Pre-Extension Demonstration of Agricultural Technologies


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PREFACE

The Agricultural and Rural Development Policy and Strategy of the country which was designed nearly a decade and half ago, has highly emphasized the important role of agriculture as a means of ensuring rapid economic growth, enhancing benefits to the people, eliminating food aid dependency, and promoting the development of a market-oriented economy. The national plans, programs and projects focusing on the development of the agriculture sector have been implemented and are being implemented throughout the country towards answering the national Agricultural policy and strategy. Among such programs, the Agricultural Growth Program (AGP-II) is one and perhaps the biggest World Bank and other donor partners supported project with significant achievements in generating demand driven agricultural technologies, demonstrating proven technologies to farmers and end users, producing ample early generation seeds and other source technologies, and enabling the implementing institutions/centres through physical & human capacity building.

Being one of the implementing institutions, the Oromia Agricultural Research Institute (IQQO) conducted 459 different research activities during the last three years (2016/17 – 2018/19) through its 15 implementing center. These include 188 research activities under technology generation, 130 pre-extension demonstration and 141 source technology production activities. About 349 research activities were completed so far. Among those, 100 deliverable technologies were generated (56 from demand driven and 44 from end stage verifications), 113 improved agricultural technologies were fully approved by 341 completed Farmers Research Extension Groups (FREGs) involving 5497 direct beneficiary farmers (28.3% were female). Besides, 474.6 tons of early generation crop seeds were multiplied; several physical capacity developments activities were implemented across the implementing centers. Overall, about 95% of the five years plan was implemented during the last three years.

In 2011 EFY, a total of 262 research activities were planned and have been implemented. Among those, 150 research activities were completed and 112 ongoing activities. Out of the completed activities, 24 (16.55%) were gender related, 38(26.21%) climate smart agriculture, 19 (13.10%) nutrition sensitive and 69 (44.14) activities were multipurpose. Under technology generation and adaptation, a total of 36 deliverable technologies were recommended and can be promoted to pre-extension demonstration stage. Under technology demonstration and popularization, 44 technologies were fully recommended based on biological data (yield and related traits) and social data (farmers' preference) and thus could be promoted to public extension service. A total of 91 mixed FREGs were completed involving 1594 participant farmers (28.73% women). This workshop is organized with the purpose of reviewing research findings related to pre-extension demonstration and evaluation of improved agricultural technologies. The workshop involves researchers from the different disciplines of the 15 implementing research centers, director general, deputy director generals, research directorate directors and other stakeholders from Regional and Federal AGP-II coordination units.

Dagnachew Lule (PhD)

AGP-II Research Regional Coordinator

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CROP RESEARCH

Pre-Extension Demonstration of Improved Food Barley (*Hordeum vulgare* L) Varieties in Dugda and Lume districts, Oromia Region, Ethiopia

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Abstract

The activity was conducted in 2018 main cropping season at Dugda and Lume districts of East shoa zone. Two improved food barley vareties (Diribie and Bentu) were demonstrated with the objective to evaluate for grain yield, yield related traits and farmers' perception or preference. Sites were selected based on barley production potential of the area. Trainings were given for farmers, development agents and experts and other stakeholders. Quantitative data such as yield and economic data was collected and analysed using SPSS and Excel, respectively, whereas farmers feedback were analysed qualitatively. Recommended seed and fertilizer rate were used for the demonstration trial establishment. According to the results, mean grain yield of 1882 kg ha^{-1} and 2020 kg ha^{-1} were recerded for Bentu and Diribie, respectively. Thus, Diribie variety is recommended for further scaling up activities at Dugda and Lume districts taking into consideration its yield and economic return.

Key Words: Demonstration, Food barley, Pre-extension

Introduction

In 2017/18 'meher' season of the Ethiopian production season, out of the total grain crop area, 80.71% (10,232,582.23 hectares) was covered with cereals. Barley production covered 951,993.15 ha of land with a percent distribution of 7.51 among cereals (CSA, 2018). Barely is the fifth most important crop after teff, maize, sorghum and wheat. There are two species of barley in Ethiopia: food barley for human consumption and malt barley, which can be converted into malt, a key ingredient in beer making. Barley is used in different forms such as bread, porridge, soup, and roasted grain and for preparing alcoholic and non-alcoholic drinks. Its straw is used for animal feed, roof thatching and bedding.

Barley is one of the very versatile crops; which has a wide adaptation to diverse agro-ecological conditions. In central rift valley areas of oromia, barley is produced majorly for household consumptions relying on local varieties. These varieties are adaptable to the high moisture stress of the area but their productivity is very low.

In the process of improving the production and productivity of barley in the rift valley areas, efforts were made by the research and extension system of the country. Yet, there is a pressing need to introduce moisture stress barley varieties to mid rift valley areas and in

drought prone areas production system through evaluation of improved varieties that have been released by regional and national agricultural research canters.

To this end, in 2016/17 production season, participatory variety selection trial was conducted in the rift valley areas of East Shoa zone, Ethiopia using five food barley varieties namely Gobe, Bentu, Dirbie, Wolker, and Golden-eye. Among the tested varieties two varieties (Bentu and diribie) performed well in grain yield per ha and maturity (in terms of period and uniformity) and farmers preference. Therefore, this study was proposed with an objective of demonstrating these selected varieties in Lume and Dugda districts, East Shoa zone; Rift valley areas of Ormia Ethiopia.

Material and Methods

Description of the study areas

The study was conducted in selected districts of East shoa zone. The zone has an area of 10241km^2 and Adama town is serving as the capital town of the zone. There are 10 districts within the zone among which Dugda and Lume districts are the study districts where this demonstration activity took place.

Dugda district is located at 135km from the capital city of Ethiopia, Addis Ababa and 90 km from East Shoa's zonal capital Adama. The district covers 5.2 % of East shoa zone with area of 751km^2. Dugda has 18 Kebele's among which one kebele was used for this study. The district has an average 636mm annual rainfall and 26^{o}c average temperature.

Lume district's capital is located 88km from Addis Ababa and 25km from zonal capital Adama town. The district covers 9.8% of East shoa zone with area of 870km^2. Lume has 38 Kebele's among which two kebele were used for this study. The district's annual rainfall ranges from 500-1200mm and temrature ranging from 18 to 28 degrees. The major crops produced include teff, wheat, chickpea and lentil.

Site and farmers selection:

One Kebele from Lume district and two kebele from Dugda were selected based on their production potential. Farmer's research and extension group (FREG) approach was followed to select farmers and group under trial farmers. A total of 3 FREG's were organized having 36 male and 9 female members. Among the FREG member a total of eight (8) interested trial farmers were selected in both districts. The trial farmers were selected based on their willingness to contribute a land size of 100m^2 per variety. Packaged production technologies (seed rate, seed treatment, spacing, fertilizer management and weed management) recommended for Barley production were used. Plots were kept free of weeds.

Planting materials used

Two adaptable early maturing bread wheat varieties (*Diribie* and *Bentu*) were used. Planting materials (Seed) were acquired in advance from Kulumsa Agricultural Research Center.

Data Collection

Grain yield, Farmers' feedbacks and costs and income gained involved were collected. The grain and economic data were collected using data collection sheets. The feedbacks were collected using checklist by conducting group discussions and key informant interviews.

Yield advantage:
Yield advantage of the demonstrated varieties was calculated using the following formula.

$$\text{Yield advantage \%} = \frac{\text{Yield advantage of new variety} - \text{Yield advantage of standard check}}{\text{Yield advantage of standard check}} \times 100$$

Variety preference ranking
The variety preference ranking was conducted using group discussions. The farmers were let to observe and set selection criteria at the maturity stage of the crop. The selected criteria were then used to select the preferred variety.

Economic evaluation
Simple financial analysis was employed to analyse the costs involved and the net benefit gained from the production of each varieties and location used for the demonstration. The calculations were done by converting the parameters per hectare. The final selling price used was the farm gate selling price at the localities of the participant farmers.

Data analysis
The collected agronomic data was organized, summarized and analyzed to describe using SPSS, V20. The financial data was analyzed using excel and presented using tables. Farmers' variety preference were also analyzed qualitatively and presented using table.

Results and Discussions

Yield performance of the demonstrated varieties
As shown in the following table 1, the mean grain yield obtained was 1882 kg ha^{-1} and 2020 kg ha^{-1} for Bentu and Diribie varieties, respectively. In this study, the mean grain yield obtained from the two varieties was not statistically significant at $p< 0.05$. The mean grain yield of Diribie variety was less than from previously conducted demonstrations (Dagnachew et al., 2017), while that of Bentu variety was similar to the earlier demonstration. This yield difference could be associated with rain shortage occurred at the critical stage of the crop.

Table 1: Combined analysis of grain yield in qt/ha of demonstrated food barley varieties at Dugda and Lume districts

Parameters	Bentu	Diribie
Mean grain yield (kg ha^{-1})	1882 [a]	2020 [a]
N	7	7
Std. Deviation	2.98907	4.97415
SE (±)	1.12976	1.88005

Financial analysis

In terms of profitability, the financial analysis result shows that an average return of 18,618.75 and 20,518.75 ETB per hectare was obtained from Bentu and Diribie varieties, respectively, in one production season (Table 2).

Capacity development

Training

Table 3 shows the number of farmers, Development agents, district office of agriculture experts and other participants who attended training related with barley production and management before starting the activity. A total of 63 participants attended the training.

Table 2: Financial analysis of food barley production at Dugda and Lume districts (2018)

Parameters	Lume		Dugda	
	Varieties			
	Bentu	Diribie	Bentu	Diribie
Yield qt/ha (Y)	20.04	22.58	17.91	18.41
Price (P)	1250	1250	1250	1250
TR= YxP	25050	28225	22387.5	23012.5
Variable costs				
Seed cost	900	900	900	900
Fertilizer cost	1200	1200	1200	1200
chemicals	150	150	150	150
labour cost (land preparation, Planting, weeding, chemical spraying, harvesting	750	750	750	750
Transport, sacks	100	100	100	100
TVC	3100	3100	3100	3100
Fixed costs				
Cost of land	2000	2000	2000	2000
TFC	2000	2000	2000	2000
TC = TVC+TFC	5100	5100	5100	5100
GM = TR-TVC	21950	25125	19287.5	19912.5
Profit= GM-TFC	19,950.00	23,125.00	17,287.5	17,912.5

Table 3: Number of farmers participated trainings

Training topic	No of participants											
	Farmers			DA'S			SMS			Others		Total	Overall total
	M	F	Total	M	F	Total	M	F	Total	M	F		
Food barley production and management	36	9	45	6	1	7	2	0	2	8	1	9	63

Feedbacks and farmers preference

The varieties demonstrated were compared based on farmers' preferences and presented in the following table. The participant farmers preferred **Diribie** variety and their first choice.

Table 4: rank of varieties demonstrated based on farmers preferences

Varieties	Rank	Reasons
Diribie	**1st**	Very good yield, Good plant height, good tillering capacity, disease tolerant
Bentu	**2nd**	Good yield, Early maturing, disease tolerant, good stand and not lodging

Conclusion and Recommendation

The results indicated that both varieties gave promising under moisture stress environment. Furthermore, both varieties were profitable. In terms of farmers preference Diribie variety was selected as first choice by the participating farmers followed by Bentu. Therefore, basing adaptability to the study areas, farmers' preference, grain yield and profitability, Diribie variety is recommended for further scaling up.

References

Dagnachew Lule, Chemeda Daba, Belete Shenkute, Kemal Ahimed, Zerihun Abebe, Kefyalew Asefa, Tadele Tadese and Tesfaye Letta (eds), 2017. Oromia Agricultural Research Institute workshop proceeding on adaptation and generation of agricultural technologies, 27-30 April 2017, Adama, Ethiopia. 173pp

Witcombe JR, Joshi A, Joshi, KD, Sthapit BR. 1996. Farmer participatory crop improvement. I. Varietal selection and breeding methods and their impact on biodiversity. Exp. Agric. 32: 445-460

Pre-extension Demonstration of Bread Wheat Varieties at Dugda and Lume Districts

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Abstract

The activity was conducted in 2018 rainy season at Dugda and Lume districts of East shoa zone, Oromia, Ethiopia with the objective of demonstrating and evaluating the performance of improved bread wheat varieties along with their management practices under farmers' circumstances and raising farmers' knowledge and skill on bread wheat production and management practices. Two improved bread wheat varieties (Ogolcho and Kingbird) were demonstrated along with standard check (Kekeba). The varieties were sown using farmers as a replication on a plot size of 850m^2/ variety. Quantitative data such as yield and economic data was collected and analysed using SPSS and Excel, respectively. Farmers' feedbacks were analysed qualitatively. Accordingly, a statistically significant difference for mean grain yield was found at Lume while non-significant grain yield differences among the varieties were observed at Dugda district. The demonstrated varieties performed better at Lume than Dugda due to the differences in rain availability. Results obtained through direct matrix ranking showsd that farmers preferred ogolcho as their first choice followed by kingbird for future productions based on their own criteria. Thus, ogolcho variety is recommended for further scaling up activities. Yet, kingbird is also an additional variety which can be used for further scaling up activities in Dugda and Lume districts taking into consideration its comparable yield and economic return.

Key Words: *Bread wheat, Pre-extension demonstration*

Introduction

In Ethiopia, cereals are the major food crops both in terms of the area they are planted and volume of production obtained. They are produced in larger volume compared with other crops because they are the principal staple crops among cereals. Wheat is a major cereal crop contributing importantly to the nutrient supply of the population with wide adaptation to diverse agro-ecological conditions (CSA, 2017/18). According to CSA 2017/18 report, out of the total grain crop area, 80.71% (10,232,582.23 hectares) was covered with cereals. Out of which wheat took up 13.38% (1,696,907.05 hectares) of the grain crop area.

Within the country the top wheat producing districts are primarily located in Oromia, Amhara, and Tigray regional states. Oromia accounts for the largest of all with its top producing districts located in the Arsi-Bale areas of the region (Warner et.al., 2015). According to Warner et.al., 2015, East shoa zone is also among the top 25 wheat producing zones in the country, major producing districts within the zone being Dugda and Gimbichu.

Although the country is the major producer in sub Saharan Africa, it is still reliant on foreign wheat import to supplement its demands. The national average of Wheat yield of Ethiopia is around 2.7 t ha^{-1} (CSA 2017/18), which is far below from experimental yields of over 5 t ha^{-1} (Mann et, al 2015). To solve this challenge and improve production and productivity, efforts were made by the research and extension system of the country by releasing and demonstrating improved varieties along with their management practices. Furthermore, the yield gap of 2.3 t/ha indicates the potential for increasing productivity of Wheat production through utilization of improved seeds along with their recommended packages.

In mid rift valley areas, Wheat is among the major cereals produced with production mostly relying on less productive variety released some years ago. In addition, the knowledge base of farmers about Wheat production and management is limited. To improve this gap, Adami Tulu Agricultural Research Center (ATARC) has conducted on-station trails and participatory variety selections of improved varieties in the past years with support form AGP-II. The trial results showed that the improved varieties performed well when compared with farmers' verities. Accordingly, a follow-up pre-extension demonstration of the experimental and 2017 rainy season demonstration activity was initiated in different kebeles for the 2018 production season with the objective to demonstrate and evaluate the performance of bread wheat varieties under farmers' conditions & to enhance farmers' knowledge and skill on bread wheat production and management.

Material and Methods

Description of the study areas

The study was conducted in selected districts of East shoa zone. The zone has an area of 10241km^2 and Adama town is serving as the capital town of the zone. There are 10 districts within the zone among which Dugda and Lume districts are the study districts where this demonstration activity took place.

Dugda district is located at 135km from the capital city of Ethiopia, Addis Ababa and 100km from East shoa's zonal capital Adama. The district covers 5.2% of East shoa zone with area of 751km^2. Dugda has 18 Kebele's among which one kebele was used for this study. The district has an average 636mm annual rainfall and 26^{o}caverage temperature. The major crops produced are wheat, teff and maize.

Lume districts capital is located 88km from the capital, Addis Ababa and 25km from zonal capital Adama town. The district covers 9.8% of East shoa zone with area of 870km^2. Lume has 38 Kebele's among which two kebele were used for this study. The district's annual rainfall ranges from 500-1200mm andtemrature ranging from 18 to 28 degrees. The major crops produced includeteff, wheat, chickpea and lentil.

Site and farmers selection:

One Kebele's from lume district and two kebele from Dugda were selected based on their wheat production potential. Farmer's research and extension group (FREG) approach was followed to select farmers and group under trial farmers. A total of 3 FREG's were organized

having 36 male and 9 female members. Among the FREG members, a total of nine (9) interested trial farmers were selected in both districts. The trial farmers were selected based on their willingness to contribute a land size of 0.25ha. The recommended wheat production package of technologies (seed rate, seed treatment, spacing, fertilizer management and weed management) was used to establish the trials. Urea (46 % N) was used as a source of nitrogen fertilizer and two-third of N fertilizer was applied within the rows as basal application at planting. The remaining 1/3 dose of nitrogen fertilizer was top-dressed at tillering stage. All plots were kept free of weeds.

Planting materials preparation

Two adaptable early maturing bread wheat varieties (*Ogolcho and Kingbird*) and one check (Kekeba) were used. Planting material (Seed) were obtained in advance from Oromia Seed enterprise.

Data Collection

Grain yield, farmers' feedbacks and costs and income gained involved were collected. The grain and economic data were collected using data collection sheets. The feedbacks were collected using checklist by conducting group discussions and key informant interviews.

Data analysis

The collected agronomic data was analyzed using descriptive statistics and one-way ANOVA. The financial data was analyzed using excel and presented using tables. Farmers' variety preference were also analyzed qualitatively and presented using table.

Yield advantage:

Yield advantage of the demonstrated varieties was calculated using the following formula.

$$\text{Yield advantage \%} = \frac{\text{Yield advantage of new variety} - \text{Yield advantage of st; check}}{\text{Yield advantage of standard check}} \times 100$$

Variety preference ranking

The variety preference ranking was conducted using group discussions. The farmers were let to observe and set selection criteria at the maturity stage of the crop. The selected criteria were then used to select the preferred variety.

Economic evaluation

Simple financial analysis was employed to analyse the costs involved and the net benefit gained from the production of each varieties and location used for the demonstration. The calculations were done by converting the parameters per hectare. The final selling price used was the farm get selling price at the localities of the participant farmers.

Results and Discussions

Yield performance of the demonstrated varieties

Table 1 below shows the result on yield performance of the varieties demonstrated in both Dugda and Lume districts. According to the results, a mean grain yield of 3304, 3270 and 2812 kg $ha^{-1}$was obtained from ogolcho, kingbird and kekeba varieties, respectively at Lume district while a mean grain yield of 1777, 1860, 1662 kg ha^{-1} was obtained at Dugda district from the same varieties in the same order. The result shows a statistically significant yield difference at $p<0.05$ among the demonstrated varieties at Lume while no statistically significant difference was observed among the varieties at Dugda district. The better yield performance at Lume than Dugda could be associated to the differences in rain availability across districts.

Table 1.Analysis result of grain yield (kg ha^{-1}) across districts for demonstrated bread wheat varieties

Varieties	Dugda	Lume
Ogolcho	1777± 1.33 [a]	3304 ±3.57 [a]
KingbIrd	1860 ±1.45 [a]	3270 ±3.41 [a]
Kekeba	1662 ±1.95 [a]	2812 ±2.362 [b]
CV%	17.66	3.91
Sig level	Ns	*

The mean grain yield found for the demonstrated varieties were found to be less than a previously conducted demonstrations (Tesfaye and Fiseha, 2018) and Higher than PVS results in the same districts (Dagnachew et al., 2017). This yield difference between the two demonstration years could be associated with rain differences across years and the rainfall shortage occurred for a month at the critical stage of the crop during the 2018 demonstration. Yet the varieties still had an extra 17% and 9.25 % average yield advantage than their check at Lume and Dugda districts respectively.

