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Lead Farmers Approach in Disseminating Improved Tef Production Technologies

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አህፅርኦት

ይህ ጥናት የተወጠነው ተሻሽሎ በቅርብ ጊዜ የተለቀቀውን ኮራ የተባለውን የጤፍ ዝርያ በአርሶ አደር ማሳ ላይ የሚሰጠውን ምርታማነት ለመገምገም ሲሆን ለጥናቱ የተመረጡ ወረዳዎች አድአ፣ ምንጃር-ሸንኮራ እና ሞረትና ጅሩ ነበሩ፡፡ የመጀመሪያውን ውሂብ ለመሰብሰብ ጥቅም ላይ የዋሉት መንገዶች ቅድመ ፍተሻ በማድረግ የተዘጋጀ ቃለ-መጠይቅ እና ዝርያውን በተመረጡ አስር ግንባር ቀደም አርሶአደሮች ማሳ ላይ መፈተሽ ነበሩ፡፡ አስሩ ግንባር ቀደም አርሶ አደሮች የተመረጡት ከ45 ግንባር ቀደም አርሶ አደሮች መካከል በዕጣ ነበር፡፡ ውሂቡ የተተነተነው የድግግሞሽ ብዛት፣ ዝቅተኛ ዋጋ፣ ከፍተኛ ዋጋ፣ አማካይ ዋጋ፣ መደበኛ ልይይት እና የልይይት ትንተና በመጠቀም ነበር፡፡ ኮራ በተሞከረባቸው ሁሉም ቦታዎች ላይ ከፍተኛ ምርት ስለሰጠ ከአስሩ ግንባር ቀደም አርሶ አደሮች መካከል ስምንቱ በዝርያው ከፍተኛ ርካታ እንዳገኙ የጥናቱ ውጤት ያመለክታል፡፡ ዝርያው የሰጠው ምርት ከ0.7 እስከ 2.9 ቶን በሄክታር ሲሆን አማካዩ ግን 2.2 ቶን በሄክታር ነበር፡፡ በአንድ ሄክታር ላይ ጤፍ ለማምረት የሚያስፈልገው አማካይ ተለዋዋጭ ወጪ 18135.90 ብር ሲሆን የሚገኘው አማካይ ገቢ 43414.00 ብር ሆኗል፡፡ ከማምረቻ ወጪዎች መካከል የሰው ጉልበት 56% እና ማዳበሪያ 23% ድርሻ ይይዛሉ፡፡ በመሆኑም በአንድ ሄክታር የጤፍ ማሳ ላይ የወጣው ወጪ መጠን ሲተነተን የአንበሳውን ድርሻ የሚወስዱት የሰው ኃይልና የማዳበሪያ ወጪዎች እንደሆኑ ከጥናቱ ተረጋግጧል፡፡ ስለዚህ በትናንሽ የአርሶ አደር ማሳ ላይ የጤፍን ምርት ለማስፋፋት የሰው ኃይል ማነቆ እንደሆነ የጥናቱ ውጤት ጠቁሟል፡፡

Abstract

*The study was designed to assess the performance of an improved and recently released tef variety called Kora. Districts selected for the study were Ada, Minjar-Shenkora and Moretna-Jirru. Primary data were collected using a set of validated interview schedule and testing the tef variety on field plots of ten lead **farmers** who were randomly selected from forty-five lead farmers. Data analysis was carried out using frequency counts, minimum, maximum, mean, standard deviation and analysis of variance. The results of the analysis showed that eight of the lead farmers were very satisfied with the new variety. High grain yield was obtained at the 10 on-farm sites due to the introduction of new variety. While the grain yields ranged from 0.7 and 2.9 tons/ha, the mean yield was 2.2 tons/ha. On average, the total variable costs and total revenues of farms per/ha were Birr 18135.90 and Birr 43414.00, respectively. The cost structure analysis revealed that the two highest production costs were labor (56%) and fertilizer (23%). Hence, labor appears to be the most important limiting factor of production in small-scale tef farming.*

Introduction

Over the years, a number of improved tef (*Eragrostis tef) production technologies* have been developed in Ethiopia. But the adoption and use of these technologies by the farmers have generally been low due chiefly to unavailability of high quality planting seeds and poor networking among policy, research, extension services, seed and input supplies in technology dissemination (Daniel and Ingie, 2004).

