-20 kg ha^{-1}, while farmers individually decided on all other agronomic management practices including the frequency of ploughing, time of sowing, time of application and hand weeding, and the type, time and rate of fertilizer and herbicide applications. Moreover, except for the seed, farmers used their own inputs, and they were also responsible for managing the trials, while researchers and the extension agents were responsible for facilitating and providing guidance. They also assisted the lead farmers to ensure that the trials were done uniformly at all sites.

Data collection and analysis

Relevant agronomic and cost data were collected from the primary sources. Data on grain yield, labor and oxen use, and use of seeds and fertilizers were recorded. The data were coded and entered into the SPSS computer software package for analysis. Data were initially analyzed using descriptive statistics such as frequency, percentages, minimum, maximum, means and standard deviations.

Gross margin was calculated as the difference between gross revenue and variable costs. Gross revenue refers to the value of the total grain and straw yields in monetary terms. Performance indicator is the ratio between the total output and the total input.

All inputs, costs and revenues were initially quantified for the 0.25 ha land of each farmer in the current study, and later extrapolated to the hectare basis.

Results and Discussion

A group that consisted of the researcher, extension agent and farmers visited the experimental sites to assess the field performance of the varieties. Based on the results of the visit, 68 host farmers out of the 75 host farmers participated in the study had shown better performance, and properly recorded the costs they outlaid and managed their fields. The plots from the remaining farmers were not considered for evaluation due to seed adulteration, incorrect farming practices, inadequate/irregular field supervision, incorrect data collection and negligence of the farmers. One of the major challenges reported by the lead farmers was their failure to maintain the purity of the varieties because of natural causes such as flood coming with local seed from neighboring or adjacent fields.

The selected lead farmers were entered into an agreement to produce seeds of the improved varieties and to sale 4-5 kg to five fellow-farmers at affordable price. But the seed quality was a big challenge to sale to fellow-farmers. As an entry point, between 2016 and 2020, farmers were trained to devise mechanism to ensure seed quality. After the training, the lead farmers agreed to constitute farmers' fields monitoring team (5-6 farmers) to have a direct control over seed production, quality and distribution

Socio-economic characteristics of tef farmers

The findings from key socio-economic parameters of the farmers are briefly presented below.

Age: The results of the analysis showed that 57.6% of the farmers participated were between the ages of 41-50 years, 15.2% were between 21-30 years and 15.2% were older than 50 years (Table 2).

Education: Table 2 shows that there is high level of education among the respondents as the majority of them had attended primary school and the other 16% completed secondary school. This shows that the majority of the respondents are literate. This relatively higher level of literacy is expected to enhance innovativeness of farmers.

Farm size: Over 27% of the respondent farmers participated possessed a land size larger than 2.5 ha while 24.2% of the respondents had a land between 2.1-2.5 ha. This result indicated that the majority of the tef farmers belong to small-scale category in terms of land holdings. This is in agreement with earlier report which classified the majority of tef farmers as small landholders (Abate *et al.,* 2005).

Farming experience: Almost 65% of the respondents had more than 10 years of farming experiences. The implication of this finding is that the majority of the respondents were experienced farmers who can be considered responsible and rational in taking farm related decisions.

Table 2. Socio-economic characteristics of the selected tef farmers (n = 68)

Variables	Frequency	Percentage
Age (years)		
21-30	10	15.2
31-40	8	12.1
41-50	38	57.6
>50	10	15.2
Education level		
Illiterate	7	10.6
Primary school	48	72.7
Secondary school	11	16.7
Farm size (ha)		
<1	4	6.0
1.1-1.5	13	197
1.6-2.0	15	22.7
2.1-2.5	16	24.2
>2.5	18	27.3
Farming experiences (years)		
1-5	11	18.2
4-10	12	16.7
>10	43	65.2

Estimates of yield

Within the same environment, there are three distinguished clusters of factors with which tef yield differences can be associated: the input used, management, and socio-cultural clusters. In the input cluster, the use of basic inputs such as improved seeds, fertilizers do significantly improve yields (Seufert *et al.*, 2012). However, there are constraints at farm and household levels that may have to be overcome to optimize the availability and use of farm inputs. In the farm management cluster, the method of residue management, crop rotations and time management of field operations, and the control of pests and diseases are important in determining yield differences. In the socio-cultural clusters, the farmers' capability in making farm decisions and access to agricultural production resources are the dominant factors in bringing yield gaps. In this demonstration trials, both farmers and researchers paid close attention to estimate data on grain and straw yields through minimizing the three distinguished clusters of factors.