Table 2. Yield advantage of Ogolcho and Kingbird varieties over the check (Kekeba)

Varieties	Yield advantage over the check (Kekeba) (%)	
	at Lume	at Dugda
Ogolcho	17.5	6.5
Kingbird	16.5	12

Financial analysis

In terms of profitability the financial analysis result show that an average return of 31,158.8 and 31,219.1 ETB per hectare was gained from Ogolcho and Kingbird varieties, respectively in one production season while the income obtained from the check (Kekeba) was 26,724.20 ETB.

Table 3. Financial Analysis of bread wheat production using ogolcho and kingbird varieties at Dugda and Lume districts (2018)

Parameters	Location : Dugda			Lume		
	Varieties					
	Ogolcho	Kingbird	Kekeba	Ogolcho	Kingbird	Kekeba
Yield qt/ha (Y)	33.04	32.71	28.13	28.6	29.02	24.96
Price (P) per quintal	1400	1400	1400	1400	1400	1400
Total Revenue (TR)= TR= YxP	46256	45794	39382	40040	40628	34944
Variable costs						
Seed cost (including transport)	1350	1350	1350	1350	1350	1350
Fertilizer cost	2140	2140	2140	2140	2140	2140
Chemicals	2800	2800	2800	2800	2800	2800
labour cost (land preparation, Planting, weeding, chemical spraying	1000	1000	1000	1000	1000	100
Combiner harvesting	1982.4	1962.6		1716	1741.2	1497.6
Cost of transport, sacks	200	200	200	200	200	200
Total variable costs (TVC)	9472.4	9452.6	7490	9206	9231.2	8087.6
Fixed costs						
Cost of land	2500	2500	2500	2800	2800	2800
Total fixed costs (TFC)	2500	2500	2500	2800	2800	2800
Total Cost (TC) = TVC+TFC	11972.4	11952.6	9990	12006	12031.2	10887.6
Gross Margin (GM) = TR-TVC	36783.6	36341.4	31892	30834	31396.8	26856.4
Profit= GM-TFC	34283.6	33841.4	29392	28034	28596.8	24056.4

Capacity development

Training

Table 4 shows the number of farmers, development agents, district office of agriculture experts and other participants who attended training related with bread wheat production and management before starting the activity. A total of 63 participants attended the training.

Table 4: Number of farmers participated trainings

	No of participants											
	Farmers			DA'S			SMS			Others		Total	Overall
Training topic	M	F	Total	M	F	Total	M	F	Total	M	F		total
Bread wheat , production & management	36	9	45	6	1	7	2	0	2	8	1	9	63

Feedbacks and farmers preference

The varieties demonstrated were compared based on farmers' preferences and presented in the following table. The participant farmers preferred *ogolcho* variety as their first choice.

Table 4: rank of varieties demonstrated based on farmers preferences

	Rank	Reasons
Ogolcho	1st	Very good yield, Good plant height, uniformity on heading and maturity, good tillering capacity, disease tolerant, attractive seed color /size for market
Kingbird	2nd	Good yield, Early maturing, disease tolerant, very good crop stand, , medium seed size/color for market, for making bread
Kekeba	3rd	low yield, early maturing, susceptible to disease/rust, attractive for market and for making bread

Conclusion and Recommendation

The results indicated that both varieties demonstrated gave promising yield having an average 13.12% yield advantage over farmers' variety. Furthermore, both varieties are profitable with an average return greater than the check in one production season. In terms of farmers preference, Ogolcho variety was selected as first choice by the participating farmers followed by kingbird. Therefore, *ogolcho* is recommended for further scaling up. Yet, *kingbird* is also an additional variety which can be used for further scaling up activities in Dugda and Lume districts taking into consideration its comparable yield and economic return.

References

CSA (Central Statistical Agency). 2017/18. Report on Area and Production of Major Crops. Statistical Bulletin 584. Addis Ababa, Ethiopia

Dagnachew Lule, Chemeda Daba, Belete Shenkute, Kemal Ahimed, Zerihun Abebe, Kefyalew Asefa, Tadele Tadese and Tesfaye Letta (eds), 2017. Oromia Agricultural Research Institute workshop proceeding on adaptation and generation of agricultural technologies, 27-30 April 2017,Adama, Ethiopia. 173pp

Mann, Michael & Warner, James. (2015). Ethiopian Wheat Yield and Yield Gap Estimation: A Small Area Integrated Data Approach (IFPRI WP). 10.13140/RG.2.1.3867.8564.

Tesfaye Gemechu and Fiseha Tadese, 2018. Participatory Evaluation and Demonstration of Bread Wheat (Triticumaestivum L) Varieties at Dugda and Lume Districts, Oromia Regional State, Ethiopia *International Journal of Research Studies in Agricultural Sciences* , 4(7) : 26-30.

Warner J., Stehulak T., and Leulsegged K., 2015. Woreda-Level Crop Production Rankings in Ethiopia: A Pooled Data Approach. *International Food Policy Research Institute (IFPRI).*Addis Ababa, Ethiopia.

Pre-extension Demonstration of Improved Durum Wheat Varieties in Bale and West Arsi Zones

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Abstract

Pre extension demonstration of improved durum wheat varieties was conducted in Dodola and Adaba Districts of West Arsi Zone and Agarfa District of *Bale Zone. The main objective of the study was to demonstrate and evaluate recently released (Bulala) variety along with standard check. The demonstration was undertaken on single plot of 20mx20m area for each variety with the spacing of 20cm between rows and recommended seed rate of 150kg/ha and fertilizer rates of 100/110kg/ha NPS/UREA. Mini-field day involving different stakeholders was organized at each respective site. Yield data per plot was recorded and analysed using descriptive statistics, while farmers' preference to the demonstrated varieties was identified using focused group discussion and summarized using pair wise and simple ranking methods. The demonstration result revealed that Bulala variety performed better than the standard check (Dire variety) with an average yield of 4602 kg ha^{-1}, while that of the standard check was 3904 kg ha^{-1}. Bulala variety had 17.27% yield advantage over the standard check. Farmers selected this variety. Thus, Bulala variety was recommended for further scaling up.*

Key words: *Bulala, Demonstration, durum wheat, Farmers' preference*

Introduction

Wheat (*Triticum aestivum* L.) is one of the world's leading cereal grains serving as a staple food for more than one-third of the global population. Globally, it is cultivated on approximately 218 million hectares of land (HGCA, 2014). Durum wheat (*Triticumturgidum*var. *durum Desf*) accounts for 8% of global wheat production and its cultivation is concentrated in the Mediterranean basin, the North American Great Plains, India, and the former USSR (Palanarchuk, 2005).

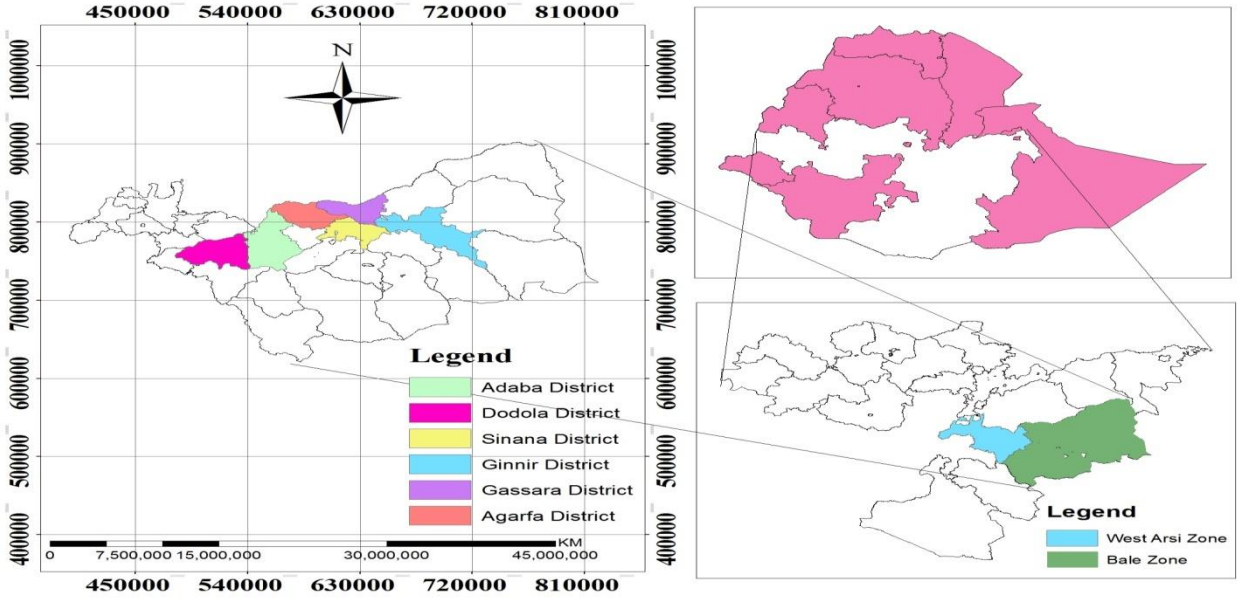
Durum wheat produced for food and industrial purposes and used as raw materials for pasta and macaroni industries. However, due to low volumes and poor quality of national durum wheat production, pasta industries are importing huge amount of wheat and pasta every year costing about 30 million USD or >600 million Eth. Birr (Ethiopian Revenue and Customs Authority, 2013). In Oromia, it is one of the major cereal crops grown within the range of 1500 to 2800masl in Bale, Arsi, West Arsi and West Shewa zones, Oromia National Regional State, Ethiopia. These areas have reliable rainfall and are considered as "the wheat belt area of the country" (Bekele, 2011). In 2016/17 cropping season, the area covered with wheat production in Bale and West Arsi zones was about 166,539.45 and 124,339.43 hectares, respectively with average yield of 33.33 and 34.21 quintals, respectively (CSA, 2017).

To overcome low yield, low disease resistance, quality problem of Durum wheat, Sinana Agricultural Research Centre released new variety of durum wheat called 'Bulala' which has relatively better resistance to wheat rust diseases and good in protein quality. Bulala has yield potential of 48-78 quintal per hectare with yield advantage of 16.9% and 25% over standard (Toltu) and local checks (Ingliz), respectively. Thus, it is a paramount important to demonstrate and evaluate recently released durum wheat variety (Bulala) under farmers' management condition.

Methodology

Description of the study areas

The trial was conducted in selected districts of West Arsi and Bale zones of Oromia National Regional State. These districts were Dodola and Adaba from West Arsi whereas Agarfa was from Bale zone.



Site selection

Pre-extension demonstration of improved durum wheat varieties were conducted in Dodola and Adaba districts of West Arsi Zone and Agarfa district of Bale Zone. Purposive sampling methods were employed to select three representative districts from both zones based on their potential for durum wheat production. One kebele from each Dodola and Adaba districts and two kebeles from Agarfa district were also selected purposefully based on their accessibility and production potential of the crop.

Trial farmers' selection

Willingness to allocate the land suitable for the trial, vicinity to the roads, ability to implement and properly manage the field and willingness to explain the technologies to others were the criteria used to select the hosting farmers. Accordingly, a total of nine farmers were selected to undertake the activity.

Materials used and Field design

The recently released durum wheat variety (Bulala) and the standard check (Dire) were planted on selected farmers' land on 20m x 20m plot for each variety in the main cropping season. Full packages of technologies that include row planting with the spacing of 20cm between rows; recommended seed rate of 150 kg per hectare and fertilizer rate of 100kg/110kg of NPS/UREA per hectare were applied. In addition, twice hand weeding was done on time (i.e. the first weeding one month after planting and the second weeding one month after the first weeding).

Sinana Agricultural Research Center (SARC) was the source of agricultural inputs (seed and fertilizers). Hosting farmers provided their land. Land preparation was carried out by trial/hosting farmers, whereas land leveling, planting, first and second weeding, follow up and visit, harvesting, threshing were handled and managed by SARC.

Data type and method of data collection

Both qualitative and quantitative data were collected using direct field observation/ measurements, key informant interview and focused group discussion (FGD). Total number of farmers participated on field visits and mini field days were recorded. Farmers' preference to the demonstrated varieties was identified. Each plot was harvested and yield data was also recorded.

Data Analysis

Descriptive statistics were used to analyze the yield data. Pair wise ranking was used for traits of demonstrated varieties and simple ranking method was used to compare varieties. Independent sample t test was used to compare the mean difference of demonstrated varieties.

Farmers' variety evaluation and selection

Consulting the intended end users to assess which quality/ies of a particular variety they desire is highly important to hasten the adoption rate of the variety/ies and associated packages. Because, it will not only be resource saving in terms of preferred variety promotion/dissemination, but also time saving and fast adoption (Dan, 2012). Accordingly, the task of variety evaluation and selection was carried out in Adaba, Dodola and Agarfa districts.

Table 1: Participants of Variety evaluation and selection

	Number of participants		
Location	Farmers	Experts (DAs & SMS)	Subtotal
Adaba	26	6	32
Dodola	32	6	38
Agarfa	42	13	55
Total	**100**	**25**	**125**

Focused Group Discussion (FGD)

Before leading the participant farmers and experts to focus group discussion, brief orientation was given to the evaluators on why variety/technology evaluation and selection is necessary in research process. Evaluators were grouped in to small manageable groups (by selecting one group leader and one secretary) and encouraged to set their own criteria to select the demonstrated varieties in order of their preference, how to carefully assess each variety by considering each criteria and using rating scale, how to organize collected data, how to make group discussion and reach on consensus, and finally report through their respective group leader.

Results and Discussions

Yield performance of demonstrated varieties

The result of durum wheat varieties demonstration revealed that, the newly released durum wheat variety performed better than the standard check Dire variety at all demonstration sites. Accordingly, Bulala variety gave higher yield (4602 kg ha^{-1}) than Dire variety which gave 3904kg ha^{-1}. Bulala had 17.27% yield advantage over the standard check Dire variety. As shown in table 3 below, the cost benefit ratio analysis also showed, Bulala has higher net benefit ratio (1.94) than Dire (1.51). This means Bulala variety is more profitable than Dire variety and it is better if farmers use this variety for increasing productivity and profitability of their farms.

Table 2: Mean grain yield of Bulala and Dire varieties across study districts and Kebeles

Varieties	Mean grain yield (Kg ha^{-1}) across districts			Overall mean	Yield advantage (%)
	Adaba	Dodola	Agarfa		
Bulala	4425	4250	5132	4602	17.27
Dire	3825	3750	4138	3904	

Table 3: Cost Benefit Ratio Analysis

No	Variables	Varieties Bulala	Dire
1.	Yield obtained (kg ha^{-1})	4604	3926
2.	Sale price (ETB/qt)	1500	1500
3.	Gross Returns (Price X Qt) TR	69060	58890
4.	Land preparation	4050	4050
	Seed purchase	2250	2250
	Fertilizers purchase (NPS)	1400	1400
	Fertilizers purchase (UREA)	1430	1430
	Herbicide purchase	1200	1200
	Labor for spray	300	300
	Fungicide purchase	1240	1240
	Labor for spray	600	600
	Combiner rent	2762	2355
	Packing, Loading and store	250	230
	Store (bag purchase)	470	400
	Total Variable Costs TVC (ETB/ha)	15482	15455
5.	Fixed cost	8000	8000
6.	Total cost (TC)	23482	23455
7.	Net Return (GR-TC)	45578	35435
8.	Benefit cost ratio (NR/TVC)	1.94	1.51

The result of independent sample t-test revealed that, there is statistically significant difference between the mean yields of both varieties. It also had a mean difference of 698 kg ha^{-1} (Table 4).

Table 4: result of independent sample t test

	Test for Equality of Variances		t-test for Equality of Means				
	F	Sig.	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Equal variances assumed	3.16	.150	2.37	4	.077	6.98	2.95

Table 5: Descriptive statistics

Variety	N	Minimum	Maximum	Mean	Std. Deviation
Bulala	3	4250	5132	4602	4.67
Dire	3	3750	4138	3904	2.06

Among the newly released (Bulala) variety the maximum and minimum yield obtained were 5132kg ha^{-1} and 4250 kg ha^{-1}, respectively with the mean yield of 4602 kg ha^{-1}. Similarly, among the standard check (Dire) variety the maximum and minimum yield obtained were 4130 kg ha^{-1} and 3750 kg ha^{-1}, respectively with the mean yield of 3904 kg ha^{-1}. The standard deviations of Bulala and Dire varieties are 4.67 and 2.06, respectively (Table 5). Bulala variety has higher standard deviation. This means Bulala has higher yield variations across the location.

Table 6: Pair wise ranking result to rank variety traits in order of importance

Code	Variety trait	Yield	Tiller	Seed/spike	Stem strength	Seed color	Adaptability	Disease tolerance	Plant height	Seed size	Spike size	Frequency	Rank
1	Yield											9	1st
2	Tiller	1										7	3rd
3	Seed/spike	1	2									6	4th
4	Stem strength	1	2	3								0	10th
5	Seed color	1	2	3	5							3	7th
6	Adaptability	1	2	3	6	6						5	5th
7	Disease tolerance	1	7	7	7	7	7					8	2nd
8	Plant height	1	2	3	8	5	6	7				1	9th
9	Seed size	1	2	3	9	9	6	7	9			4	6th
10	Spike size	1	2	3	10	5	6	7	10	9		2	8th

The traits of the varieties identified were ranked using pair wise ranking based on their importance. Accordingly, yield, disease tolerance, tillering capacity, seed/spike and adaptability were the top five priority concern of variety traits given by participant farmers (Table 6).

Table 7: Rank of the varieties based on farmers' selection criteria

No	Varieties	Rank	Reasons
1	Bulala	1st	High yielder, Seed/spike(64-80), tiller(7-8), better stem strength, good seed colour, more adaptable to environment, tolerant to disease, good plant height, bigger seed size, big spike,
2	Dire	2nd	Low yielder, Seed/spike(47-54), tiller(3-4), softer stem, less adaptable to environment, not tolerant to disease, good plant height, smaller seed size, small spike

Conclusions and Recommendations

Pre extension demonstration and evaluation of durum wheat varieties was carried out on nine (9) representative trial farmers' fields. Improved variety viz. *Bulala* was demonstrated along with Dire variety which is the standard check. Accordingly, Bulala gave higher yield than Dire variety. Moreover, Bulala was selected by participant farmers in all districts due to its high yield, seed/spike (64-80), tillering capacity (7-8), better stem strength, good seed color, adaptability to environment, tolerance to disease, good plant height, bigger seed size and big spike. Similary, farmers selected Bulala variety. Based on these facts, Bulala variety was recommended for further scaling up.

References

Bekele Diriba. (2011). Analysis of Rural Women Farmers' Drudgery and Their Role in Agricultural Production: The Case of Sinana Districts, Bale Zone, Oromia National Regional State, Ethiopia. M. Sc. Thesis. Haramaya University, Ethiopia.

Central Statistical Agency (CSA). 2017. The Federal Democratic Republic of Ethiopia. Central Statistical Agency Agricultural Sample Survey 2016/2017 (2009 E.C.): Report on Area and Production of Major Crops (Private Peasant Holdings, Meher Season), Volume I. Addis Ababa, Ethiopia.

Dan Makosa. (2012). Integrating consumer preferences into breeding: A stepping stone to food security. Department of Agricultural Economics, Tokyo University of Agriculture, Japan. Presented on Wheat for Food Security in Africa. October 8-12, Addis Ababa, Ethiopia.

Annual Report of Ethiopian Revenue and Customs Authority, (2013). Addis Ababa, Ethiopia.

HGCA (2014). Prospects: IGC 2014 wheat harvest area estimates. http://www.hgca.com/markets/market-news/2014/february/11/prospects-igc-2014-wheat-harvest-area-estimates.aspx. Accessed 2 April 2014.

Palanarchuk A (2005). Selection strategies for traits relevant for winter and facultative durum wheat. In: Royo C, Nachit MM, Di Fonzo N, Araus JL, Pfeiffer WH, Slafer GA (eds) Durum wheat breeding. Current approaches and future strategies. Haworth Press, New York. 2:599-644.