The major constraints of farmers in using improved technologies are weak linkages between farmers and limited use of extension and research results. According to Ogwal-Kasimiro *et al.,* (2012) and Butt (2002), to circumvent these problems and to achieve better results, responsive adaptive research trials should be established with actively participating lead farmers under full guidance of extension workers.

One can still witness the persistence of subsistence agriculture with an ever more dynamic and competitive environment. This entails the risk of the existence of wider gaps between the performance of research and farm averages. The ambition to go beyond subsistence agriculture presents so many challenges (Amede, *et al*., 2004; Agwu, 2004; Mbata, 1997).

Researchers have an important role in the dissemination of research results. Moreover, minimal linkage among policymakers, researchers, extension workers and farmers probably constitutes the single most important barrier towards agricultural development in Ethiopia (Daniel and Ingie, 2004).According to Chabata and Wolf (2013), imperfections in the technology dissemination system are generally the result of the following problems:

- Information dissemination problem which means that farmers do not know about the technologies;
- Training problem which means that farmers heard about or even saw the innovation but do not know how to implement it;
- Technology-fit or enabling environment problem which implies that farmers cannot face the financial and/or labour requirements of the proposed options.

Over the decade, the modalities of conducting agricultural extension and dissemination have changed. With the increasing pressure for land and other resources, new approaches and orientations were adopted, and the need for training farmers to raise productivity through the use of new technologies is increasing so rapidly. As it is difficult to reach millions of small-scale farmers, the lead farmer model of technology dissemination is being used, whereby lead farmers are trained and then pass the skill on the improved technologies to their peers. The lead farmer approach works with groups of 15 to 30 smallholder farmers, and the lead farmer is the main contact person for the project and partner organizations. This paper, therefore, explores the effectiveness of lead farmers approach in disseminating improved tef production technologies to small-scale farmers.

Materials and Methods

Study area

Ada, Minjar-Shenkora and Moretna-Jirru districts were selected for the study on the basis of cereal farming system and the long recorded experiences of farmers in using improved technologies. Wheat and tef are major crops, which occupy 75 percent of the total cropped area. Virtually, all farm lands are cultivated and farmers use improved seeds and fertilizer to replace land scarcity.

Design and sampling

Forty five lead farmers were identified, out of them, ten lead farmers were randomly selected for both interview and testing the tef production technology in their field plots. Inadequate seed supply of the newly released variety was the main reason to limit the number of lead farmers.

Lead farmers were selected based on their technical expertise, their role in the community, level of literacy, level of acceptance of the technology being demonstrated and implementation in their own fields, willingness to motivate other farmers to practice the new technologies, and endorsement by the community as a group leader.

The new tef variety Kora was demonstrated on the ten lead farmers at a seed rate of 16 kg/ha leaving land preparation, time of critical sowing, timing and amount of fertilizer application to the farming calendar (wisdom of farmers) of the respective districts.

Farmers' fields at the three districts were monitored on a monthly basis over the 2015 cropping year. Cost data were collected and monitored by a senior researcher and a trained technical assistant prior to harvesting. Cost data collection and monitoring during the growing season were done by farmers using recording formats for farm operations. To this effect, a day-long training was given to the lead farmers to keep farm records on inputs used for the trials. The input parameters recorded were categorized into ploughing, sowing, weeding, harvesting and threshing. At the end, structured questionnaire was employed to assess the socio-economic characteristics and level of satisfaction of the lead farmers.

An in-depth group discussion was held with three groups of ten farmers in each district. Lead farmers, extension agents and other farmers in the vicinity were involved in the group discussion. A senior research led the group discussion and two experienced extension staff were present to keep the minutes. These discussions made it possible to explore topics raised by farmers which had not been dealt with the lead farmers, because farmers complement each other during group discussion.