The grain yields of the two tef varieties were comparable. There are no significant differences between them (Table 3).

Table 3. Grain yield of recently released tef varieties (kg ha^{-1})

	Dagim (n =36)	*Bora* (n =32)	*Total*
Mean	2544.0	2484.0	2514.0
Standard deviation	262.2	246.7	254.5
Minimum	1800.0	1800.0	1800.0
Maximum	3200.0	2840.0	3020.0

Estimates of farm inputs

Five main input types were identified in the small-scale farming system in the study districts. These were seeds of improved variety, fertilizer and herbicide, labor and oxen inputs. The use of these inputs was neither uniform among all farmers nor constant from one cropping season to the next. While all farmers participating in the study admit to having used all of these inputs at one time or another, some host farmers obtained the maximum attainable yields due to efficient management of available resources (land, seed, fertilizer and labor) within the study period. Farmers were advised to keep track of farm inputs they utilized on their demonstration plots.

1) Improved tef variety seeds

Reasons cited by farmers (92%) for using improved variety of tef in the study district were many, the most important of which is that they yielded better with fertilizer application than the landraces.

2) Chemical fertilizers

Another input is fertilizer application. Commonly, the mean rates of fertilizer application for tef were calculated to be 208.2 kg ha^{-1} nitrogen, phosphorus and sulphur (NPS) and 123.5 kg ha^{-1} urea (refer Table 4 for details). In many cases, the rate applied by farmers was greater than the recommended rate. When farmers were asked for the reason as to why they not applying the recommended rate, they indicated that the fertility of their farm (plot) was too low due to lack of crop rotation. During the last 2-3 cropping years, farmers abandoned growing leguminous crops because of pest and disease problem. Secondly, farm size is diminishing from time to time to feed the family. Thus, farmers felt that the recommended rate could not be sufficient to provide an acceptable yield to satisfy family needs.

3) Herbicides

Herbicide is one of the modern labor reducing inputs in tef production. The total labor cost to weed a hectare of tef farm was estimated at Birr 400 to 6000 while the cost of herbicide (PALLAS 45-OD) was estimated at Birr

1800 to 2000, despite the other merits it has. Using herbicide gives an opportunity to farmers to control the weed in time and to expand tef area from time to time.

4) Labor inputs

Labor inputs encompass the labor used for plowing, planting, weeding, harvesting, transporting to threshing place, threshing and winnowing. But the man-hours spent on transporting the harvested crop from the farm to homestead, stacking, and post-threshing processes, which include cleaning and winnowing the seeds, were not included in the study. Farmers in the study districts used traditional methods of harvesting, which depend heavily on manual labor. Tef is harvested entirely by hand using sickles, transported to threshing place by men, donkey back or both.

5) Traction (oxen) as an input

Traction (oxen) input encompasses seedbed preparation, planting and threshing (Table 4). In all these operations, the use of oxen is mandatory in the traditional farming practices. Usually in the grain-threshing system, the harvested tef is spread over a smooth, cow dung-plastered threshing floor and animals are allowed to trample on it to separate the seeds from the stalks.