Sperling L.E.; J.A. Ashby; M.E. Smith; E. Weltzen and S. McGuire, Participatory plant breeding approaches and results. *Euphytica*122: 439-450, 2001.

Pre-extension Demonstration of Improved Food Barley Varieties in Bale Zone

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Abstract

Pre-extension demonstration of improved food barley varieties were conducted at Sinana and Agarfa districts of Bale zone. The main objective of the study was to demonstrate and evaluate recently released food barley (Robera) variety. The demonstration was under-taken on demo plots of 32mx32m area with the spacing of 20cm between rows and recommended seed and fertilizer rates. Mini-field day was organized at the respective woreda and different stakeholders were participated, and experiences were shared. Farmers' feedbacks were collected through focused group discussion and during field days. The demonstrated Robera variety gave mean grain yield of 3350 kg ha^{-1}. Participant farmers were very interested in Robera variety for its high yield, disease tolerance, adaptability to the environment and good uniformity, good seed color, high number of seed/spike, good tillering capacity, good crop stand and more resistance to lodging & thus Robera variety was recommended for further scaling up.

Key words: *Demonstration, Farmers' preference, food barley, Robera*

Introduction

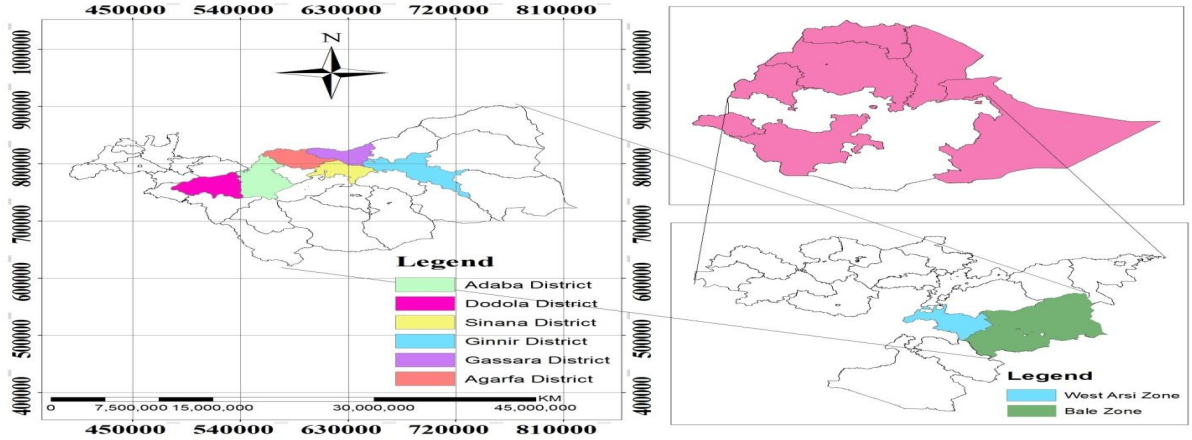
Barley is the most important cereal crops cultivated in Ethiopia. The crop stands fifth in area and volume of production (CSA, 2017/18). However, the productivity of barley is yet very low (1.965 t/ha) compared to world average of 3.095 t/ha (Barley commodity strategic plan document, 2016). In Bale Zone, barley stands third in area coverage (44,929.97 ha) and second in volume of production (1,108,131.50 quintals) of all crops with the productivity of 24.66 kg ha^{-1} (CSA, 2017).

However, grain yield and quality are still not of the desired level even in areas of adequate rainfall due to susceptibility to diseases, insect pests, inappropriate agronomic practices and low crop management practices. Besides, its potential productivity is limited by lack of sufficient improved food barley varieties and low use of the recommended packages. To solve these problems, the SARC has released an improved food barley variety called robera which gives 24-42 kg ha^{-1}. The variety has 10% yield advantage over standard check (Abdanne) and 17% over local check (Aruso). Thus, undertaking participatory demonstration of the newly released improved food barley variety with the participation of farmers and other stakeholders has paramount importance.

Methodology

Description of the study areas

The trial was conducted in Sinana and Agarfa districts of Bale Zone. Bale zone has eighteen (18) rural and two (2) town districts, out of which nine (9) rural districts are suitable for crop production. The other nine (9) rural districts are agro-pastoralists and pastoralists. The total area of Bale zone is about 63,555km^2 (6,355,500 hectares), which is 16.22% of ONRS. It is estimated that 88% and 22% are rural and urban dwellers, respectively. About 95% of the population is engaged in agriculture. The agro-ecological zones of the zone are extreme highland (cold) 0.04%, highland (14.93%), midland (21.5%) and lowland (63.53%). The mean annual temperature of the zone is found between 3.5^{o}c and 35^{o}c, respectively. The area receives an average annual rainfall of 1450mm whereas the minimum and maximum rainfall is 400mm and 2500mm, respectively. Bale zone has bimodal rainfall patterns and two distinct seasons, namely, Belg (in Afan Oromo called 'Ganna' by referring to the harvesting time) extends from March to July and Meher (in Afan Oromo called 'Bona' by referring to the harvesting time) extends from August to January. The zone is bounded by West and East Hararghe zones in the North, Arsi and West Arsi zones in the West, Guji zone in the South and Somali National Regional State in the East. Robe town is the capital town and administrative center of the zone (BZADO, 2014).



Site selection

The trail was implemented at Agarfa and Sinana districts of Bale zone. Districts were selected based on the potential of the crop. Two kebeles from Agarfa district and one kebele from Sinana district were selected purposively based on their accessibility and production potential of the crop. A total of eight farmers were selected from both districts.

Materials used and field design

One recently released variety of food barley Robera was used. The new variety was planted on demonstration plot of 32 x 32m. The recommended seed rate of 120 kg ha^{-1} and fertilizer rates of 100 kg ha^{-1} NPS and 50 kg ha^{-1} UREA was used.

Data collection and Analysis

All sites were harvested and yield data was collected. Farmers' feedbacks were collected by using Focus Group discussion. Descriptive statistics was used to analyze the yield data.

Result and Discussion

Yield performance of the demonstrated food barley variety

The demonstrated food barley variety showed good performance at all locations. Accordingly, Robera variety gave high yield at Agarfa followed by Sinana with the mean yield of 3600 kg ha^{-1} and 3100 kg ha^{-1}, respectively and overall mean yield of 3350 kg ha^{-1} (Table 1). This showed that, this variety is stable and has good performance across locations in the study area. The cost benefit ratio analysis also revealed it has cost benefit ratio of 1.11 (Table 2). This showed that, if farmers invest to produce this variety, they can make 21170 birr net profits.

Table 1: yield obtained from demonstration sites

District	Kebele	Yield obtained (Kg ha-1)
Sinana	Selka	31
Agarfa	Ali	34.25
	Ilani	37.75
	Mean	36
Overall mean		33.5

Table 2: Cost Benefit Ratio Analysis

No	Variables	Variety Robera
1.	Yield obtained (kg ha^{-1})	3350
2.	Sale price (ETB/qt)	1200
3.	Gross Returns (Price X Qt) TR	40200
4.	Land preparation	3240
	Seed purchase	1440
	Fertilizers purchase (NPS)	1400
	Fertilizers purchase (UREA)	650
	Herbicide purchase	800
	Labor for spray	200
	Fungicide purchase	600
	Labor for spray	150
	Combiner rent	2010
	Packing, Loading and store	200
	Store (bag purchase)	340
	Total Variable Costs TVC (ETB/ha)	11030
5.	Fixed cost	8000
6.	Total cost (TC)	19030
7.	Net Return (GR-TC)	21170
8.	Benefit cost ratio (NR/TVC)	1.11

Field Day and Focus Group Discussion (FGD)

Mini field day was arranged to create awareness, collect feedback and facilitate knowledge & experience sharing among farmers. Regular joint monitoring and evaluation (follow up actions) and provision of technical advice were undertaken at different crop stages based on necessary emerging knowledge and skill needs. Mini farmers' field days were organized at each demonstration site inorder to involve key stakeholders and enhance better linkage among

relevant actors. Discussion session and result communication forum were also organized. Accordingly, participant farmers appreciated Robera Variety for its high yield, disease tolerance, adaptability, to the environment, and good uniformity, good seed color, many number of rows high number of seed/spike, high tillering capacity, good crop stand and more resistance to lodging.

Conclusions and Recommendations

Pre-extension demonstration and evaluation of food barley varieties was carried out on eight (8) representative trial farmers' fields. Improved variety viz. *Robera* was demonstrated and evaluated under farmers' condition. According to the demonstration result, Robera variety has performed good giving a mean of 3350 kg ha^{-1}. Moreover, participant farmers appreciated Robera Variety for its high yield, disease tolerance, adaptability, to the environment, and good uniformity, good seed color, many number of rows high number of seed/spike, high tillering capacity, good crop stand and more resistance to lodging. Thus, Robera Variety was recommended for further scaling up in the study areas and other similar agro ecologies to reach more number of farmers with the technology.

References

Bale Zone Agriculture Development Office. 2015. Annual Report (Unpublished), Bale-Robe

Barley commodity strategic plan document (2016). Addis Ababa, Ethiopia.

Central Statistical Agency (CSA). 2017. The Federal Democratic Republic of Ethiopia. Central Statistical Agency Agricultural Sample Survey 2016/2017 (2009 E.C.): Report on Area and Production of Major Crops (Private Peasant Holdings, Meher Season), Volume I. Addis Ababa, Ethiopia.

Central Statistical Agency (CSA). 2018. The Federal Democratic Republic of Ethiopia. Central Statistical Agency Agricultural Sample Survey 2017/2018 (2010 E.C.): Report on Area and Production of Major Crops (Private Peasant Holdings, Meher Season), Volume I. Addis Ababa, Ethiopia.

Pre-extension Demonstration of Improved Faba Bean Varieties in Bale and West Arsi Zones

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Abstract

Pre-extension demonstration of improved faba bean varieties was carried out at Adaba district of West Arsi zone and Sinana and Agarfa districts of *Bale zone using one recently released improved variekgty. The main objective of the study was to demonstrate and evaluate improved faba bean varieties. The demonstration was under taken on a demonstration plot of 32m x 32m area with the spacing of 40cm between rows and using recommended seed rate of 180 kg ha^{-1} and fertilizer rate of 100 kg ha^{-1} NPS. Mini-field day was organized across test site on which different stakeholders were participated and experiences were shared. Yield data per plot was recorded and analysed using descriptive statistics. The demonstrated improved faba bean variety, Moti, gave a mean yield of 3926 kg ha^{-1}. Moreover, the participant farmers liked the variety for its high yield and other qualities. Thus, it is important to further scale up/out the variety in all demonstration sites and similar agro ecologies.*

Key words: *Demonstration, Farmers' preference, faba bean, Moti variety*

Introduction

Ethiopia ranks 2nd in area coverage in legume production next to china and 4th in productivity in the world. Faba bean production ranks the 1st among pulse crops in area and volume of production in the country. From 1,598,806.51 hectares of land allocated for pulse in 2017/2018 production season, faba bean covered 437,106.04 hectares of land from which 9,217,615.35 quintals of grain was produced with the productivity of 2109 kg ha^{-1} (CSA, 2018). In Bale and West Arsi Zones, 15,347.32 ha and 1,430.83 ha of land was covered by faba bean and 372,559.31 and 36,282.90 quintals of grain was produced with the productivity of 24.28 qt/ha and 25.36 qt/ha, respectively during 2016/2017 (CSA, 2017).

Faba bean has ecological and economic importance and used for food (rich in protein), income source and foreign currency (attractive market price), soil fertility restoration (NP) and food security. Bale and West Arsi Zones are characterized by integrated (mixed) farming systems in which most of the crop areas were under cereal based mono-cropping (Bekele, 2011). Crop diversification can be a means to stay in sustainable crop production in the study zones. Faba bean are the best break crops for wheat production. Bread wheat grown after these crops gave higher grain yield than after cereal crops with a yield advantage of 15% (Sinana ARC Profile, 2014).

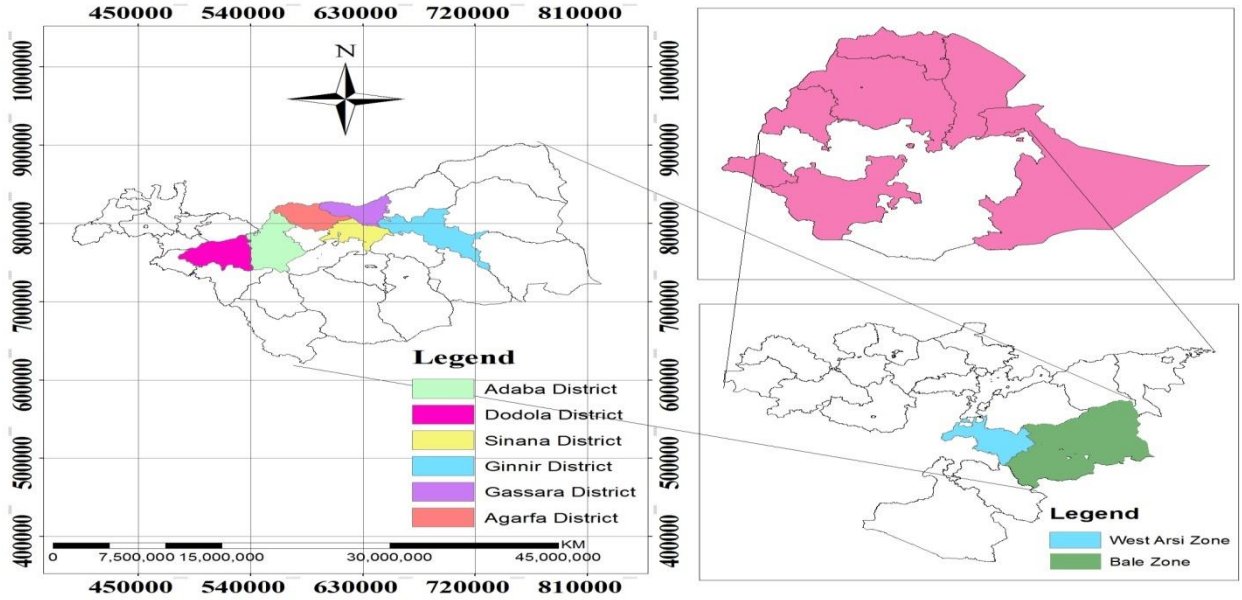
However, lack of adequate number of faba bean varieties and low promotion of the existing varieties were remained to be one of the major limiting factors for faba bean production. To

overcome the problem, Sinana Agricultural Research Center (SARC) has undertaken adaptation of newly released faba bean variety Moti. Thus, this trial was conducted to demonstrate & evaluate improved faba bean variety along with its recommended packages.

Methodology

Description of the study areas

The trial was conducted in Agarfa and Sinana districts of Bale zone and Adaba district of West Arsi Zone. Bale and West Arsi are among the 20 Administrative zones located in south eastern parts of Oromia, Ethiopia.



Site selection and Farmers selection

The districts were selected based on the potential for faba bean production. Two kebeles from Agarfa district, one kebele each from Sinana and Adaba districts were selected purposely based on their accessibility and production potential of the crop. A total of twelve farmers were selected from both districts. The trial farmers were considered as replications.

Materials used and field design

One recently released improved variety of faba bean Moti was used. The variety was planted on demo plot size of one mide (32 x 32m). The recommended spacing of 40cm between rows, seed rate of 180kg/ha and fertilizer rate of 100kg/ha NPS were used.

Data collection and Analysis

All plots were harvested and yield data was collected. Farmers' preference & feedback was also collected by using Focus Group discussion. Descriptive statistics was used to analyze the yield data and farmers' feedbacks.

Results and Discussions

Yield performance of the demonstrated Variety

The demonstrated faba bean variety (Moti) in Bale and West Arsi zones performed good at all demonstration sites. The mean yield of the variety Moti, was 3750 kg ha^{-1}, 38.25 kg ha^{-1} and 5136 kg ha^{-1} at Adaba, Sinana and Agarfa districts, respectively with overall mean yield of 3926 kg ha^{-1}. This showed that, Moti variety was stable and had good performance at all demonstration locations. The maximum and minimum yield was gained from Agarfa (5136 kg ha^{-1}) and Adaba (3750 kg ha^{-1}), respectively. The cost benefit analysis showed that it has a net benefit of 1.56. This showed that, this variety is profitable and it is good for farmers if they use it to increase the profitability of their farm.

Table 1: yield obtained from demonstration sites

District	Kebele	Yield obtained (Qt/ha)
Adaba	Ejersa	37.5
Sinana	Selka	38.25
Agarfa	Ali	51.85
	Ilani	50.87
	Mean	51.36
Overall mean		39.26

Table 2: Cost Benefit Analysis

No	Variables	Variety Moti
1.	Yield obtained (qt/ha)	39.26
2.	Sale price (ETB/qt)	1800
3.	Gross Returns (Price X Qt) TR	62816
4.	Land preparation	2430
	Seed purchase	3240
	Fertilizers purchase (NPS)	1400
	Weeding cost	2000
	Fungicide & insecticide purchase	1200
	Labor for spray	400
	Harvesting & threshing	5000
	Packing, Loading and store	200
	Store (bag purchase)	400
	Total Variable Costs TVC (ETB/ha)	16270
5.	Fixed cost	8000
6.	Total cost (TC)	24270
7.	Net Return (GR-TC)	38546
8.	Benefit cost ratio (NR/TVC)	1.56

Mini field day organized

Mini field day was arranged to create awareness and farmers shared experience and knowledge. Regular joint monitoring and evaluation (follow up actions) and provision of

technical advice were undertaken at different crop stages based on necessary emerging knowledge/skill and technical advice needs. Field day is a method of motivating people to adopt new practices by showing what has already achieved under field conditions. In other words, it is to show the performance and profitability of new practices/technologies/innovation and to convince about the applicability. Besides, it is a way of facilitating people to visit new innovation for the purpose of bringing mass mobilization. Thus, mini field days were organized at each demonstration site in order to involve key stakeholders and enhance better linkage among relevant actors. Discussion session and result communication forum were also organized.

Participant farmers were very interested with Moti. It is high yielder, disease tolerant, resistant to lodging, adaptable to the environment and has high number of tillers, high pods/plant, high seed/pod, good plant height, good crop stand, strong stem, big seed size.

Conclusions and Recommendations

Pre extension demonstration and evaluation of improved faba bean varieties was carried out on twelve (12) representative trial farmers' fields. Improved variety viz. *Moti* was demonstrated and evaluated under farmer's condition. Accordingly, the demonstrated Moti variety performed good in all demonstration sites. Moreover, the participant farmers liked the variety for its high yield, disease tolerance, resistance to lodging, adaptability to the environment, good tillering capacity, high pods/plant, high seed/pod, good plant height, good crop stand, strong stem and big seed size. It is therefore important to further scale up the variety in the study area and other similar agro ecologies.

References

Bale Zone Agriculture Development Office. 2014. Annual Report (Unpublished), Bale-Robe

Bekele Diriba. (2011). Analysis of Rural Women Farmers' Drudgery and Their Role in Agricultural Production: The Case of Sinana Districts, Bale Zone, Oromia National Regional State, Ethiopia. M. Sc. Thesis. Haramaya University, Ethiopia.

Central Statistical Agency (CSA). 2017. The Federal Democratic Republic of Ethiopia. Central Statistical Agency Agricultural Sample Survey 2016/2017 (2009 E.C.): Report on Area and Production of Major Crops (Private Peasant Holdings, Meher Season), Volume I. Addis Ababa, Ethiopia.

Central Statistical Agency (CSA). 2018. The Federal Democratic Republic of Ethiopia. Central Statistical Agency Agricultural Sample Survey 2017/2018 (2010 E.C.): Report on Area and Production of Major Crops (Private Peasant Holdings, Meher Season), Volume I. Addis Ababa, Ethiopia.