Data analysis

The cost data collected from the trials were coded and entered in the SPSS computer software package for analysis. Data were analyzed and the minimum and maximum rates, means, and standard deviation were determined. Finally, analysis of variance was applied to identify variables that have statistically significant differences among group means and their associated procedures.

Results and Discussion

Socio-characteristics of the lead farmers

According to studies conducted in other countries, dissemination and adoption of technology is related to farmers characteristics such as age, level of education; characteristics of the farm such as farm size, location and credit; characteristics of technology/innovation itself in terms of relative advantage, compatibility, complexity, duality and communicability; and characteristics of change agents in terms of personal behavior, communication skills and amount of participation showed (Olaniyi and Ayoade, 2008; Agwu, *et al*., 2008; Mijinadadi and Njoku, 1995; Onyenwaku, 1988; Anderson and Gershon, 2004).

For this study, farm size, level of education, age and farming experiences of the lead farmers were considered. It is hypothesized that the above mentioned parameters can be positively or negatively related to farm productivity and efficiency. For instance, the level of education of the lead farmers is assumed to increase farmers' ability to produce and use information relevant to farm productivity and efficiency.

Farmers were also asked to indicate their level of satisfaction with the tef production technology disseminated to them. Farmers found to be very satisfied with the technology demonstrated in their farm plots (Table 1). This satisfaction level is expected to motivate other farmers to adopt the technology in the future. With this reality on the ground, farmers were asked on how they evaluate technology generated either from the research centres or from other local agencies. The vast majority of the lead farmers reported that they use relative economic viability, technical feasibility and capacity to absorb as evaluation criteria to accept or reject technology/innovation. This finding is similar to the findings of Abate *et al*., (2012) who reported that the same criteria were used by farmers.

Table 1. Socio-economic characteristics of lead farmers and level of satisfaction with the tef technology disseminated (N = 10)

Socio-economic characteristic	N of respondents	% respondents
Age		
21-30	1	10
31-40	1	10
41-50	5	50
Above 50	3	30
Educational status		
Non formal education	1	10
Primary school level	6	60
Secondary school level	3	30
Tertiary level	0	0
Farming experience		
1-5 years	1	10
5-10 Years	3	30
> 10 years	6	60
Farm size		
< 1 hectare	1	10
1-2 hectares	5	50
> 2 hectares	4	40
Family size		
1-3	1	10
3-6	5	50
>6	4	40
Level of satisfaction		
Very satisfied	8	80
Satisfied	2	20
Not satisfied	0	0

Agronomic data of the tef trials in the field

In this study, fixed seeding rate was used for sowing at all sites but plant population and tillers across the selected locations exhibited big variability. Thus, at maturity, the plant population ranged between 443 and 1218 per square meter, whereas, the total tillers and fertile tillers per square meter ranged from 7.30 to 17.30 and 3.8 to 17.0, respectively. The mean plant population across the three districts was 785.45 per square meter. The average number of tillers and fertile tillers of all sites were 12.96 and 11.52 per square meter (Table 2). Plant population and tiller variations were associated with seed bed preparation, sowing date, soil moisture status and soil packing at planting. The higher plant population usually has a direct positive correlation with high plant biomass (straw) which is very important in tef production.

Big grain yield variability is observed across the locations. The low yield obtained at one location was partly due to shoot fly *(Atherigonahyalinipennis)* and rust damage (*Uromyces eragrostidis)*, poor moisture conditions during the crop growth stages particularly grain filling and the difference in the use of

appropriate cultural management. Higher plant population and better yields obtained at other locations due to the seed bed packing practice after planting, better soil moisture condition at planting and grain filling stages.
As indicated in Table 2, the mean plant population and the grain yield were 785.45/m^2 and 2.17 ton/ha, respectively. However, the higher plant population per unit area at some locations did not result a corresponding grain yield increase.