Table 4. Amounts of seeds, fertilizer, labor and oxen used in the demonstration trials as recorded by the farmers and checked by researcher (n = 68)

Parameters	Seed ($Kg\ ha^{-1}$)	Fertilizer ($kg\ ha^{-1}$)		Labor ($Man\text{-}hour\ ha^{-1}$)	Oxen ($Oxen\text{-}hour\ ha^{-1}$)
		NPS*	Urea**		
Mean	16.4	208.2	123.5	908.8	454.2
Standard deviation	1.9	20.8	36.4	39.4	23.3
Minimum	16.0	200.0	100.0	800.0	408.0
Maximum	20.0	266.0	200.0	1008.0	504.0

*NPS contains 19% nitrogen, 38% P_2O_5 and 7% Sulphur
**Urea contains 46% nitrogen

Estimates of variable costs

Given the input prices that prevail in the selected districts, the means of costs of variable inputs of 68 host farmers are summarized on Table 5. The major inputs considered in tef production were seed, fertilizers, and labor for seedbed preparation, sowing, weeding, harvesting and threshing as well as oxen time for plowing, planting and threshing. Product transport from the farm to the homestead (threshing ground), stacking, winnowing and cleaning costs were not included in the total variable costs.

On the average, the total variable costs were 31,559.38 Birr ha^{-1} out of which the mean labor cost was 16,723.10 Birr ha^{-1}. This indicates that close to 53% of the variable costs were for labor.

Table 5. Variable input costs of tef demonstration trials (n = 86)

Parameters	Seed cost (Birr ha^{-1})	Fertilizer cost (Birr ha^{-1})	Labor cost (Birr ha^{-1})	Oxen cost (Birr ha^{-1})	Herbicide cost (Birr ha^{-1})	Total cost (Birr ha^{-1})
Mean	922.5	5,788.1	16,723.1	6,322.6	1,803.0	31,559.38
St. Deviation	12.5	800.0	748.7	306.6	271.2	1,313.6
Minimum	900.0	4,740.0	13109.2	5,591.5	1,500.0	28,345.4
Maximum	1,125.0	7,079.0	17,291.6	6,993.0	2,200.0	33,536.1

Estimates of cost structure

Of the total production cost, a significant higher percentage (53%) incurred for labor (Table 6). Farmers were asked about costing procedures and methods of labor payments. Eighty percent of the farmers reported that hourly labor payment for harvesting remains higher due to the overlap of different farm operations across crops, and the fact that harvesting for tef should be done within short period of time (one to two weeks). Farmers further explained that neither migrant nor family labor fulfills the labor demand for harvesting. Thus, to perform harvesting and threshing in a given period of time, they indicated their need for mechanized solution. Consequently, introducing farm machinery especially for harvesting and threshing offers an opportunity to improve the productivity of tef farming in the future.

A reasonable amount of cost also went to oxen-hour whereas the seed cost was insignificant. This shows that small-scale tef farming absorbs labor and oxen cost. It is, therefore, arguable that small-scale farmers should either use labor effectively or use farm machinery to increase tef production per unit area. Harvesting with sickles, oxen-trampling to dislodge or to separate the seeds during threshing and cleaning the seeds using pitchfork and manual winnowing would not enable meeting the high demand from both domestic and foreign markets as tef is not only a popular grain in Ethiopia but also becoming a life-style crop in Europe and North America.

Labor cost

In developing countries, the bulk of the labor force is concentrated in agriculture. However, labor becomes very scarce at the time of harvesting. The situation gets worse when untimely small rains appear during the harvesting period of tef as the demand for labor gets high thereby increasing the wage for tef harvesting. This means that labor supply fails to keep pace with demand during harvesting. As a consequence, labor prices tend to rise. Due to these constraints in labor shortage and unexpected rise in harvesting costs, introducing farm machinery is the most important breakthrough in order to overcome this critical shortage of labor during harvesting. Farm machinery reduces the drudgery of farm work and facilitates optimum period for tef harvesting and threshing. Investment in technology that reduces the shortage of labor and improves the flow of agricultural labor to industrial development needs to be promoted (Norton and Alwang, 1993; Mijinadadi and Njoku, 1995; Agwu *et al*., 2008).

Oxen cost

In many developing countries like Ethiopia, oxen are the principal source of power as they are used in several activities including plowing, planting and threshing. Oxen traction is indispensable in diverse types of terrains and soil types including those difficult to work with. The study revealed that 21% of the total production cost went for oxen power and from the total oxen-hours, 61% was allocated to threshing while 28% was to plowing. Normally, farmers hire labor and increase the numbers of oxen to perform threshing in short period of time before untimely rain spoils their harvest.