Sinana Agricultural Research Center (SARC). (2014). Information Bulletin, December, 2014.

Pre-Extension Demonstration of Improved Kabuli type Chickpea (*Cicer Arietinum* L) Varieties in Ginnir district of Bale zone

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Abstract

Pre-extension demonstrations of improved Kabuli type chick pea varieties were conducted in Ginnir District of Bale Zone. The main objective of the study was to demonstrate and evaluate recently released (Harbu and Dhera) varieties. The demonstration was under taken on single plot of 20mx20m area for each variety with the spacing of 30cm between rows and recommended seed rate of 140kg/ha and fertilizer rates of 100kg/ha NPS. Yield data per plot was recorded and analysed using descriptive statistics, while farmers' preference to the varieties was identified using focused group discussion and summarized using pair wise and simple ranking methods. The demonstration result revealed that Habru variety performed better than Dhera variety with an average yield of 2550 kg ha^{-1} and 20.5 kg ha^{-1}, respectively. Habru variety had 24.39% yield advantage over Dhera variety. Habru was selected by participant farmers at Ebisa kebele. Similarly, Dhera was selected by farmers at Lobocha Kebele. Therefore, these varieties are recommended for further scaling up.

Key words: *chick pea, Demonstration, Farmers' preference*

Introduction

Chick pea (*Cicer arietinum* L.) is the world's second most important grain legumes after common bean (*Phaseolus vulgaris* L.) among food legumes grown for production worldwide (Guar *et al*., 2012). It is one of the major pulses grown in Ethiopia, mainly by subsistence farmers usually under rain fed conditions. It is one of the main annual crops in Ethiopia both in terms of its share of the total cropped pulse area and its role in direct human consumption. It is grown widely across the highlands and semi-arid regions of the country (Bejiga et al. 1996). An average national chickpea yield on farmers field was 2058 kg ha^{-1} although its potential is more than 5000 kg ha^{-1} (CSA, 2018). This is resulted from lack of improved varieties and susceptibility of landraces to frost, drought, water logging and poor cultural practices; low or no protection measures against weeds, diseases and insect pests (Bejiga et al. 1996).The usage of improved seeds is one of the most efficient ways of raising crop production, but in Ethiopia less than 10 percent of farmers use improved seeds (FAO, 2010).

However, limited access to improved varieties in mid land areas of Bale zone is the main problem that hampers production of this crop. Technology development process failed to consider the socio economics and agro ecological circumstances of the end users. Farming community is not exposed to evaluate technologies under their existing system of production. As a result dissemination and adoption rates of many technologies popularized so far was not impressive. Furthermore, technologies from research station failed to fulfill farmers' technology selection criteria; hence adoption rate become low (Abera, 2004).

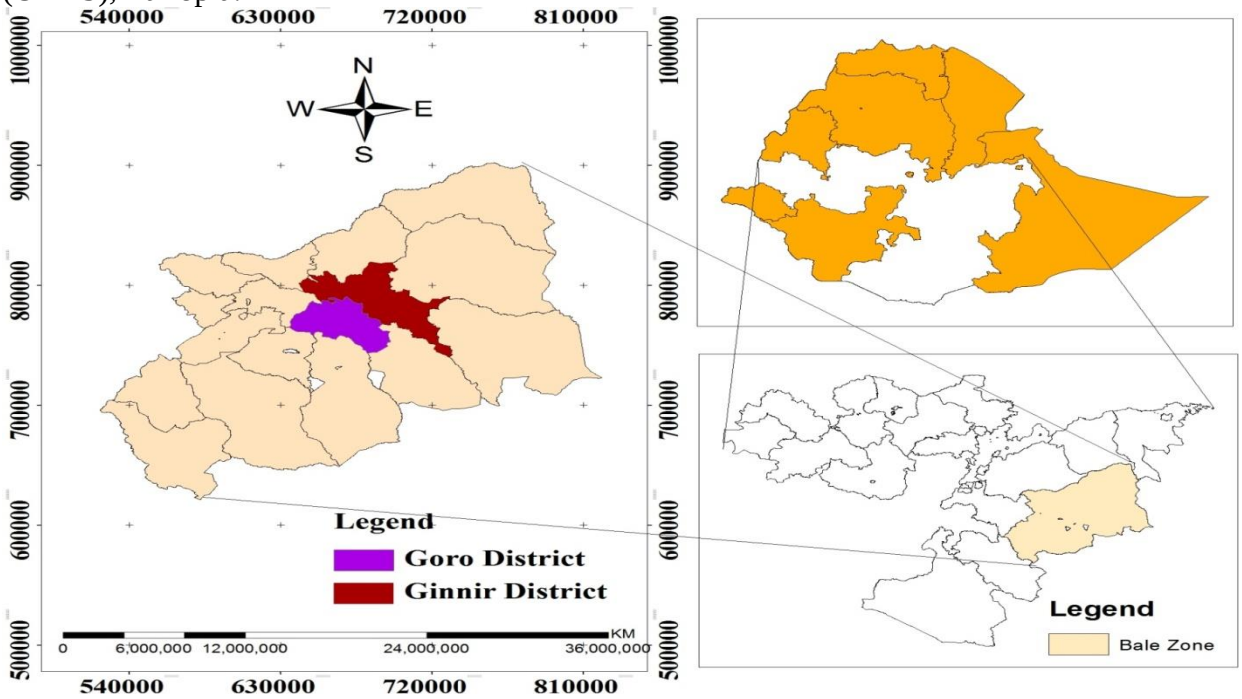
In line with this, the research system made a lot of efforts to address the bottleneck of farming communities and has developed 21 Kabuli and Desi chickpea varieties over the last three decades. Among these varieties, Habru and Dhera varieties of kabuli types are high yielder, preferred and making an impact in mid agro-ecologies of the Easter Shoa Zone of Oromia Region. However, the formal seed sector for chickpea is almost non-existent as compared to major cereal crops like wheat in Bale zone. Hence, it is important to address end users with these improved varieties of chickpea in order to improve the income of small holder farmers and to enhance crop rotation.

Therefore, participatory research and extension approach whereby stakeholders, mainly farming community actively participate in decision making and implementation from stage of problem identification through experimentation to utilization and dissemination of research results is by far crucial in addressing those problems. The two way feedback between farmers and researchers is indeed vital component of high yielder and disease and pest resistant varietal development (Getachew *et al,* 2008). Hence, participatory on farm demonstration of these varieties under farmers' condition and enhancing farmers to select variety/ies of their interest to their locality is a vital task.

Methodology

Description of the study area

The research was carried out at Ginnir district of Bale zone, Oromia National Regional State (ONRS), Ethiopia.



Site selection
Purposive sampling methods were employed to select the representative district from the zone based on its potential for chick pea production. Three kebeles were selected purposefully based on their accessibility and production potential of the crop.

Trial farmers' selection
Availability of suitable and sufficient land to accommodate the trials, willingness to contribute the land, vicinity to roads so as to facilitate the chance of being visited by many farmers, initiatives to implement the activity in high-quality, good in field management and willingness to explain the technologies to others were the criteria used to select the hosting farmers. Accordingly, a total of ten farmers were selected to implement the activity.

Materials used and field design
Two recently released chick pea varieties (Dhera and Habru) were planted on selected farmers' land with simple plot design (20mx20m) in the main cropping season. The varieties were treated with full recommended chick pea production and management packages. Hosting farmers provided their land & SARC provided input. Land preparations were carried out by trial/hosting farmers. Depending on weed infestation, two effective weeding were applied; the first at one month after sowing and the second at two months after sowing of the varieties.

Data type and method of data collection
Data were collected using direct field observation/measurements, key informant interview and focused group discussion (FGD). Yield data per plot in all locations were recorded. Farmers' preference to the demonstrated varieties (likes and dislikes, which is the base for plant breeding process and perceptions towards the performance of the technologies) was identified.

Data analysis
Descriptive statistics was used to analyze the yield data. Pair wise ranking was used for traits of demonstrated varieties. Simple ranking method was used to compare demonstrated varieties. Independent sample t test was used to compare the mean difference of demonstrated varieties.

Farmers' variety evaluation and selection
The selection process was carried out by informing farmers to set their own selection criteria. Farmers have a broad knowledge base on their environments, crops and cropping systems built up over many years and do experiments by their own and generate innovations, even though they lack control treatment for comparison and statistical tools to test the hypothesis (Bänziger, 2000).

Results and Discussions

Yield Performance of the demonstrated varieties
The following table (table 1) showed the yield performance of the demonstrated chick pea varieties obtained from the demonstration sites. Accordingly, Habru gave higher yield at all

locations. The mean yield showed 2432 kg ha^{-1}, 2628 kg ha^{-1} and 2590 kg ha^{-1} at Ebisa, Lobocha and Jame kebeles, respectively. Similarly, Dhera gave mean yield of 1986 kg ha^{-1}, 2097 kg $ha^{-1}$and 2067 kg ha^{-1} at Ebisa, Lobocha and Jame kebeles, respectively. Habru has yield advantage of 24.39% over Dhera. The maximum yield was obtained from Habru variety at Lobocha kebele (2628 kg ha^{-1}) and the minimum yield was gained from Dhera variety at Ebisa kebele (1986 kg ha^{-1}). According to the result of cost benefit ratio analysis Habru and Dhera has benefit cost ratio of 1.48 and 2.01, respectively. This shows Habru variety is more profitable than Dhera variety.

Table 1: Yield obtained from demonstration sites

Varieties	Mean grain yield (kg ha^{-1}) across kebeles			Overall mean	Yield advantage (%)
	Ebisa	Lobocha	Jame		
Dhera	1986	2097	2067	2050	24.39
Harbu	2432	2628	2590	2550	

Table 2: Cost Benefit Ratio Analysis

No	Variables	Varieties Dera	Varieties Habru
1.	Yield obtained (kg ha^{-1})	2050	2550
2.	Sale price (ETB/qt)	3000.00	3000
3.	Gross Returns (Price X Qt) TR	61500	76500
4.	Land preparation	3500	3500
	Seed purchase	4200	4200
	Fertilizers purchase (NPS)	1400	1400
	Weeding cost	2000	2000
	Fungicide & insecticide purchase	1200	1200
	Labor for spray	600	600
	Harvest ad thresh	3500	4000
	Packing, Loading and store	200	250
	Store (bag purchase)	210	260
	Total Variable Costs TVC (ETB/ha)	16810	17410
5.	Fixed cost	8000	8000
6.	Total cost (TC)	24810	25410
7.	Net Return (GR-TC)	36690	51090
8.	Benefit cost ratio (NR/TC)	1.48	2.01

Table 3: result of Independent Sample t test

	Test for Equality of Variances		t-test for Equality of Means				
	F	Sig.	T	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Equal variances assumed	1.862	.244	-7.293	4	.002	-5.0	.68559

As shown in the above table (table 3) there is statistically significant difference between both varieties. There was 5qt/ha yield difference between them.

Table 4: Descriptive statistics

Variety	N	Minimum	Maximum	Mean	Std. Deviation
Dhera	3	19.86	20.97	20.50	.57
Habru	3	24.32	26.28	25.50	1.04

The above table showed that, the maximum, minimum and mean yields of Habru variety was 2628 kg ha^{-1}, 2432 kg ha^{-1} and 2550 kg ha^{-1} respectively. Similarly, the maximum, minimum and mean yields of Dhera variety was 2097 kg ha^{-1}, 1986 kg ha^{-1} and 2050 kg ha^{-1} respectively. The standard deviation of Habru and Dhera was 1.04 and 0.57, respectively. This means Habru had more variation than Dhera variety over location.

Table 5: Pair wise ranking of traits in order of importance

code	variety traits	Stem strength	See/pod	Early maturity	Adaptability	Frost tolerance	Pod/plant	No of branch	Yield	Frequency	Rank
1	Stem strength									0	8th
2	See/pod	2								1	7th
3	Early maturity	3	3							3	4th
4	adaptability	4	4	3						3	4th
5	Frost tolerance	5	5	5	5					5	3rd
6	Pod/plant	6	6	6	4	5				3	4th
7	No of branch	7	7	7	7	7	7			6	2nd
8	Yield	8	8	8	8	8	8	8		7	1st

Pair wise ranking were used to summarize the farmers preference of variety traits. Accordingly, yield, number of branch/plant, frost tolerance, pod/plant, adaptability, early maturity and seed/pod were the priority concern given by participant farmers (Table 5).

Table 6: Rank of the varieties based on farmers' selection criteria at Ebisa Kebele.

No	Varieties	Rank	Reasons
1	Habru	1st	High yielder, higher number of branch, higher number of pod/plant, seed/pod (2), better stem strength, more adaptable to environment and soil type, more resistant to frost, early mature
2	Dhera	2nd	Less yielder, less number of branch, less number of pod/plant, seed/pod (1), less stem strength, less adaptable to environment and soil type, less resistant to frost, late mature

Table 7: Rank of the varieties based on farmers' selection criteria at Lobocha Kebele

No	Varieties	Rank	Reasons
1	Habru	2nd	Low yielder, higher number of branch, fewer number of pod/plant, less adaptable to environment and soil type, less resistant to drought
2	Dhera	1st	high yielder, higher number of branch, higher number of pod/plant, more adaptable to environment and soil type, more resistant to drought

Conclusions and Recommendations

Habru variety gave higher grain yield & also selected by participant farmers at Ebisa kebele due to it is high yielder, higher number of branch, higher number of pod/plant, seed/pod, better stem strength, more adaptable to environment and soil type, more resistant to frost, early mature. Similarly, Dhera was selected by farmers at Lobocha kebele due to high yielder, higher number of branch, higher number of pod/plant, more adaptable to environment and soil type, more resistant to drought. Based on these facts, Habru and Dhera varieties were recommended for further scaling up in the area they were selected.

References

Abera D. 2004. In proceeding of work shop on Farmer Research Group: Concepts and Practices.

Bejiga G, Eshete M and Anbessa Y. 1996. *Improved cultivars and production technology of chickpea in Ethiopia*. Debre Zeit Agricultural Research Center (DZARC), Debre Zeit, Ethiopia.

Central Statistical Agency (CSA). 2018. The Federal Democratic Republic of Ethiopia. Central Statistical Agency Agricultural Sample Survey 2017/2018 (2010 E.C.): Report on Area and Production of Major Crops (Private Peasant Holdings, Meher Season), Volume I. Addis Ababa, Ethiopia.

Dan Makosa. 2012. Integrating consumer preferences into breeding: A stepping stone to food security. Department of Agricultural Economics, Tokyo University of Agriculture, Japan. Presented on Wheat for Food Security in Africa. October 8-12, Addis Ababa, Ethiopia

FAO/WFP (Food and Agriculture Organization, and World Food Programme). 2010. Crop and Food Security Assessment Mission to Ethiopia. Available at: http://www.faostat.fao.org

Gaur, M. P., Aravind, K. J., and Rajeev, K. V. 2012.A review of impact of Genomic technologies on chickpea breeding strategies. *Agronomy*, 2: 200-203.

Getachew Belay, Hailu Tefera, Anteneh Getachew, Kebebew Assefa and Gizaw Metaferia. 2008. Ethiopian Institute of Agricultural Research, Debre Zeit Centre, P.O. Box 32, Debre Zeit, Ethiopia. Highly client-oriented breeding with farmer participation in the Ethiopian cereal tef [*Eragrostistef* (Zucc.) Trotter]. African Journal of Agricultural Research Vol. 3 (1), pp. 022-028, January 2008.

Pre-extension Demonstration and Evaluation of Onion Varieties in Selected AGP-II Districts of Harari Region and Dire Dawa City Administrative Council

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Abstract

The research activity was conducted at Dire Dawa and Harari Region with the objective of demonstrating and evaluating the best performed onion varieties in 2017/2018. The farmers selected the varieties based on their own criteria such as dry bulb yield, diseases tolerance, leaf color, leaf arrangement, bulb size, maturity, bulb shape. Based on the above criteria's; farmers evaluated the varieties and ranked Nasik Red followed by Bombay Red across locations. Accordingly, trial farmers interested in producing Nasik red and Bombay Red varieties. The yield of the preferred varieties were 22.3 and 22.9 ton/ha at Wahil, but the mean grain yield across location was and 22.2 and 22.5 ton/ha, respectively

Key words: *Bombay Red, Demonstration, Nasik Red, Onion*

Introduction

Onion (*Allium cepa L.*) is one of the bulb crops belonging to the family Alliaceae. It is considerably important in the daily Ethiopian diet. All the plant parts are edible, but the bulbs and the lower stems sections are the most popular as seasonings or as vegetables in stews. Onion prefers well-drained sandy loam with a high content of organic matter. It is considered as one of the most important vegetable crops produced on large scale in Ethiopia. It also occupies an economically important place among vegetables in the country. The total area under production reaches 15,628 hectares and the production was estimated over 1,488,549 quintals (MoARD, 2009). The area under onion is increasing from time to time mainly due to its high profitability per unit area and ease of production and the increases in small scale irrigation areas (Olani and Fikre, 2010). Increasing onion production contributes to commercialization of the rural economy and creates many off-farm jobs. For the supply of such seeds, the informal sector is playing significant role in reaching large number of farmers. The optimum altitude range for Onion production is between 700, 2200 m.a.s.l., and the optimum growing temperature lies between 15^{o}C and 23^{o}C (MoARD, 2009). It receives average annual rain fall of 670.24 - 804.06 mm. The minimum and maximum temperature of the area is 20 – 25^{o}C and 30 – 35^{o}C, respectively, and its altitude ranges from 1200 – 1600masl Fadis Agricultural research Center, 2017.

Onion is valued for its distinct pungency or mild flavour and form of essential ingredients of many dishes. It is consumed universally in small quantities and used in many home almost daily, primarily for flavouring of dishes, sauces, soup, and sandwiches in many countries of the world. Onion also contains Vitamin B, Vitamin C, carbohydrate and small percent of proteins (Lemma 2004).The result of Adaptation trial done by Fadis Agricultural Research

Center showed that Bombay Red gave maximum bulb yield 294.64 Qt/ha which means double of the standard check (132.58qt/ha) followed by Bombay Red 294.64qt/ha and Nasik Red 206.69qt/ha, respectively. However, Nasik has good marketable quality. The objective of this study is to evaluate and demonstrate Nasik Red and Bombay Red Onion varieties in AGP-II Selected District of Harari Region (Sofi) and Dire Dawa Administration Wahil .This project aimed at alleviating the problems of low quality Onion obtained from informal seed sectors and ensures the benefits to be obtained from improved Onion varieties**.**

Materials and Methods

Description of the study area

This pre-extension demonstration of onion Nasik and Red Bombay varieties were conducted in (Agricultural Growth Program-II) nationally selected districts of Dire Dawa administration and Harari Region. Dire Dawa Administration is located on distance of 515 kms from capital city Addis Ababa in direction of county's Eastern part; Somali, and Oromia regions in all directions border it. Dire Dawa Administration has both urban and rural set governance system. The climatic condition of Dire Dawa is almost dry land.

Harari Regional State is located on distance of 526 kms from capital city Addis Ababa in direction of country's eastern part; it is totally bordered by Oromia Region and hosts one capital town of Oromia Regional State's Zone that is East Hararghe. The climatic condition of the region includes highland, midland and lowland; the soil type exist in the region is different in different ecologies of the region that is clay, loam, sandy and black types.

Site and farmers selection

PAs were selected purposively based on the potentiality, appropriateness of the area by considering lodging, slop's land escape, access to road, suit for repeatable monitoring and evaluation in progress of sowing to harvesting. One District from Harari Region (Sofi) and one district from Dire Dawa Administration (Wahil) were selected. Kile from Sofi and Wahil were selected purposively. Farmers were selected purposively based on their interest, innovation he/she has, land provision for this pre-extension demonstration, interest in cost-sharing, willingness to share experiences for other farmers, and studying their profile with the participation of DAs and community leaders. The selected farmers were grouped in the form of Farmers Research Group (FREG) with the member of 15 farmers per PAs in consideration of gender issues (women, men and youth). In the study areas total of 4 FREGs (2FREG/ PAs- from one PA 15 farmers and totally 60 farmers were grouped in 4 FREG). In the FREG 10 farmers were trial farmers per PAs (6 male trial farmers and 4 female trial farmers) and five farmers work with trial farmers.