Table 2. Results of agronomic-related parameters from tef production technology dissemination trials on ten lead farms

Parameters	Plant pop. (No m^{-2})	Plant height (cm)	Panicle length (cm)	Tillers (No m^{-2})		Shoot biomass (t ha^{-1})	Grain yield (t ha^{-1})	Harvesting index, %
				Total	Fertile			
Minimum	443.00	96.30	30.60	7.30	3.80	6.25	0.72	11.00
Maximum	1218.50	150.30	50.30	17.30	17.00	11.26	2.86	28.00
Mean	785.45	120.03	39.39	12.95	11.52	9.53	2.17	22.00
Std. deviation	325.98	19.02	7.20	3.39	4.47	1.75	0.77	5.72

Economic data

Nature can deliver enough of what is needed to obtain higher yield. But higher yield for small farmers don't necessary mean higher profit if the increase in production costs exceeds the increase in yield. It is, thus, important to record economic data required for such decision making. Here, specific economic data refer to the cost data directly related to technology of tef production employed (seed, fertilizer, labor and draft power for plowing and threshing).

Estimated inputs used by farmers

It is easier to obtain information on yield, costs and prices than those on-farm input quantities farmers used for their farms (Abate Bekele and Kebebew Assefa, 2013). The costs of production could be estimated when the farmers keep records on farm input quantities used. Accordingly, producing tef requires substantial amount of labour and oxen-hours, averaging 805.36 man-hours and 459.38 oxen-hours/ha, respectively (Table 3). Categorically,; greater portion of the labour allocated on harvesting and weeding. The results of the study revealed that the lead farmers used variable rates of DAP and urea. This indicates that farmers did not apply the recommended doses of fertilizer of the studied crop. The mean DAP and urea rates were 212 and 130 kg/ha, respectively.

Table 3. Amount of inputs, labour and oxen time used by the ten lead farmers

Parameters	Seed (kg ha^{-1})	Fertilizer (kg ha^{-1})		Labour (man-hour ha^{-1})	Oxen (Oxen-hour ha^{-1})
		DAP*	Urea**		
Minimum	16.00	100.00	50.00	689.40	388.00
Maximum	16.00	300.00	200.00	916.80	496.00
Mean	16.00	212.00	130.00	805.34	459.38
Std. Deviation	.00	71.31	63.25	87.32	40.31

*DAP 16% nitrogen and 46% P_2O_5
**Urea contains 46% nitrogen

Estimates of variable costs and gross margin

The goal of farming is to maximize gross margin and profit or minimize cost for a specified output level. Thus, gross margin of the farm is defined as total revenue minus total variable costs. Given the input and output prices that prevail in the selected districts, cost of variable inputs and gross margin of the ten lead farmers are summarized on Table 4. The major inputs considered in tef production were seed, fertilizers, labour and oxen for seedbed preparation, sowing, weeding, harvesting and threshing. Product transporting from the farm to homestead (threshing ground), stacking, winning and cleaning costs were not included in the total costs.

On average, the total variable costs and total revenue of farms per/ha was Birr 18135.90 and Birr 43414.00, respectively. The difference between revenue and total variable cost equals to Birr25278.10. Unfortunately, one out of the ten farms had incurred loss due to shoot fly and rust damage. However, the farmer stated that he stayed profitable if the straw feed to his cattle was included in the estimation of total revenue.

Taking all costs in account, all lead farmers in the study districts hire labour for weeding and harvesting. The mean labor cost used was Birr 10199.77/ha. Meaning that big proportion of the total cost went into labour. Farmers were asked about costing procedures and method of labour payment. Majority (70%) of the farmers reported that hourly labor payment for harvesting always remains higher due to climate (hot and humid), economical (water and food) and physical (heavy type of work)reasons. Farmers further categorized the cost of farm labour into light, medium and heavy work.

Table 4. Variable input costs and gross margin of tef production technology dissemination trials at ten lead farms

Parameters	Costs (Birr ha^{-1})					Revenue (Birr ha^{-1})	Gross margin (Birr ha^{-1})
	Seed	Fertilizer	Labour	Oxen	Total cost		
minimum	400.00	2011.50	9219.30	3156.40	14861.70	14400.00	-461.70
Maximum	400.00	6118.00	11201.10	3651.80	21258.90	57200.00	38749.10
Mean	400.00	4101.34	10199.77	3434.68	18135.90	43414.00	25278.10
Std. Deviation	.00	1527.14	839.22	179.91	2116.99	15395.11	13655.33