Table 6. Structure of production cost (%)

Parameters	Seed	Fertilizer	herbicide	Labor	Oxen
Mean	2.9	18.3	5.7	53.0	20.0
St. Deviation	0.1	2.0	0.9	2.0	0.9
Minimum	2.8	14.8	4.9	46.0	18.9
Maximum	3.0	22.6	8.2	56.7	22.7

Estimates of gross margin

Given the input and output prices that prevailed in the selected districts, the mean revenue and mean variable costs of the farming operation were estimated to determine the mean gross margin of the demonstration trials (Table 7). The results revealed that when averaged over all of the four improved varieties the mean variable costs and gross margins were 31,559.38 and 83,445.62 ETB ha^{-1}, respectively.

The tef straw value was also considered because farmers believe that it adds to the gross margin as it is used either to feed their cattle or sold for different purposes (feed, house plastering, bedding). The straw prices were collected from the four study districts to estimate the gross revenue obtained from sales of the straw. Therefore, the total revenue is the sum of revenues obtained from grain and straw income. Finally, benefit-cost ratio of all improved varieties was 1.69. This indicates the rate of return from a unit of investment.

Table 7. Average variable costs, gross benefits and profits obtained from improved tef varieties

Costs and benefits	Mean value ((n = 68)
Costs	
Seed (ETB ha^{-1})	922.52
Fertilizer (ETB ha^{-1})	5,788.10
Herbicide	1,803.05
Labor (ETB ha^{-1})	16,723.10
Oxen (ETB ha^{-1})	6,322.61
Total variable costs (ETB ha^{-1})	31,559.38
Fixed costs* (ETB ha^{-1})	3,944.92
Total costs (ETB ha^{-1})	35,504.30
Benefits	
Grain yield (ETB ha^{-1})	113,130.00
Straw yield (ETB ha^{-1})	1,875.00
Total revenue** (ETB ha^{-1})	115.005.00
Gross margin (ETB ha^{-1})	83,445.62
Profit (ETB ha^{-1})	79,500.70
Benefit-cost ratio	3.24

* *Fixed costs contribute for 12.5% of the total variable costs*
***Grain and straw were priced at 45.0 and 2.5 ETB kg^{-1}, respectively*

Conclusions and Recommendations

Host farmers reported that both *Dagim* and *Bora* varieties are outstanding varieties ever they experienced before. As a result, farmers are paying a strong attention to promote the varieties to their fellow farmers.

The grain yield means from the two tef varieties were comparable with amounts of 2.54 and 2.48 $t\ ha^{-1}$ for *Dagim* and *Bora*, respectively. The overall mean grain yield of all the improved tef varieties in the demonstration trials was 2.51 t ha^{-1}.

Given the input and output prices that prevailed in the selected districts, the mean production costs (variable and fixed) were estimated at 35,504.30 Birr ha^{-1}. The current study revealed that 53% of the total cost went to labor. Of the total labor cost, the lion share (57%) was allocated to harvesting. Almost 20% of the total production cost went to oxen traction, of which 61% was allocated to threshing. It is, therefore, recommended that the usage of farm machinery especially for the harvesting ((and threshing) operation should sought for in order to overcome the critical shortage of labor during harvesting and threshing. In addition, farm machinery usage reduces post-harvest loss that often occurs due to delay harvesting. Achieving and sustaining food security in the long-run will not be feasible without addressing the critical shortage of labor at harvesting and threshing.

The host farmers in the study districts have benefited substantially from using improved tef seeds, but they still complain that the improved varieties released to date are not pure and in short supply. Therefore, the seed production system must be further strengthened to supply sufficient quantity and adequate quality of improved seeds of the new varieties to farmers at reasonable prices.

Good quality seeds as an input into small-scale farming systems have proven to be instrumental in yield improvements. The replacement of traditional varieties of most consumed cereals, in association with improved farm management practices, was instrumental in sustaining yield level of any crop.

This participatory and evidence-based demonstration helped farmers in getting access to improved tef varieties and to produce quality seeds of the newly released tef varieties for their farms and to sell to fellow-farmers in the vicinity.

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