Table 1: Summary of selected site and farmers with area coverage of the experiment

District	PAs	No. of trial farmers	FTCs	Area covered
Dire Dawa	Wahil	20	1	20mx 20m for each plots
Sofi	Kile	20	1	
	Total	40	2	

Research design
The two improved onion varieties were sown on 40 trial farmers land. 20m*20m plot size of land from individual trial farmers were used for each experiment/ varieties. Each variety planted at the spacing of 20cm between rows and 10cm between plants (20cm* 20cm). Fertilizer rate depends on the soil fertility of an area 100 kg DAP all applied at transplanting and 150 kg Urea in split, half at transplanting and the other half after a month (30-45) days after transplanting.

Technology evaluation and demonstration methods/technique
The evaluation and demonstration of the trials were conducted on farmers' fields to create awareness about the Onion varieties. The evaluation and demonstration of the trials were followed process demonstration approach by involving FREGs, development agents and experts at different growth stage of the crop. The activity was jointly monitored by FREGs, researchers, experts and development agents.

Data Collection & analysis
Both quantitative and qualitative data were collected through personal field observation, individual interview, Focus Group Discussion by using checklist and data sheet tools. Quantitative data includes yield performance. While qualitative data were farmers' perceptions towards the new technology and ranked using pair wise ranking and Matrix ranking. Quantitative data was summarized using simple descriptive statistics (Mean, Frequency and Percentage) while the qualitative data collected using group discussion and field observation and oral histories was analyzed using narrative explanation or PRA (Participatory Rural Appraisal) tools and argument. Finally, data from different sources was triangulated to get reliable information.

Results and Discussion

Training of farmers and other stalk holders
Multidisciplinary research team; crop, extension and socio-economic research team and other stakeholders (Offices of Agriculture and Natural Resource) actively participated by sharing their experience and knowledge and journalists for the sake of publicity of the work done Development agents, experts and farmers were participated on the training given on Onion production and management, post-harvest handling and marketing information. Field day was also organized for more awareness creation.

Table 2: Number of participants during the training at the two Districts, 2017/18

No.	Participants	Kile		Wahil		Total
		Male	Female	Male	Female	
1	Farmers	28	3	32	13	76
2	DAs	3	2	6	0	11
3	District experts	3	2	4	0	9
4	Journalist	3	0	3	0	6
	Total	37	7	45	13	102

Among the training participant stakeholders, 74% were farmers. From those farmers, 21% are female. Different extension materials were used and distributed for the participants. For those individuals, 70 leaflets and 40 small manuals on the technology that are organized in Afaan Oromoo and English languages were distributed. During the training different questions, opinions and suggestions were raised and reacted from the concerned bodies. Most farmers showed high interest towards improved onion technology production because of better yield and earned income by selling it for different stakeholders (neighbors' farmers and Non-Government Organizations). Generally, all farmers were very interested to have the technology for their future production. Therefore, all concerned bodies were shared their responsibility for the future intervention and wider out reach of the technology.

Agronomic and yield performance

The following table describes the yield performances of the demonstrated onion varieties across the study site. The yield performance of the improved varieties (Bombay Red and Nasik Red) were 22.9 and 22.3 ton/ha at Wahil, 22.5 and 22.2ton/ha at Kile, respectively. The average yield performance of Bombay Red was somewhat higher than Nasik Red at both location but statistically no significant difference between two improved varieties across the locations.

Table 3.Yield performance of improved onion varieties across districts on Farmers land

PA	Varieties	Mean(ton/ha)	Maximum	Minimum
Wahil	Bombay Red	22.9	23.4	21.5
	Nasik Red	22.3	23	21.2
Sofi	Bombay Red	22.5	23.2	21.1
	Nasik Red	22.2	22.8	21.3
Total	Bombay Red	22.7	22.4	21.1
	Nasik Red	22.3	23	21.2

Economic Analysis

Table 4. Gross Margin

Cost item	Amount incurred	Total product		Unit Price	Total income	Gross Margin
Fertilizer	1289	Max	2700Kg	13	35,100	26,824.65
Fuel	500					
Labor	2000					
Seed	2500					
Land	1200	Min	2025Kg	13	26325	18,049.65
Interest	524.23					
Half year interest	262.12					
Ground Total cost	8275.3					

Farmers' opinion/perception

Farmers' in the study area selected the best performing improved onion varieties by using their own criteria. Farmers set these criteria after having know-how about the variety and using those criteria they selected the varieties at harvest. The opinion of those farmers on varietal preference was collected from participants during variety demonstration. The major criteria used by farmers were Dry bulb, diseases tolerance, leaf color, leaf arrangement, bulb

size, maturity, bulb shape. Based on the above criteria's; farmers evaluated the varieties and ranked Nasik Red followed by Bombay Red. Generally, farmers selected the varieties (Nasik Red and Bombay Red) based on their, Dry bulb, diseases tolerance, leaf color, leaf arrangement, bulb size, maturity, bulb shape and adaptability to the environment. Therefore, most farmers selected both improved onion varieties to reuse on their farm for the future. The following table describes farmers' selection criteria and their perception (feedback) toward the varieties.

Table 5: Ranks of the varieties based on farmers' selection criteria**.**

Crop varieties	Farmers rank	Reasons
Nasik Red	1st	Early maturity, Yield, Disease tolerance, Deep green leaf color ,medium bulb size, Glob bulb shape, medium red bulb skin color and seed set
Bombay Red	2nd	Medium maturity ,Yield, diseases tolerance ,Dark green leaf color ,medium bulb size, flat Glob bulb shape, light red bulb skin color and seed set

Table 6: Pair-wise ranking matrix result to rank variety traits.

Code no.	Traits	Early maturity	Yield	Disease tolerance	Leaf color	Bulb size	Bulb shape	Bulb skin color	Seed set	Frequency	Rank
1	Early maturity		2	3	1	1	6	1	1	4	4th
2	Yield			3	2	2	2	2	2	6	2nd
3	Disease tolerance				3	3	3	3	3	7	1st
4	Leaf color					5	5	4	4	2	6th
5	Bulb size						5	5	5	5	3rd
6	Bulb shape							6	6	3	5th
7	Bulb skin color								7	1	7th
8	Seed set									0	8th

Discussion

The trial farmers in the three locations are aware of the physical characteristics and field performance of all the onion varieties. The major variety selection criteria of farmers in the three locations were almost similar except in very few cases where they vary in level of emphasis to a particular criterion like leaf color, bulb size, bulb shape and bulb skin color

Conclusion and Recommendation

Even though these improved varieties were introduced, different smallholder growers are still using the planting material which has been obtained from their local markets and informally imported seed which is not checked and non-resistant to different diseases and insect pests. Moreover, lack of appropriate agronomic practices and a little attention given to the crop production makes the study area below average producers. Currently, onion production status has been substantially at increasing rate by smallholder farmers that create the commercialization of wahil and sofi for their daily livelihoods. Generally, the yield of the improved varieties (Bombay Red and Nasik Red) were 22.9 and 22.3 ton/ha at Wahil, 22.5 and 22.2ton/ha at Kile, respectively. The average yield performance of Bombay Red somewhat higher than Nasik Red at both location but statistically no significant difference between two improved varieties across the location and both varieties were recommended for further scaling up.

References

MoARD, 2009. *Crop Variety Registration* ISSUE No.12 .Addis Ababa, Ethiopia

Olani .N., Fikre,. M. 2010.Onion Seed Production Technique A Manual for Extension and seed Agents producers.*FAO Crop Diversification and Marketing Development Project*

Pre-extension Demonstration and Evaluation of Potato Varieties in Selected AGP-II Districts of Harari Region

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Abstract

Pre-extension demonstration and evaluation of potato varieties with the objectives of promoting and popularizing best performing potato varieties, creating awareness, improving farmers' knowledge and skill were conducted in the production season of 2017/2018. A total of fifteen (15) trial farmers were selected from two potential potato growing kebeles of Harari Region. Two FREGs having 30 farmers were established at each kebele.Two improved potato varieties, Bubu and Gudane and one local variety were planted on a plot of 40mx40m per variety. Trial farmers were used as replication. Training on which a total of 38 participants took part were also organized at Harari Region. Potato varieties were evaluated based on their tuber size yield, storability and disease tolerance. Agronomic data and yield data were collected and analyzed using descriptive statistics. Based on the yield data (23.8 ton/ha) and (23ton/ha) compared to local check (15.3 ton/ha) were obtained from Bubu, Gudane and local varieties, respectively. Bubu and Gudane have 55.56 % & 50.32 % yield advantage over local check, respectively. Thus Bubu ranked first by tuber yield, Gudane second and both varieties are recommended for scaling up

***Key words**: Bubu, Gudane, Demonistration*

Introduction

The development of agriculture is a key building block to healthy economies for the country. Ethiopia has possibly the highest potential for potato production of any country in Africa with 70% of arable land suitable to potato cultivation. Ethiopia a country of 85 million people has the potential to develop the agricultural sector to provide a sustainable food source for its own population and surplus for export. The potato (*Solanum tuberosum* L.) is the fourth most important food in the world (Naz *et.al*. 2011). But so far, it has not featured prominently in the debate on food security. Over one million highland farmers could grow potatoes in Ethiopia (Vita and CIP 2013, Adane *et al*., 2010).

It is a major part of the diet of half a billion consumers in the developing countries (Mondal, 2004). Potato is an important food and cash crop in eastern and central Africa, playing a major role in national food security and nutrition, poverty alleviation and income generation, and provides employment in the production, processing and marketing sub-sectors (Lung'aho *et al*., 2007).The potato crop is of key importance in that it provides high nutrition and is an adaptive species for climate change. Potatoes use less water per nutritional output than all other major food sources; it provides more food per unit area than any other major staple crop, three or five times that of wheat or rice. Potatoes are the perfect food and one of the few that

can actually sustain life on its own. One medium-sized potato has 110 calories and provides complex carbohydrates, amino acids and anti-oxidants. Rural women provide most of the labour in both small- and large scale potato productions, from conservation, seed selection to planting, harvesting, storing and marketing making potatoes a very 'gender sensitive' crop.(Vita and CIP 2013).

Bubu and Gudane are among potato varieties released from Haramaya University and Holota Agricultural Research Center respectively and Bubu is a medium maturing and high yielding potato variety with tuber size,taste and shape preferred by the farmers and its tuber yield is 31.96 (tons/ha) with 99 days to maturity and 44 days to flowering (Girma Chala , Niguisse Dechas,2015). Gudane tuber yield tons/ha 31.50 days to flowering 71 and days to maturity 108 (Lamessa& Zewdu 2016).The objective of this study is to evaluate and demonstrate Bubu and Gudane potato varieties in AGPII- Selected Districts of Harari Region (Dire Tayara& Sofi). This project aimed at alleviating these problems low quality Potato Seed and ensures the benefits to be obtained from these improved Potato varieties.

Methodology

Description of the study area

This pre-extension demonstration of potato varieties were conducted in (Agricultural Growth Program-II) nationally selected Districts of Harari Region. Harari Regional State is located on distance of 526 kms from capital city Finfine in direction of country's eastern part; it is all in all bordered by Oromia region and hosts one capital town of Oromia Regional State's Zone that is East Hararghe. The climatic condition of the region includes highland, midland and lowland; The valley is characterized by 3 m reddish sandy/gravely soil above the weathered metamorphic rock. The basement is fractured and weathered as observed in the gully downstream of the site. This weathered rock under the gravely sandy soil cover is highly porous. The soil type exist in the region is different in different ecologies of the region that is clay, loam, sandy and black types (World Bank 2013) These selected Districts are where the potentiality of the program succeeded in consideration of residents' problems, potential succession of the technologies these fit problems and solve; including the outcomes prevailed in AGP-I.

Site and farmers selection

One district from Harari Region (Dire Tayara) was selected by AGP-II for this study. From the District the kebele were selected purposively based on the potentiality, appropriateness of the area by considering lodging, slop's, landscape, access to road, suit for monitoring and evaluation in the process of sowing to harvest. Farmers were selected purposively based on their interest, innovation he/she has, land provision for this pre-extension demonstration, interest in cost-sharing, willingness to share experiences for other farmers, and studying their profile with the participation of DAs and community leaders. The selected farmers were grouped in the form of Farmers Research Group (FREG) with the member of 15 farmers per Kebeles in consideration of gender issues (women, men and youth). Two FREGs (1FREG/ PAs) and a total of 30 farmers were grouped in 2 FREG. In the FREG, 5 farmers were trial (3 male trials and 2 female trials) farmers and 10 farmers worked with trials farmers.

Table 1: Summary of selected site and farmers with area coverage of the experiment

District	PAs	No. of trial farmers	FTCs	Area covered
Dire Tayara	Dire Tayara	10	1	40mx40m for each plots
Total		10	1	

Research design

Two improved (Bubu and Gudane) potato varieties and one local check were replicated across five trial farmers per kebeles. Two improved and one local check were sown on 20 farmers land. Plot size of 40m*40m was used on an individual trial farmer for each experiments/ varieties. Spacing for Gudane and Bubu 75cm*30cm (between row and plant) respectively .Five trial farmers per PA's were used as replication of the varieties. Fertilizer rate (150 kg/ha DAP and 117 kg/ha UREA was applied as recommended by research and seed rate 15-18 qt/ha (MoRD, 2011).

Technology evaluation and demonstration methods/technique

The evaluation and demonstration of the trials were implemented on farmers' fields to create awareness about the potato varieties. The evaluation and demonstration of the trials was followed method demonstration approach by involving FREGs, development agents and experts at different growth stage of the crop. The activity was jointly monitored by FREGs, researchers, experts and development agents.

Data Collection

Both quantitative and qualitative data were collected through personal field observation, individual interview, Focus Group Discussion by using checklist and data sheet tools. Types of collected quantitative data were number of farmers participated in FREG, yield performance and number of stakeholders participated on the training. While qualitative data were farmers' perception toward the new technology and ranked using pair wise ranking and Matrix ranking.

Data analysis

Quantitative data was summarized using simple descriptive statistics (Mean, Frequency and Percentage) and SPSS software version 20 while the qualitative data collected using group discussion and key informant interviews, field observation and oral histories was analyzed using narrative explanation or PRA (Participatory Rural Appraisal) tools and argument. Finally, data from different sources was triangulated to get reliable information.

Results and Discussion

Training of farmers and other stakeholders

Multidisciplinary research team; crop, extension and socio-economic research team and other stakeholders (Offices of Agriculture and Natural Resource) actively participated by sharing their experience and knowledge. Development agents, experts and farmers were participated on the training given on potato production and management, post-harvest handling and marketing information.

Table 2: Type of profession and number of participants on the training at Dire Tayara, 2017/18

		DireTayara		
No.	Participants	Male	Female	Total
1	Farmers	25	9	34
2	DAs	2	0	2
3	District experts	2	0	2
	Total	29	9	38

Among the training participant stakeholders, 89.5% were farmers. From those farmers, 26.5% are female. Different extension materials were prepared and distributed for the participants. For those individuals, 30 leaflets and 20 small manuals on the technology that are organized in Afaan Oromoo and English languages were distributed. During the training, different questions, opinions and suggestion were raised and reacted from the concerned bodies. Most farmers showed high interest towards improved potato technology production because of better grain yield and earned income by selling seeds for different stakeholders (neighbors' farmers and Non-Government Organizations) as compare to the local seeds. Generally, all farmers were very interested to have the technology for their future production. Therefore, all concerned bodies were shared their responsibilities for the future intervention.

Agronomic and Yield performance

The following table describes the yield performances of the demonstrated varieties across the study site. The grain yield performance of the improved varieties (Bubu, Gudane and local) were 23.8 ton/ha, 23 ton/ha and 15.3 ton/h at Dire Tayara, respectively. The average tuber yield performance of Bubu and Gudane showed statistically significant tuber yield difference at 5% probability level over local check but no significant tuber yield difference was observed between two improved varieties.

Table.3: Yield performance of improved potato varieties on the Farmers' land.

PA	Varieties	Mean ton/ha	Maximum	Minimum
Dire Taya	Bubu	23.8	26.7	22.4
	Gudane	23	25.8	21
	Local	15.3	16.3	14.3
Total	Bubu	23.8	26.7	22.4
	Gudane	23	25.8	21
	Local	15.3	16.3	14.3

The result indicated that demonstration of potato varieties of Bubu and Gudane obtained the higher tuber yield (23.8 ton/ha) and (23 ton/ha) compared to local check (15.3 ton/ha) respectively. The percentage increases of the improved varieties over the local check were 55.56 % by Bubu and 50.32 % Gudane under farmer condition. This showed that improved Potato varieties had advantages over the local check.

Table 4: Summary of yield performance in the study areas

Varieties	Average yield ton/ha	Yield difference	Yield advantage over the local check (%)
Bubu	23.80	8.5	55.56
Gudane	23.0	7.7	50.32
Local check	15.3	-	-

Farmers' Opinion/Perception

Farmers' in the study area selected the best performing improved potato varieties by using their own criteria. Farmers set these criteria after having know-how about the varieties and using those criteria they could select the varieties at harvest time. The opinion of those farmers on varietal preference was collected during variety demonstration. The major criteria used by farmers were; tuber yield, marketable tuber size, storability disease tolerance and maturity. Based on the above criteria; farmers evaluated the varieties and ranked Bubu first and followed by Gudane variety. Therefore, most farmers selected both improved varieties to reuse on their farm for the future.

Table 5: Ranks of the varieties based on farmers' selection criteria at Dire Tayara district, 2017/18.

Crop varieties	Farmers rank	Reasons
Bubu	1st	Good Tuber yield, Good Marketable Tuber Size, Relatively good Storability, Disease tolerance and Medium maturity.
Gudane	2nd	Good Tuber yield, Good Marketable Tuber size, Good Storability, Disease tolerance and Medium maturity.
Local check	3rd	Low Tuber yield, Low Marketable tuber size, Good storability, low disease tolerance and Late maturity.

Table 6: Pair-wise ranking matrix result to rank variety traits at Dire Tayara district, 2017/18.

Code no.	Traits	Tuber yield	Marketable tuber size	Storability	Disease tolerance	Maturity	frequency	Rank
1	Tuber yield		2	1	1	1	3	2nd
2	Marketable tuber size			2	2	2	4	1st
3	Storability				3	3	2	3rd
4	disease tolerance					4	1	4th
5	Maturity.						0	5th

The trial farmers were aware of the physical characteristics and field performance of all the potato varieties. The major variety selection criteria of farmers were tuber yield, marketable tuber size, storability, disease tolerance and maturity

Conclusion and Recommendations

The results revealed that significant differences were observed in tuber yield between improved and local potato varieties. The most critical decision of farmers based on tuber quality with intended market and economic benefit to them, storability, disease tolerance and maturity. According to this study result, Bubu and Gudane varieties are superior in total yield and marketable yield in Dire Tayara of Harari Region and Bubu variety was recommended for scaling up at Dire Tayara because of its good storability.

References

Adane Hirpha, M.P.M. Meuwissen, Agajie Tesfaye, W.J.M. Lommen, A.O. Lansink, AdmasuTsegaye, and P. C. Struik, 2010. *Analysis of Seed Potato Systems in Ethiopia. American Potato Journal. 87:537–552.*

Girma Chala , Niguisse Dechas,2015. *Performance of Potato (Solanum tuberosum L.) Cultivars and Spacing at Different in Central Highlands of Ethiopia*

Irish Potato Federation(IPF),Vita and International Potato Centre (CIP) 2013;*Potato in Development A Model of collaboration for Farmers in Africa*

Lung'aho, C., B. Lemaga, M. Nyongesa, P. Gildermacher, P. Kinyale, P. Demo, and J. Kabira, 2007. *Commercial seed potato production in eastern and central Africa. Kenya Agricultural Institute. 140p.*

Mondal, M.A., A. Islam. M. R. Hossain, M., Mahmud, and M.K. Islam, 2004. *Genetic variability and path coefficient analysis of exotic varieties of potato (Solanum tuberosum L.).* Bangladesh Journal Plant Breeding and Genetics.17 (2): 47-50.