Production cost structure

Production cost structure signifies the proportion of the overall costs for the inputs applied in the production of tef. The production cost analysis exposed that 56% and 23% of the total production costs across the districts went to labour and fertilizers, respectively (Fig. 1).A reasonable amount of cost also went to oxen hour whereas the seed cost was insignificant. The cost structure had revealed that small-scale tef farming appeared to have been absorbing more human resource. It is, therefore, arguable that small-scale farmers should either use labour effectively or use farm machinery to increase tef production per unit area. Thus, cost minimization in labour, fertilizer and animal traction can be a more appropriate change to maximize profit. The cost structure, with high labour cost, imposes the need to use farm machinery in order to decrease cost per operating hour or area cropped per year.

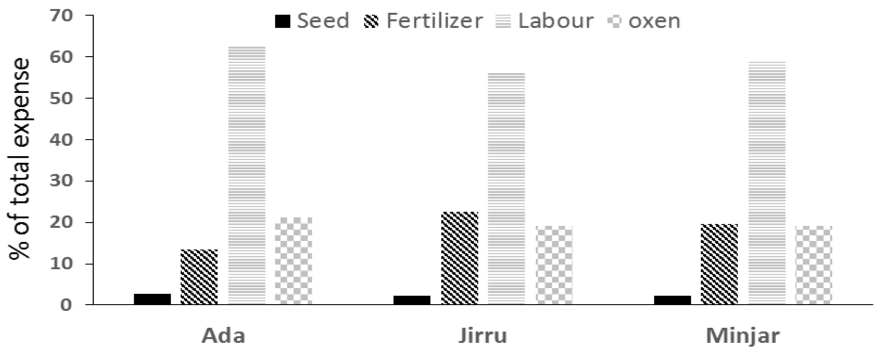

Figure 1. The proportion of major production costs for tef production technology dissemination trials at the three Districts

Growth performance indictors in tef

The central issue of technology dissemination is not the improvement in performance of actors but the improvement in farm input productivity (seed, fertilizer, land and labour) and consequences of technology dissemination on the actors are important indicators (Roling, 2009).

Growth in tef output per unit of area and per worker is generally recognized as a necessary condition for economic development. The benefits of improved tef technology in small-scale farming are realized in terms of increase in farm output, higher income and improved standard of living (Hart, *et al*., 2005). Smallholder farmers are characterized by the difference in relative endowments of improved technologies, land and labour. Substantial differences existed in tef productivity are closely associated with changes in the supply of improved technology, land and labour.

Performance indicators in tef vary based on farm size, effective use of improved technologies and labour. Compared to other cereal crops, tef is labour intensive because of low productivity per unit of labour and per unit of land. This can be partly explained by the fact that smallholder farmers cannot afford to purchase improved technologies**.** Tef yield per hectare, tef return per unit of DAP, urea, labour and oxen were the most important performance indicators in tef production (Table 5).

Table 5. Performance indicators of tef production technology disseminated to ten lead farmers, 2015/16 cropping year

Performance indicators	Value
Average tef yield, kg/ha	2170.20
Average production cost, Birr/ha	18135.90
Seed multiplication ratio	135.64
Tef grain return per unit of DAP, kg	10.23
Tef grain return per unit of urea, kg	16.71
Labour productivity in tef, kg/man-hour	2.69
Oxen productivity in tef, kg/oxen-hour	4.74
Production cost, Birr/kg	8.36

Analysis of variance (ANOVA)

Analysis of variance is employed to analyze if there are difference among group means and their associated procedures on some variables. Based on these premises, some variables that gave small significant values zoomed out and presented on Table 6. The small significant values indicate that the performance of tef (Kora) variety showed strong influence on locations and farmers within locations. At maturity, the plant population was highly significantly ($P < 0.01$) affected by locations and farmers within a location. The tef plant population in one location (Jirru) was much greater than the population in some other locations (Minjar and Ada).The variations in plant population caused by environmental, climatic and management factors. As observed in the ten lead farmers, plant population is influenced by quality of land preparation, sowing data, weeding time, timing and amount of fertilizer applied. Similarly, the total number of tillers and the number of productive tillers were highly variable ($P <0.05$) across locations and farmers. This suggests that there is strong influence of climatic and edaphic factors on tef plant population. Farmers also contributed to the total population variation through seed bed preparation, sowing date, time of weeding, fertilizer application, and soil packing at planting.