Ministry of Agriculture: Animal *and Plant Health Regulatory Directorate, Crop Variety Register* Issue No.14, June, 2011, Addis Ababa,Ethiopia

Lamessa K, Zewdu A (2016). *Effect of spacing and fertilizer dose on growth and yield of potato(Solanum tuberosum L) Gudane variety at West Hararghe, Eastern Ethiopia*. International Journal of Horticulture and Ornamental Plants 2(1): 011-018.

Naz F, Ali A, Iqbal Z, Akhtar N, Asghar S, and Ahmad B.(2011).*Effect of different levels of NPK fertilizers on the proximate composition of Potato at Abbottabad* .Sarhad Journal Agricultural science. 27(3): 353-356.

World Bank 2013, Harari National Regional State, Harar City Administration Urban Local Government Development Project Office. *Environmental and Social Impact Assessment Report for the Kile Sanitary Landfill (First draft report) E1844 V8* , Afran Consultancy Services P.L.C December, 2013,Harar

Pre-extension demonstration and evaluation of tomato variety in selected AGP-II districts of Harari region

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Abstract

*The activity was conducted during the 2017/18 main cropping season at Harari Region to evaluate and select farmers' preferred tomato variety based on their selection criteria and to create awareness on the importance of improved tomato technologies. One improved tomato variety, Melka shola, was evaluated and demonstrated on 40 farmers' fields on a plot sized 1600 m^2 along with the local check. In each kebele, two FREGs comprising of 15 farmers were established to evaluate and select the better variety. The result showed that Melka shola variety performed better in terms of fruit yield (*22.8 ton/ha*). Melka shola variety was preferred by farmers for its resistance to disease, medium fruit size, marketability, high number of fruit per plant and pear shape.Therefore, Melka shola variety was recommended for further scale up/out in Harari Region.*

Key words: *Demonstration, Harari Region, Melka shola*

Introduction

Tomato (*Lycopersicon esculuntum Mill*) is one of the most important and widely grown vegetable in Ethiopia. Fresh, processing and cherry types are produced in the country. Small-scale farmer produces the bulk of fresh market tomatoes. Processing types are mainly produced in large-scale horticultural farms. It is an important cash-generating crop to small-scale farmers and provides employment in the production and processing industries. In Ethiopia, the crop is grown between700-2000 m above sea level, with about 700 to over 1400 mm annual rain fall, in different seasons and soil type, under different weather conditions.The yield reachs 430 kg ha^{-1} on the research field and 200-270 kg ha^{-1} on farmers field (MoARD,2009).

Tomato is the most frequently consumed vegetable in many countries, becoming the main supplier of several plant nutrients and providing an important nutritional value to the human diet. It is also important source of vitamin A and C as well as minerals. It is widely consumed in every house hold in different modes including raw, as an ingredient in many dishes, sauce, salads and drinks (Tibebu Tesfaye et al., 2011).Tomatoes can make people healthier and decrease the risk of conditions such as cancer, osteoporosis and cardiovascular disease. People who ate tomatoes regularly have a reduced risk of contracting cancer diseases such as lung, prostate, stomach, cervical, breast, oral, colorectal, esophageal, pancreatic, and many other types of cancer. The studies show that tomatoes and garlic should be taken together at the same time to have its cancer preventive effects (Mebrat .T, 2014).

Farmers are interested in tomato production more than any other vegetables for its multiple harvest potential per year, which results in high profit per unit area (Mebrat, 2014). Tomato market demand is significantly increasing. To exploit the opportunity of the current growing demand for tomato, which brings actors to ultimate user of tomato is fundamental to improve quality and strengthen extension linkages. To this end, Fedis Agricultural research center has conducted adaptation of five different varieties of tomato at Harari Region. Among those five varieties, Melka shoal gave maximum yield (24.9 ton/ha) followed by Bishola (19.6ton/ha) and Eshete(17.7ton/ha) respectively. Therefore, this is proposal developed to demonstrate improved tomato variety with high yield under farmers circumstances with the local tomato variety.

Materials and Methods

Description of the study area

This pre-extension demonstration of Melka shola tomato variety was conducted in Agricultural growth program-II nationally selected districts of Harari Region. Harari Regional districts were purposively selected by AGP-II nationally. Harari Regional state is located on distance of 526 kms from capital city Finfine in direction of country's eastern part. It is bordered by Oromia Region and hosts one capital town of Oromia Regional state's zone that is East Hararghe.The agro-ecologies of the region includes highland, midland and lowland; the soil type in the region is different in different ecologies of the region that is clay, loam, sandy and black types. These selected districts are where the potentiality of the program was succeeded in consideration of residents' problems, potential succession of the technologies these fit problems and solve; including the outcomes prevailed in AGP-I.

Site and farmers selection

One district from Harari Region (Sofi) was selected by AGP-II for this study. From the district 4 kebeles were selected purposively based on the potentiality, appropriateness of the area by considering lodging, slop's, landscape, access to road, suit for monitoring and evaluation in the process of sowing to harvest. Farmers selected purposively based on their interest, innovation he/she has, land provision for this pre-extension demonstration, interest in cost-sharing, willingness to share experiences for other farmers. The selection process was done by studying farmers profile with the participation of development agents and community leaders. With this process, 15 farmers were selected per kebele. The selected farmers were grouped in the form of Farmers Research Extension Group (FREG). Generally, 60 farmers were grouped into 4 FREGs (Two FREGs per Kebele). In each FREG, 10 farmers were trial farmers (6 male and 4 female) and the rest 5 farmers worked with trial farmers.

Table 1: Summary of selected site and farmers with area coverage of the experiment

District	PAs	No. of trial farmers	FTCs	Area covered
Sofi	Kile	40	0	40mx40m for each plots
Total		40	0	

Research Design
Improved tomato variety (Melka shola) and one local check were planted across twenty trial farmers per kebele.The varieties were transplanted on 40 farmers land. Each trial farmers allocated 40m*40m plot size of land each. Each variety was planted at the spacing of 30cm between rows and 10cm between plants (30cm *10cm). Fertilizer rate DAP 100kg/ ha and UREA 100kg/ha, Seed rate 400 gm/ha were used

Technology evaluation and demonstration methods/technique
The evaluation and demonstration of the trials were implemented on farmers' fields to create awareness about the tomato varieties. The evaluation and demonstration of the trials followed process demonstration approach by involving FREGs, development agents and experts at different growth stage of the crop. FREG membbers, researchers, experts and development agents jointly monitored the activity.

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Data Collection
Both quantitative and qualitative data were collected through personal field observation, individual interview, Focus Group Discussion by using checklist and data sheet tools. Quantitative data were number of farmers participated in FREGs, yield performance, cost involved and number of stakeholders participated on the training and field days. While qualitative data were farmers' perception toward the new technology and ranked using pair-wise ranking and Matrix ranking.

Data analysis
Quantitative data was summarized by simple descriptive statistics using SPSS software version 20 (Mean, Frequency and Percentage) while the qualitative data collected using group discussion, field observation and oral histories were analyzed using narrative explanation or PRA (Participatory Rural Appraisal) tools and argument. Finally, data from different sources were triangulated to get reliable information.

Results and Discussion

Training of target group (Farmers, DAs and Experts)
Researchers from multidisciplinary research team such as crops, extension and socio-economic and other stakeholders (Offices of Agriculture and Natural Resource) actively participated by sharing their experience and knowledge. Development agents, experts and farmers were trained on Tomato production and management, post-harvest handling and marketing information and journalist were invited for media coverage. Field day was also organized for further technology popularization & awareness creation.

Table 2: Professions and number of stakeholders participated on the training at Sofi

No.	Participants	Male	Female	Total
1	Farmers	52	16	68
2	DAs	6	2	8
3	District experts	4	3	7
4	Journalists	3	0	3
	Total	65	21	86

Among the training participant stakeholders, 79.1% were farmers. From those farmers, 23.5% are female farmers' participant.

Mini-field day organized

Table 3: T Professions and number of stakeholders participated on mini field day

No.	Participants	Male	Female	Total
1	Farmers	60	24	84
2	DAs	14	6	20
3	District experts	6	5	11
4	Journalists	3	0	3
	Total	**83**	**35**	**118**

Different extension materials were utilized and distributed for the participants. For those individuals, 60 leaflets and 35 small manuals on the technology that are organized in Afaan Oromoo and English languages were distributed. During mini- field days and farm visit, different questions, opinions and suggestion were raised and reacted from the concerned bodies. Most farmers showed high interest towards improved tomato technology production because of better grain yield and earned income by selling seeds for different stakeholders (neighbors' farmers and Non-Government Organizations) as compare to the local seeds. Generally, all farmers were very interested to have the technology for their future production. Therefore, all concerned bodies were shared their responsibility for the future intervention and wider reach out of the technology.

Agronomic and yield performance

The following table describes the fruit yield performances of the demonstrated varieties across the study site. The fruit yield performance of the improved varieties (Melka shola and local) were 22.8ton/ha and 19.1ton/ha at Sofi District. The yield obtained has statistically significant difference at 5% probability level between Melka shola and local variety.

Table 4**.**Yield performance of improved tomato varieties across Farmers land .

PA	Varieties	Mean (ton/ha)	Maximum	Minimum
Sofi	Melka shola	22.8	24.7	20.40
	Local	19.1	20.4	17.5

Yield Advantage

The result indicated that improved tomato variety has better fruit yield (22.80 ton/ha) when compared with local check (19.1 ton/ha). Accordingly, the yield advantage of the improved varieties over the local check was 19.37% under farmer condition.

Table 5: Summary of yield performance in study areas

Varieties	Average yield ton/ha	Yield difference ton/ha	Yield advantage over the local check (%)
Melka shola	22.8	3.7	**19.37**
Local check	19.1		

Economic Analysis

Table 6. Gross Margin

Cost item	Amount incurred	Total product		Unit Price	Total income	Gross Margin
Fertilizer	1289	Max	6750Kg	9	60,750	55,458.15
Fuel	1000					
Labor	2000					
Land	500	Min	3600Kg	9	32,400	27,108.15
Interest	335.23					
Half year interest	167.62					
Ground Total cost	5291.85					

Farmers' Perception/Opinion

The opinion of farmers on varietal preference was collected from participants during variety demonstration. Farmers' in the study area selected the best performing improved tomato varieties by using their own criteria. Farmers set these criteria after having know-how about the variety. The selection of the varieties was done at the harvest time. The criteria were ranked using pair wise ranking to understand which criteria were the major one .Thus, the major criteria used by farmers were diseases tolerance, fruit yield, weight fruit, fruit size, number of fruit per plant, fruit shape respectively. Based on the above criteria's; farmers evaluated the varieties and ranked first Melka shola followed by local. Therefore, most farmers selected Melka shola variety for future tomato production. The following table describes farmers' selection criteria their perception (feedback) toward the varieties

Table 7: Direct Matrix Ranking of the varieties based on farmers' selection criteria.

Varieties	Rrank	Reasons
Melka shola	1st	Good fruit yield, diseases tolerance, medium fruit weight, Medium fruit size, number of fruit per plant, pear fruit shape
Local check	2nd	Good fruit yield, diseases tolerance, low fruit weight, low fruit size, number of fruit per plant, round fruit shape

Table 8: Pair-wise ranking matrix result to rank variety traits.

Code no.	Traits	Fruit yield	Diseases tolerance	Fruit weight	Fruit size	Fruit per plant	Fruit shape	frequency	Rank
1	Fruit yield		2	1	1	1	1	4	2nd
2	Diseases tolerance			2	2	2	2	5	1st
3	Fruit weight				3	3	3	3	3rd
4	Fruit size					4	4	2	4th
5	Fruit per plant						5	1	5th
6	Fruit shape							0	6th

Conclusion and Recommendation

The result of this study indicated that Melka shola variety was better yielding and preferred tomato variety by farmers at Sofi District. Local variety was low yielding variety and less preferred variety by farmers when compared with Melka shola variety in the study district. The trial farmers in the area were aware of the physical characteristics and field performance of all the tomato varieties. The major variety selection criteria of farmers in the locations were like fruit yield, disease tolerance, fruit weight, fruit size, and fruit per plant and fruit shape. Melka shola variety has has shown extra 19.37 yield advantages over the local one. Therefore, based on these findings, Melka shola variety recommended for tomato growers at the Harari Region's Sofi District for further promotion.

References

Feyera Sima, 2013. Graduation of households from social protection programmes in Ethiopia: Implications of market conditions and value chains on graduation. www.futureagricultures.org.

Mebrat Tola, 2014.*Tomato value chain in the central rift valey cas of Dugda Woreda East Shoa Zone,Oromiya Region.* An M.Sc. Thesis Presented to the School of Graduate Studies of Haramaya University.

MoARD,2009. *Crop variety Registration. Addis Ababa ,Ethiopia, Minisry of Agriculture and Rural Development, Animal and Plant Healthy Regulatory Directorate*.

Tibebu Tesfaye. 2011. *Clay plot irrigation for tomato production in the north east semi arid region of Ethiopia*. Journal of Agriculture and rural development in the tropics and sub tropics, 112(1): 11 -18.

Pre-extension Demonstration of Improved Bread Wheat Technology in selected AGP-II Districts of East & Horro Guduru Wollega Zones

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Abstract

*This activity was conducted in Jarte Jardaga, Jimma Geneti, Jimma Rare, Guduru and Gida Ayana districts of western Oromia with the objective of demonstrating the recently released Bread Wheat varieties, Senate and Liban to the farming community in these districts. Two potential PAs from each district were selected on the basis of accessibility and potentiality for wheat production & management. After selecting and establishing FREG unit in each PA training was provided. Then after, two varieties of bread wheat, Liban as a recently released variety along with Senate; as standard check were planted on 20m*10m adjacent plots on 20 farmers' fields. All recommended agronomic practices were equally applied to all the plots and the fields were closely supervised and were managed well. At maturity, the varieties were jointly evaluated with a team composed of researchers, Farmers and DAs. Despite the slight variability in criteria set by farmers at the respective locations, yield ,disease tolerance, seed color, plant height, pest resistance, tillering capacity, seed size, lodging resistant, early maturity, spike length, thrash ability were the common selection criteria across all locations. In almost all the locations, Senate beat Liban both in yield and the criteria set for evaluation; except seed color, and impressing the farmers; especially spike length, number of seeds per spike and tillering capacity. With regard to yield, 57.90 qt/ha and 52.40 qt/ha were obtained from Senate and Liban, respectively putting Senate on the first rank. Besides, Senate has 10.50 % yield advantage over Liban. Furthermore; in terms of profitability, financial analysis result of the study also showed that using Senate variety can make more profitable than Liban. Therefore, as the variety has met the intended criteria of the farmers the pre-scaling up activity should follow next season.*

Keywords: Bread wheat, FREG unit, Participatory evaluation

Introduction

Ethiopia is one of the largest grain producers in Africa, and the second largest wheat producer in Sub-Saharan Africa, after South Africa. Wheat production in Sub-Saharan Africa is at 10 to 25% of its potential and the region could easily grow more to improve food security. Farmers in Sub Saharan Africa produce 44% of the wheat consumed locally and import the rest from international markets, making the region highly vulnerable to global market and supply shocks. In Ethiopia, both the bread and durum wheat are widely cultivated in the highlands of the country largely in the areas like South East, Central and North West parts. According to (MoARD, 2005), it is estimated that 1.4 million hectare of land is covered with wheat and more than 2.18 million tons are produced annually. In terms of area cultivated and annual production, wheat is the third most important cereal crop in Ethiopia following maize and teff (CSA, 2012).

It is extensively grown in most parts of the country, with the major production areas concentrated at altitude of 2000 to 2900 m.s.l. (MoARD, 2015). Further; during 2016/17 cropping season 1,664,564.62 ha of land was covered by wheat (bread and durum) and over 42,192,572.23quintals was harvested with the average yield of 25.35 quintals per hectare at national level (CSA, 2016). Similarly, the land covered by wheat production in East and Horro Guduru Wollega Zones in 2016/17 Maher production season was 120,067.9 and 143,971.78 hectares; respectively (CSA, 2016). Even though, most agro-ecologies of East and Horro Guduru Wollega Zones are the potential areas for wheat production, the yield obtained by farming communities was below the potential. According to the report of EAAPP (2014), the low productivity is mainly due to technological and natural factors (disease, weed and insects), grain quality, lack of varieties for specific growing conditions, lack of improved seed supply for the best variety and low use of recommended full packages are among the constraints that lowered the productivity.

To tackle such a challenge, BARC has been conducting intensive research work on the crop and has recently released bread wheat varieties that have better disease tolerance than the previous varieties. To this end, Liban variety was released recently by BARC with potential yield of 60 qt/ha on farmers' field (MoARD, 2015) to reverse the scenario and alleviate the problem of low productivity. Consequently, this calls for demonstrating, validating and disseminating of the released high yielding, disease tolerant and quality bread wheat varieties that can make producers competitive in the today's competing markets. Therefore, BARC extension team initiated this on farm improved bread wheat technologies demonstration and evaluation activity with these underlying objectives.

Materials and method

Description of Study Areas

Description	Selected districts for pre-extension demonstration		
	Jarte Jardaga	**Guduru**	**Jimma Rare**
Altitude (m)	1800 -2800	2000-2350	1900- 2324
Coordination point	$8^0$55N latitudes and $36^0$44'E Longitudes	$9^0$33N latitudes and $37^0$22'E Longitudes	$9^0$88 latitudes and $37^0$87' E Longitudes
Rainfall (mm)	1200 -1800	1100-2000	900- 1700
Temp(^{0}C)	12- 20	15- 22	12-22
Agro-ecology	Suitable agro-ecologies (altitude, temperature, rain fall)	Suitable agro-ecologies (altitude, temperature, rain fall)	Suitable agro-ecologies (altitude, temperature, rain fall)
Major crop grown in term of areas coverage	Wheat, Barely, Tef, Potato, Maize, noug and Field pea	Wheat, Maize, Tef, Potato, Faba bean noug and Field pea	Wheat, Barely, Tef, Potato, Maize and Field pea

Site and Farmers Selection

Four districts were selected based on AGP-II criteria, potentiality and accessibility for supervision. One representative PA from the each district was selected based on the aforementioned criteria. In each PA, one FREG members comprising of 15 farmers was

established and managed. Gender and youth balance in each FREG member was strictly considered. A total of 16 host farmers were participated

Provision of training & input

After established of the farmers research group (FREG) theoretical and practical training were given to farmers, Development agent and district experts. Training provided on the following areas; such as, wheat technology transfer approaches, production management, breeding aspect, post harvesting (seed quality). The aim of training was to create awareness of farmers', Development agent and district experts on wheat technology. All necessary input (seed, fertilizers) were delivered to the farmers

Field design and management

Two improved bread wheat varieties; Liban (as recently released) and Senate (as standard check) were planted side by side on adjacent plots of 200m^2.The demo plots were replicated by hosting farmers. All the necessary recommended agronomic practices were equally applied for all of the plots. Accordingly, spacing of 20cm between rows, the recommended 150 kg/ha seed and 100/100 kg/ha of NPS/UREA fertilizer rate of were used. All other recommended agronomic practices were maintained equally for all plots.

Data Collectiom & Analysis

Both qualitative and quantitative data were collected. The collected data were: yield data, type and number of stakeholders participated by gender in training, field visits, and farmers' perception on the attribute of technology, costs and income gained.