Plant height and panicle length were also highly significantly ($P< 0.01$) affected by location and farmers within location. Thus, tef plants in some locations were the tallest; while tef plants in some other locations had the shortest height. These differences in plant height might be attributed to the high population density in some locations and the low population density in other locations, which in turn determines the degree of competition for available resource among the tef plants.

Location and farmers within locations also highly significantly (P< 0.01) affected grain, biomass yield, revenue and gross margin of tef. The variation can be explained by soil type, amount and distribution of rainfall, time of sowing, farmers ability to manage the day-to day farm activities. However, unlike the case of plant population, plant height and productive tillers, the contribution of farmers within location to the total variations in grain yield or biomass yield was greater than the contribution of location.

Table 6. Analysis of variance for some selected variables that gave small significant values

Variables	Grouping	df	Mean squares	F	Sig.
Plant population/m^2* Woreda	Between groups	2	417255.52	23.97	.001
	Within groups	7	17407.46		
	Total	9			
Plant height, cm * Woreda	Between groups	2	1415.50	23.25	.001
	Within groups	7	60.88		
	Total	9			
Productive tillers/m2 * Woreda	Between groups	2	66.98	10.31	.008
	Within groups	7	6.50		
	Total	9			
Shoot biomass, ton/ha * Woreda	Between groups	2	12.93	50.70	.000
	Within groups	7	0.26		
	Total	9			
Grain yield, ton/ha * Woreda	Between groups	2	2.47	43.42	.001
	Within groups	7	0.06		
	Total	9			
DAP, kg/ha * Woreda	Between groups	2	22080.00	96.60	.001
	Within groups	7	228.57		
	Total	9			
Fertilizer cost, Birr/ha * Woreda	Between groups	2	10157778.79	105.54	.001
	Within groups	7	96244.66		
	Total	9			
Revenue, Birr/ha * Woreda	Between groups	2	986666670.00	43.23	.001
	Within groups	7	22821642.86		
	Total	9			
Gross margin, Birr/ha * Woreda	Between groups	2	783613451.49	49.42	.001
	Within groups	7	15855100.26		
	Total	9			

Summary and Conclusions

The actual average tef yield obtained from the ten lead farmers was 2170.20 kg/ha. Although the fixed seed rate was used across the ten farms, there was large variability in plant population density ranging from 454 to 1218 per m^2. This variation might be due to differences in sowing date, fertilizer rate, status of soil moisture and soil packing/padding at planting.

This study has shown that producing tef requires substantial amount of labour and oxen-hours, averaging 805.36 man-hours and 465.80 oxen-hours/ha, respectively. Analysis of the production cost structure revealed that the highest proportion of the production costs across the ten lead farmers went to the cost of labor (56%) and fertilizer (23%).These findings suggest that small-scale farmers should use improved chemical for weeding and farm machinery for harvesting and threshing in order to minimize cost of labour in tef production.
In measuring the characteristics of improved tef production technologies, it would be more important and appropriate to estimate the cost or profit function. To this end, the average cost to produce one kg of tef was estimated at Birr8.25, whereas, the average current price farmers received per kilogram of tef was Birr 20.00.Given the input and output prices that prevail in the selected districts, the lead farmers obtained, on average, a gross margin of Birr 25508.32/ha, indicating that small-scale tef farming is not only a financially viable venture, but it has also significantly contributing towards generating household cash income and ensuring food security in the changing climate. Moreover, farmers experimented that the straw was most preferred by all group of animals (sheep, donkeys and livestock). This adds value to the Kora variety.

This study explored the lead farmer approach by utilizing a one cropping season experience. However, there is a need to stretch out to similar socio-economic and wider agro-ecological conditions to assess the effectiveness and applicability of the lead farmer approach used on limited number of farmers on a wider scale across the different major tef growing areas in Ethiopia.

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