The collected qualitative data was analyzed using descriptive statistics such as mean, frequencies, tables and percentages. Also quantitative data collected were subjected to SPSS software to analyse mean, standard deviation, t-test and ANOVA table. Besides; ranking scale was used to evaluate and select best bet variety/ies and to rank their criteria according to real situation of the area. According to (Sumai *et.al*., 2000) technology gap and technology were calculated using the following formula.

Technology gap = Potential yield qt/ha – demonstration yield

$$\textbf{Technology index} = \frac{\textbf{Potential yield- demonstration yield}}{\textbf{Potential yield}} * 100$$

Result and Discussion

Participatory Variety Evaluation and Selection

At maturity, the varieties were then be evaluated based on the farmers' selection criteria. At this juncture, the farmers were assisted to jot their own evaluation criteria, which then be ordered using score ranking technique. Each variety was then be evaluated against the criteria ordered based on the weight attached to each parameter. At the end of the evaluation process, result of the evaluation was displayed to the evaluators, and discussion was made on the way ahead. To this end; FREG farmers scored each variety for individual traits considered important by them and ranking of varieties were done on a scale of 1-5, 1 being very poor and 5 being the highest score representing superiority.

Accordingly; yield, disease tolerant, tillering capacity, seed color, early maturing and other traits were considered as the major selection criteria for each bread wheat variety. Based on overall mean score the best-preferred variety was evaluated and ranked. Therefore; Senate was selected by all its traits including yield except its color then followed by Liban for further scaling up in the coming seasons.

Table 1: Score ranking of bread wheat varieties by FREG farmers across the districts

Variety	Guduru			Jimma Rare			Jarte Jardaga			Gida Ayana			Overall Rank
	Total Score	Mean Score	Rank	Total Score	Mean Score	Rank	Total Score	Mean Score	Rank	Total Score	Mean Score	Rank	
Liban	42	4.2	2nd	33	3.3	1st	34	3.4	2nd	42	4.2	2nd	2nd
Senate	48	4.8	1st	31	3.1	2nd	38	3.8	1st	46	4.6	1st	1st

NB: criteria set: 1= Lodging tolerant, 2=early maturity, 3=spike length, 4=yellow rust tolerant, 5=number of seed/spike, 6= Head blotch tolerant, 7= seed color, 8=seed size, 9=Tillering capacity and 10=high yielder

On-farm performance of the varieties

In spite of the inevitable variability in performance between and even within locations/districts, the yield performances of the varieties were still promising. Accordingly; the combined mean analysis result on yield performance of the varieties demonstrated is summarized in below (table 2). Hence, mean yield of 52.40 ± 0.34 qt/ha and 57.90 ± 0.19 qt/ha for Liban and Senate varieties; respectively was gained across the districts.

Table 2: Mean yield performance of bread wheat varieties across the districts

Variety	N	Mean	SD	Min	Max
Senate	16	57.90 ± 0.19	0.76	56.69	58.96
Liban	16	52.40 ± 0.34	1.38	49.89	53.77

Figure 1 below summarizes mean yield performances of the varieties across the districts.

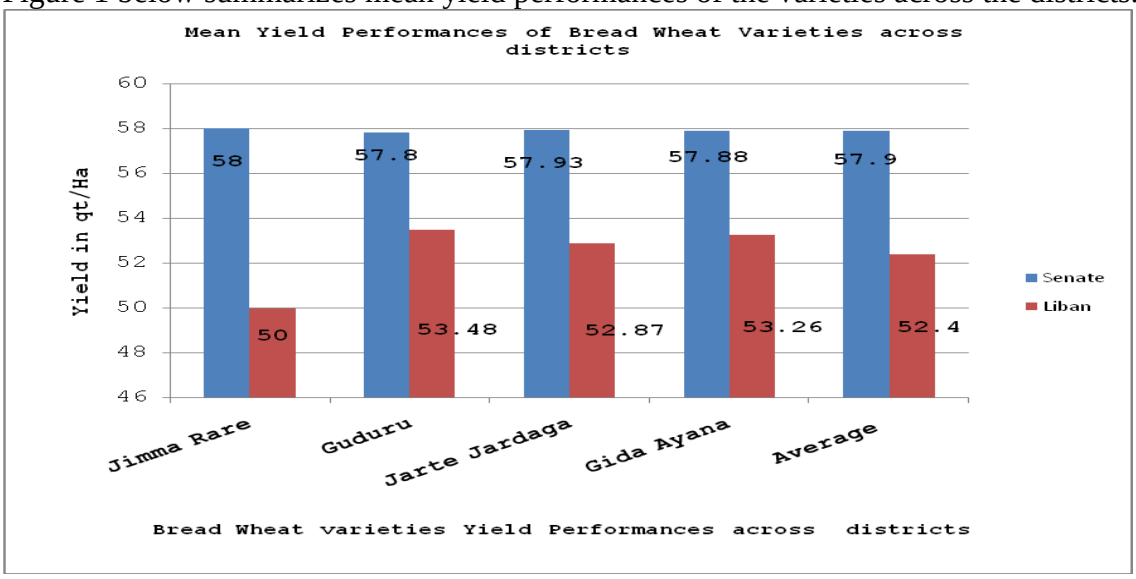

Figure 1: On farm yield performances of bread wheat varieties across districts

Moreover, ANOVA showed that as there is highly significant difference at ($p<0.05$) between the varieties and across the districts (Table 3). This means that there is highly significant difference between the bread wheat varieties. The result also shows that as there is significant difference across the districts on mean yield performances of the varieties at ($p<0.05$).

Table 3: Analysis of Variance Table for Yield

Source	DF	SS	MS	F	P
Farmer	3	0.128	0.043	0.04	0.9897
District	3	10.06	3.355	3.01	0.0501
Variety	1	224.83	224.826	201.46	0.0000
Error	24	26.78	1.116		
Total	31	261.80			
Grand Mean		55.15			
CV		1.92			

Furthermore; mean comparison (t-test) also verified that there exists highly significant difference between the varieties demonstrated across the districts at ($p<0.05$) (Table 4).

Table 4: Bread Wheat Varieties t-test for Yield across the districts

Varieties t-test	Mean	Std Error	T	P value
Senate*Liban	5.30	0.44	12.01	0.0000
Yield*Districts	52.65	0.52	101.58	0.0000

Yield advantage

Calculating yield advantage of the varieties helps to show the extra benefit in percentage that the farmers' obtained from producing improved variety. Besides; it helps to recommend based on the relative yield advantage over other varieties. Yield advantage gained for Senate over Liban variety was 10.50 % (Table 5).

Table 5. Yield advantage of newly released bread wheat variety over the standard check

Demonstrated Varieties	Yield obtained (qt/ha)	Yield advantage over the standard check (Senate)
Senate	57.90	10.5 %
Liban	52.4	

Technology gap and Technology index

Technology gap indicates that the gap in the demonstration yield over potential yield. The observed technology gap is attributed to dissimilarities in fertility, acidity, rainfall and other natural calamities (Dhaka *et.al*., 2010). According to Dhaka *et al*. (2010), its contribution is to narrow down the gap between the yields of different varieties and to provide location specific recommendations. The yield gaps can be further categorized into technology index which is used to show the feasibility of the variety at the farmer's field. The lower the values of technology index the more the feasibility of the varieties.

Table 6: Technology gap and technology index for bread wheat varieties across the districts

Parameter	Bread Wheat Varieties	
	Senate	Liban
Technology gap (qt/ha)	2.1	7.6
Technology index (%)	3.5	12.67

As indicated in the above table, the yield gap is 7.6 qt/ha and 2.1 qt/ha for Liban and Senate varieties, respectively. This indicated that the lowest gap was observed on Senate variety, which in turn shows the demonstration yield, is very close to the potential yield. In terms of technology index 12.67 % and 3.5 % for Liban and Senate varieties, respectively. That means, both varieties have an average technology index of 8.09 % and this dictates that the varieties are feasible to the farmers in the study area and other similar agro-ecologies.

Financial analysis

The financial/profitability analysis result showed that an average return of 55935.33 Birr and 49259.33 Birr per hectare could be gained from Senate and Liban varieties, respectively per production season in the areas where the activity carried out.

Table 7: Financial analysis for bread wheat varieties across the districts

Financial Analysis

Location: Jimma Rare			Location: Guduru			Location: Jarte Jardaga		
Parameters	Variety		Parameters	Variety		Parameters	Variety	
	Senate	Liban		Senate	Liban		Senate	Liban
Yield qt/ha(Y)	58	49.89	Yield qt/ha(Y)	57.5	53.5	Yield qt/ha(Y)	57.88	53.3
Price(P) per quintal	1200	1200	Price(P) per quintal	1200	1200	Price(P) per quintal	1200	1200
Total Revenue (TR)=TR=Y*P	69600	59868	Total Revenue (TR)=TR=Y*P	69000	64200	Total Revenue (TR)=TR=Y*P	69456	63960
Variable costs			**Variable costs**			**Variable costs**		
Seed cost	1600	1600	Seed cost	1600	1600	Seed cost	1600	1600
Fertilizer cost	3150	3150	Fertilizer cost	3150	3150	Fertilizer cost	3150	3150
Labor cost	6500	6500	Labor cost	6500	6500	Labor cost	6500	6500
Total Variable costs(TVC)	11250	11250	Total Variable costs (TVC)	11250	11250	Total Variable costs (TVC)	11250	11250
Fixed costs			**Fixed costs**			**Fixed costs**		
Cost of land	2000	2000	Cost of land	2500	2500	Cost of land	2000	2000
Total fixed costs (TFC)	2000	2000	Total fixed costs (TFC)	2500	2500	Total fixed costs(TFC)	2000	2000
Total cost (TC) =TVC+TFC	13250	13250	Total cost (TC) = TVC+TFC	13250	13250	Total cost (TC) = TVC+TFC	13250	13250
Gross Margin (GM) = TR - TVC	58350	48618	Gross Margin (GM) = TR-TVC	57750	52950	Gross Margin (GM) = TR - TVC	58206	52710
Profit=GM-TFC	56350	46618	Profit=GM-TFC	55250	50450	Profit=GM-TFC	56206	50710

Training of farmers, Experts and DAs

A total of 387 participants (332 farmers, 26 DAs and Supervisors and 27 agricultural experts) were participated on this training (Table 8) across the districts.

Table 8: Stakeholders training participants across the demonstration districts

Participants	Districts			Total
	Guduru	Jimma Rare	Jarte Jardaga	
Experts	10	9	8	27
DAs and supervisors	9	10	7	26
Farmers	90	122	120	332
Total	109	139	139	387

Farmers' on Field visit event

Field visit was also arranged across the districts to evaluate/select best performing varieties, to enhance farmers' knowledge on bread wheat production and management and to collect feedback from all relevant stakeholders' for the way forward. A total of 400 participants (350 farmers, 30 DAs and Supervisors and 20 agricultural experts) were participated on field visit.

Farmers' perception to wheat technology

The farmers' research groups have appreciated the new wheat technology for the following merits perceived better yielder than the standard check, perceived better resistance to yellow rust and perceived better seed size.

Conclusion and Recommendation

Generally, through this participatory evaluation and demonstration process, many farmers became aware of the importance and quality of technologies as compared to the local one. The demands for the varieties were also created. Demonstration result showed that senate variety recorded high yielder than Liban at all location. It was also preferred by participant farmers for its better agronomic performance. Based on these facts, senate variety was recommended for further scale up and scale out for demo districts and other similar areas.

References

Central Statistical Agency (CSA).2012. The Federal Democratic Republic of Ethiopia. Central Statistical Agency Agricultural Sample Survey 2011/2012 (2005 E.C.): Report on Area and Production of Major Crops (Private Peasant Holdings, Meher Season), Addis Ababa, Ethiopia.

Central Statistical Agency (CSA). 2016. The Federal Democratic Republic of Ethiopia. Central Statistical Agency Agricultural Sample Survey 2015/2016 (2008 E.C.): Report on Area and Production of Major Crops (Private Peasant Holdings, Meher Season), Volume I. Addis Ababa, Ethiopia.

Dhaka B. L., Meena B. S. and Suwalka R. L. 2010. Popularization of Improved Maize Production technology through Frontline Demonstrations in South-Eastern Rajasthan. Journal of AgriSci,1(1):39-42 (2010).

Eastern Africa Agricultural productivity Project (EAAPP) 2014. Highlights of achievements of technology generation.

Ministry of Agriculture and Natural Resource (MoARD).2015. Variety Registration Book. Addis Ababa, Ethiopia.

Ministry of Agriculture and Natural Resource (MoARD).2005. Meeting the challenge of global climate change and food security.

Pre-extension Demonstration of improved Tef Technology in selected AGP-II districts of East & Horro Guduru Wollega zones

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Abstract

*This activity was conducted in Gida Ayana, Wayu Tuqa, Jarte Jardaga, Guduru and Jimma Rare districts of western Oromia with the objective of demonstrating the newly released teff variety Dursi against Kena and Guduru to the farming community in these districts. These districts were purposively selected based on accessibility and potentiality for teff production. One potential PA from each district were selected based on the aforementioned criteria. After selecting and establishing the FREGs, training was provided across the districts. Then after, one variety, Dursi (a newly released variety) as well as Kena and Guduru (as standard checks) were planted on 20m*10m adjacent plots on 20 farmers' field. All recommended agronomic practices were equally applied to all the plots and the fields were closely supervised and were managed well. At maturity, the varieties were jointly evaluated with a team composed of researchers, Farmers and DAs. Despite the slight difference in criteria set by farmers at the different locations; yield, disease tolerance, seed color, plant height, pest resistance, tillering capacity, seed size, lodging resistant, early maturity, spike length, were the common selection criteria across all locations. In almost the entire criterion Dursi exceed the standard checks and has met the criteria of the farmers. With regard to yield, 18 qt/ha, 15 qt/ha and 13 qt/ha were obtained from Dursi, Guduru and Kena; respectively putting Dursi on the first rank. Dursi gave yield advantage of 20 % and 38.46 % than Guduru and Kena, respectively. ANOVA table and mean yield comparison (t-test) results showed as there is highly significant difference at* ($p<0.05$) *among the varieties demonstrated. Financial/ profitability analysis result of the study also showed that using Dursi variety can make farmers' more profitable than Guduru and kena. As the variety has met the intended criteria of the farmers, the pre-scaling up activity should follow the next season.*

Keywords: FREG unit, participatory evaluation, Tef

Introduction

Among cereals, teff accounts for the largest share of the cultivated area (28.5 % in 2011), followed by maize (20.3%). Teff is second (to maize) in terms of quantity of production. However, because its market price is often two or three times higher than maize, Teff accounts for the largest share of the total value of cereal production. Teff is grown by a total of 6.2 million farmers. Since Teff farm operations such as land preparation, weeding and harvesting are highly labor intensive, with limited availability of suitable mechanical technology, there is no large scale teff farmers in the country. Many farmers grow Teff as cash crop because of its higher and more stable market price (Demeke *et al*., 2013).

According to the data of the Central Statistical Agency (CSA, 2011), teff production expanded by 72 percent between 2004/05 and 2010/11. This growth was achieved mainly due to 29 percent expansion in area under cultivation and 33 percent increase in yield levels. The share of Teff in total cultivated areas increased by 2 percent, compared to the decline in barely (25 percent) and wheat (12 percent), and rapid expansion in coarse grains (maize, 11 percent, and sorghum, 19 percent). With only 1.3 tons per hectare, teff yield is the lowest among cereal crops. This is mainly due to limited use of improved seeds, inefficient agronomic practices and fragmented farm plots (Demeke et al.2013).

Tef is likely to remain a favorite crop of the Ethiopian population and the crop is gaining popularity as a health food in the western world. Studies show that tef is a gluten free crop, which makes it is suitable for patients with celiac disease (Dekking and Koning, 2005). CSA data over the past few years show that teff ranked first in terms of area coverage (accounting for 28% of the area) and is second to maize in terms of volume of production among cereals, accounting for about 20% of the total produce in the category (Bekabil *et, al.*,2011).

However, productivity has remained stagnant or has even declined in some cases until recent years due to several technical and socio-economic constraints. Weed competition, low or declining soil fertility, diseases, in appropriate use of agronomic practices such as seeding rate, sub-optimal fertilizer application and herbicide use are some of the major technical constraints. Limited supply of seeds of improved varieties, high price and unavailability of augmenting technologies like fertilizer and herbicides in required quantity and at required time, and inadequate cash or credit for purchase of inputs are the major socio-economic constraints (Kenea *et al.*, 2001). With only 1.3 tons per hectare, tef yield is the lowest among cereal crops. This is mainly due to limited use of improved seeds, inefficient agronomic practices and fragmented farm plots (Demeke *et. a*l., 2013).

In order to increase productivity of this crop, National Agricultural Research System (NARS) has been making great efforts over last ten years to develop and release large numbers of tef crop varieties and associated production technologies for diversified agro ecology of Ethiopia. In spite of the availability of several improved tef technologies generated by the research system in Ethiopia over the last four decades, most of the farmers in the Oromia region depend on the local varieties and traditional management practices.

In line with this, even though, most agro-ecologies of East and Horro Guduru Wollega Zones are the potential areas for tef production, the yield obtained by farming community was below the potential. This is due to limited availability of improved tef varieties, diseases, insect problems and limitations in using the recommended packages. To this end, BARC has recently released new variety; Dursi with potential yield of 22.85 qt/ha on farmers' field and 26 % yield advantage over the recently released varieties (MoARD, 2017). Consequently, this calls for demonstrating, validating and disseminating of the released high yielding, disease tolerant and quality teff varieties that can make producers competitive in the today's

competing markets. Therefore, this project is initiated with objectives of demonstrating improved teff technologies so as familiarize the farming communities with the new teff varieties, which in turn will facilitate the adoption process and bridge the productivity gap.

Methodology

Site and Farmers Selection

Five districts; Jimma Rare, Jarte Jardaga, Guduru, Wayu Tuqa and Gida Ayana, were selected based on AGP-II criteria, potentiality and accessibility for supervision. One representative PA from each district was selected based on the aforementioned criteria. In each PA one FREG members comprising of 15 farmers was established and managed. Gender and youth balance in each FREG member was strictly considered. A total of 20 hosting farmers were participated.

Provision of training & Input

After establishing of the farmers research group (FREG) theoretical and practical training were given to farmers, Development agent and district experts. Training provided on the following areas such as, tef technology transfer approaches, Production management, and post harvesting (seed quality). The aim of training is to create awareness to farmers, Development agents and district experts on tef technology. All necessary input (seed, fertilizers) were delivered to the farmers.

Field design and management

Three improved tef varieties; Dursi, the newly released variety along with standard checks (Guduru and Kena) were planted side by side on adjacent plots of 200m^2. The demonstration plots were replicated by hosting farmers. All the necessary recommended agronomic practices were equally applied for all of the plots. Accordingly; spacing of 20cm between rows was used for the demonstration and the recommended 15 kg/ha seed and fertilizer rate of 100 kg/ha NPS and 50kg/ha UREA were used. All other recommended agronomic practices were maintained equally for all plots.

Data Collected

Both quantitative and qualitative data were collected. The collected data includes yield data, total number of farmers and other stakeholders' participated in training and field visits, farmers' perception on the attribute of technology, costs and income gained.

Data Analysis

The collected qualitative data was analyzed using descriptive statistics such as mean, frequencies, tables and percentages. Quantitative data were subjected to SPSS software to analyse mean, standard deviation, t-test and ANOVA table. Besides, ranking scale was used to evaluate and select best bet variety/ies and to rank their criteria according to real situation of the area.

Technology gap indicates that the gap in the demonstration yield over potential yield. The observed technology gap is attributed to dissimilarities in fertility, acidity, rainfall and other natural calamities (Dhaka *et al*., 2010). According to Dhaka *et al*., 2010, its contribution is to narrow down the gap between the yields of different varieties and to provide location specific recommendations. The yield gaps can be further categorized into technology index which is used to show the feasibility of the variety at the farmer's field. The lower the values of

technology index the more the feasibility of the varieties. To this end, According to Sumai *et al*, (2000) technology gap and technology index were calculated using the following formula;

Technology gap = Potential yield qt/ha – demonstration yield

$$\text{Technology index} = \frac{\text{Potential yield- demonstration yield}}{\text{Potential yield}} * 100$$

Yield advantage gained for Dursi over Guduru and Kena varieties were calculated using the underlying formula;

$$\text{Yield advantage \%} = \frac{\text{Yield of new variety - Yield of standard check}}{\text{Yield of standard check}} X\ 100$$

Results and discussion

Participatory Variety Evaluation and Selection

At maturity, the varieties were evaluated based on the farmers' selection criteria. At this juncture, the farmers were assisted to jot their own evaluation criteria, which then be ordered using score ranking technique. Each variety was evaluated against the criteria ordered based on the weight attached to each parameter. At the end of the evaluation process, result of the evaluation was displayed to the evaluators, and discussion was made on the way ahead. To this end; FREG farmers scored each variety for individual traits considered important by them and ranking of varieties were done on a scale of 1-5, 1 being very poor and 5 being the highest score representing superiority.

Accordingly; yield, disease tolerant, tillering capacity, seed color, early maturity and other traits were considered as the most selection criteria for each teff variety. Based on overall mean score, the best preferred variety was evaluated and ranked. Hence, Dursi was selected by all its traits including yield followed by Guduru and thus will be proposed for further scaling up.

Table 1: Score ranking of teff variety by FREG farmers across the districts

Variety	Jarte Jardaga			Guduru			Wayu Tuqa			Overall Rank
	Total score	Mean score	Rank	Total score	Mean score	Rank	Total score	Mean score	Rank	
Kena	44	4.4	1st	40	4.4	1st	26	2.89	3rd	2nd
Guduru	29	2.9	3rd	30	3.3	3rd	36	4	2nd	3rd
Dursi	38.5	3.85	2nd	36	4	2nd	43	4.78	1st	1st

NB: criteria set: 1= Lodging tolerant, 2=early maturity, 3= Disease tolerant, 4= seed color, 5=seed size, 6=Tillering capacity, 7=high yielder, 8= Marketability and 9=spike length

On-farm yield performance

In spite of the inevitable variability in performance between and even within locations, yield performances of the varieties were still promising. Accordingly, the combined mean analysis result on mean yield performances of the varieties demonstrated is summarized in the table below (table 2). Accordingly; a mean yield of 18.39 ± 0.58 qt/ha, 15.25 ± 0.78 qt/ha and 13.26 ± 0.57 qt/ha for Dursi, Guduru and Kena varieties; respectively were recorded.

Table 2: Mean yield of teff varieties across the districts

Variety	N	Mean	SD	Min	Max
Dursi	20	18.39 ± 0.58	2.61	13.49	23.83
Guduru	20	15.25 ± 0.78	3.51	10.26	22.06
Kena	20	13.26 ± 0.57	2.53	9.79	17.84

Figure 1 summarized on farm mean yield performances of the varieties across the districts.

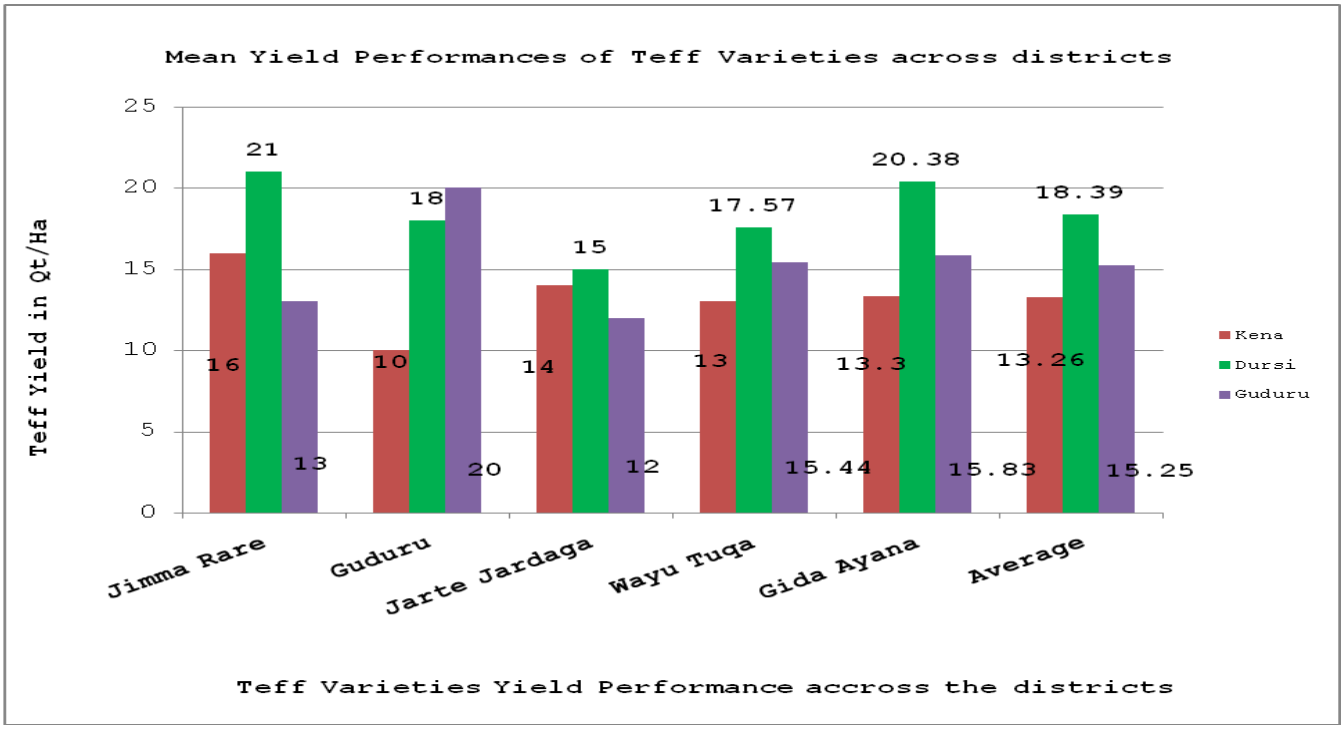

Figure 1: On farm yield performances of teff varieties across the districts

Moreover, ANOVA showed that there is significant difference at ($p<0.05$) between the varieties and districts (Table 3).

Table 3: Analysis of Variance Table for Yield

Source	**DF**	**SS**	**MS**	**F**	**P**
Farmer	3	13.90	4.63	0.57	0.635
District	4	67.67	16.92	2.09	0.0955
Variety	2	267.39	133.68	16.55	0.0000
Error	50	403.98	8.08		
Total	59	752.93			
Grand Mean		15.87			
CV		17.9			

Furthermore; the t-test result summarized in table 4 below also verified that as there exist significant difference between the varieties demonstrated across the districts at ($p<0.05$).

Table 4: Mean yield comparison (t-test) for teff varieties on yield across the districts

Varieties t-test	Mean	Std Error	T	P value
Dursi*Guduru	3.31	1.01	3.42	0.0028
Dursi*Kena	5.10	0.76	6.73	0.0000

Yield advantage

Calculating yield advantage of the varieties helps to show the extra benefit in percentage that the farmers' obtained from producing improved variety. Besides, it helps to recommend based on the relative yield advantage over other varieties. Yield advantage gained for Dursi over Guduru and Kena varieties were 20.59 % and 38.96 %, respectively.

Table 5. Yield advantage of newly released teff varieties over the standard check

Demonstrated Varieties	Yield obtained (qt/ha)	Yield advantage over the standard checks
Dursi	18.39	38.96
Guduru	15.25	20.59
Kena	13.26	-

Technology gap and Technology index

The technology gap and index of demonstrated varieties (Kena, Dursi and Guduru) were calculated and presented in below table.

Table 6: Technology gap and index for teff varieties across the districts

Parameter	Teff varieties		
	Kena	Dursi	Guduru
Technology gap (qt/ha)	4.74	4.46	1.75
Technology index (%)	26.33	19.52	10.29

As described in the above table the yield gap is 4.46 qt/ha, 1.75 qt/ha and 4.74 qt/ha for Dursi, Guduru and Kena varieties, respectively. An average technology gap observed was 3.65 qt/ha This indicated that the lowest gap was observed on the varieties which in turn show the demonstration yield is very close to the potential yield. Moreover, the technology index 19.52 %, 10.29 % and 26.33 % for Dursi, Guduru and Kena varieties; respectively. The average technology index for the varieties is 18.71 % and this dictates that the varieties are feasible to the farmers in the study area and other similar agro-ecologies.

Financial Analysis

In terms of profitability the financial analysis result show that an average return of 11,133.33 Birr, 20,466.67 Birr and 15,133.33 per hectare can be gained from Kena, Dursi and Guduru varieties; respectively per production season in the study areas.

Table 7: Financial analysis for teff across the districts

Location: Jimma Rare				Location:Guduru				Location: Jarte Jardaga			
Parameters	Variety			Parameters	Variety			Parameters			
	Kena	Dursi	Guduru		Kena	Dursi	Guduru		Kena	Dursi	Guduru
Yield qt/ha (Y)	16	21	13	Yield qt/ha (Y)	10	18	20	Yield qt/ha (Y)	14	15	12
Price(P) per quintal	2000	2000	2000	Price(P) per quintal	2000	2000	2000	Price(P) per quintal	2000	2000	2000
Total Revenue (TR) = TR = Y*P	32000	42000	26000	Total Revenue (TR) = TR = Y*P	20000	36000	40000	Total Revenue (TR) = TR=Y*P	28000	30000	24000
Variable costs				**Variable costs**				**Variable costs**			
Seed cost	2550	2550	2550	Seed cost	2550	2550	2550	Seed cost	2550	2550	2550
Fertilizer cost	3150	3150	3150	Fertilizer cost	3150	3150	3150	Fertilizer cost	3150	3150	3150
Labor cost	7000	7000	7000	Labor cost	7000	7000	7000	Labor cost	7000	7000	7000
Total Variable costs (TVC)	12700	12700	12700	Total Variable costs (TVC)	12700	12700	12700	Total Variable Costs (TVC)	12700	12700	12700
Fixed costs				**Fixed costs**				**Fixed costs**			
Cost of land	2000	2000	2000	Cost of land	2500	2500	2500	Cost of land	2000	2000	2000
Total fixed costs (TFC)	2000	2000	2000	Total fixed costs (TFC)	2500	2500	2500	Total fixed costs (TFC)	2000	2000	2000
Total cost (TC) = TVC+TFC	14700	14700	14700	Total cost (TC) = TVC+TFC	15200	15200	15200	Total cost (TC) =TVC+TFC	14700	14700	14700
Gross Margin (GM)=TR-TVC	17300	27300	13300	Gross Margin (GM)=TR-TVC	7300	23300	27300	Gross Margin (GM)=TR-TVC	15300	17300	11300
Profit=GM-TFC	15300	25300	11300	Profit=GM-TFC	4800	20800	24800	Profit=GM-TFC	13300	15300	9300

Training of farmers, Experts and DAs

Below table 7 summarizes stakeholders' participated on the training across the districts.

Table7: Stakeholders training participants across the demonstration districts

Participants	Districts				Total
	Guduru	Jimma Rare	Jarte Jardaga	Gida Ayana	
Experts	6	4	5	-	15
DAs and supervisors	6	8	7	5	26
Farmers	60	50	40	49	199
Total	72	62	52	50	240

Field Visit

Field visit was also arranged across the districts to evaluate/select best performing varieties, to enhance farmers' knowledge on teff production and management and to collect feedback from all relevant stakeholders' to suggest the way forward. On the field visit event organized, a total of 450 participants; 350 farmers, 60 DAs and Supervisors and 40 agricultural experts were participated across the districts.

Farmers' perception on tef technology

The farmers' research groups have appreciated the selected tef technology for the following merits; perceived better yielder than the standard checks, perceived better resistance to disease, perceived better seed size and perceived better Seed color.

Conclusion and recommendation

Generally, through this participatory evaluation and demonstration process, farmers became aware of the importance and quality of technologies as compared to the local one. The demand for the variety was also created. Demonstration result showed that the Dursi variety was recorded high yielder than Guduru and Kena at all location. It was also preferred by participant farmers for its better agronomic performance. Based on these facts, Dursi variety was recommended for further scale up and scale out for demo districts and other similar areas.

References

Bekabil Fufa, Befekadu Behute, Rupert Simons and Tareke Berhe. 2011. Strengthening the Tef Value Chain in Ethiopia.

Central Statistical Agency (CSA). 2012. The Federal Democratic Republic of Ethiopia. Central Statistical Agency Agricultural Sample Survey 2011/2012 (2005 E.C.): Report on Area and Production of Major Crops (Private Peasant Holdings, Meher Season), Volume I. Addis Ababa, Ethiopia.

Central Statistical Agency (CSA). 2016. The Federal Democratic Republic of Ethiopia. Central Statistical Agency Agricultural Sample Survey 2015/2016 (2008 E.C.): Report on Area and Production of Major Crops (Private Peasant Holdings, Meher Season), Volume I. Addis Ababa, Ethiopia.

Demeke M., Di Marcantonio F., 2013. Analysis of incentives and disincentives for teff in Ethiopia. Technical notes series, MAFAP, FAO, Rome.

Dekking, L.S, and Koning, K.F. 2005.The Ethiopian Cereal Tef in Celiac Disease. The New England Journal of Medicine 353; 16

Dhaka B. L., Meena B. S. and Suwalka R. L. 2010. Popularization of Improved Maize Production technology through Frontline Demonstrations in South-Eastern Rajasthan. Journal of AgriSci,1(1):39-42 (2010).

Kenea Yadeta, Getachew Ayele. & Workneh Negatu. 2001. Farming Research on Tef: Small Holders Production Practices. In: Hailu Tefera, Getachew Belay and M. Sorrels (eds.).Narrowing the Rift: Tef Research and Development.Ethiopian Agricultural Research Organization (EARO).Addis Ababa, Ethiopia, pp.9-23.

Ministry of Agriculture and Natural Resource (MoARD). 2017. Variety Registration Book. Addis Ababa, Ethiopia.

Pre-extension Demonstration of improved Soybean technology in selected AGP-II districts of West Shewa and East Wollega zones

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Abstract

*This activity was conducted in Bako Tibe and Wayu Tuka districts of western Oromia with the objective of demonstrating soybean varieties such as Katta and Korme againest Didessa as standard check. These districts were purposively selected based on accessibility and potentiality for Soybean production. These varieties were planted on 20m*10m adjacent plots on 8 farmers' field. All recommended agronomic practices were equally applied to all the plots and the fields were closely supervised and properly managed. At maturity, the varieties were jointly evaluated with a team composed of researchers, Farmers and DAs. Despite the slight variability in criteria set by farmers at the respective locations, the major selection criteria includes disease tolerance, seed color, yield, seed Size, number of seeds per pod, number of pods per plant & early maturity. Accordingly, Katta was found high yielder than others and met the intended criteria of the farmers. Grain yield of 23.75qt/ha, 19.44 qt/ha and 15qt/ha were obtained from Katta, Didessa and Korme; respectively. Besides, Katta showed 22.17 % yield advantage over Didessa. ANOVA and mean yield comparison (t-test) analysis showed significant difference* ($p<0.05$) *among the varieties demonstrated. Profitability analysis showed that using Katta variety can make farmers' more profitable than Korme and Didessa & therefore, the pre-scaling up activity should follow next season.*

Keywords: FREG, participatory evaluation, soy bean, yield advantage

Background and Justification

The origin and early history of soybeans are unknown. It is not uncommon to read in agronomic publications that the earliest recorded origins of soybeans date back to 2800 B.C. in China (Whigham, 1974). Soybean, a short-day plant, is a very important oil and protein crop. It can grow on all types of soil, but deep fertile loam with good drainage is most suitable for growth (Whigham, 1974). The soybean (*Glycine max*) is one of the most important food plants of the world, and seems to be growing in importance. It is an annual crop, fairly easy to grow, that produces more protein and oil per unit of land than almost any other crop. It is a versatile food plant that, used in its various forms, is capable of supplying most nutrients. It can substitute for meat and to some extent for milk. It is a crop capable of reducing protein malnutrition. In addition, soybeans are a source of high value animal feed (Martin, 1998).

Soybean is an alternative protein source to the rural families and can be utilized at home in various forms and the surplus can be sold to other consumers and manufacturers for income (Ambitsi *et.al*., 2007) . Soybean is among the major industrial and food crops grown in every continent (Dugje *et.al*., 2009). Soybean has an average protein content of 40% (Collombet, 2013) and is more protein-rich than any of the common vegetable or animal food sources. Soybean seeds also contain about 20% oil on a dry matter basis, and this is 85% (Dugje *et.al*.,

2009) unsaturated and cholesterol-free (Ambitsi *et.al*., 2007). There is strong demand from the nutritious food industries; factories that supply to the World Food Program alone have a total annual demand of 60,000 tons to cater for soy blends for the food insecure and malnutrition affected areas (CDI, 2012).

Soybean is a multipurpose crop, which can be used for a variety of purposes including preparation of different kinds of soybean foods, animal feed, soy milk, raw material for the processing industry, and it counter effects depletion of plant nutrients in the soil resulting from continuous mono-cropping of cereals, especially maize and sorghum, thereby contributing to increasing soy fertility (Hailegiorgis, 2010). There is also a potential to intercrop soybean with long stem crops such as maize and sugarcane (Jagwe and Owuor, 2004).

Food insecurity and malnutrition are among the urgent challenges that developing countries face this days. The major staple food crop of most developing Sub- Saharan African Countries, maize, contains low protein (5.2-13.7 %) (FAO, 2010). The challenges are especially acute in Ethiopia and relatively more serious in the rural than urban areas, mainly because of a low level of understanding of a balanced diet and lack of capacity to purchase animal source proteins. Producing and consuming more soy would improve the situation as soy provides a nutritious combination of both calorie and protein intake: it is the most nutritionally rich crop, as its dry seed contains the highest protein and oil content among grain legumes (40 to 42% protein) with a good balance of the essential amino acids and has 18-20% oil on a dry seed weight basis. It is cheap and rich source of protein for poor farmers, who have less access to animal source protein, because of their low purchasing capacity (Osho, 1995). Despite the significance of soy bean to address food and nutrition insecurity problems prevailing in the country, little emphasis has been given to production, supply and export of this important commodity.

Access to local markets appears to be the main constraint in many developing countries in the tropics and sub-tropics where local soybean production could improve farmer incomes and the sustainability of the production system. Often soybean is imported into countries by the local vegetable oil and feed industries and as a consequence no demand for the crop is felt in the farming community. Where good market links from processors to local farmers have been made, as in Nigeria and especially in India, the farmers generally respond and the crop finds a good home in diverse cereal and root crop based production systems. Farmer incomes improve and the production systems become more sustainable. The rate of smallholder-based soybean production increase in India is one of the most remarkable stories in recent agricultural history. Many farm communities where the crop has found a niche have had substantive improvements in income and quality of life. Soybean can be a valuable alternative crop for many small-holder producers (Thoenes, 2014).

The total hectare of land under soy bean production between 2001/02 and 2011/12 has increased by 10 folds; while the total volume of soy bean production during the same period has increased by more than 21 folds. The increased hectare of land for the production of soy bean as well as increased total production during the last ten years has been resulted from increasing demand for soy bean at local and international market (CSA 2000-2011). Despite

the tremendous increase in the amount of land allocated for soy bean production during the last ten years, the amount of land allocated for the production of soy bean is very low compared to land allocated for other oil crop commodities (FAO 2010). In line with this; according to CSA, 2016, the area allocated for soy bean production in Ethiopia in general and Oromia region in particular were 38,166.04 ha and 14, 626.75 ha; respectively, with a national average yield of 21.29 qt/ha.

The last ten years trend in the productivity level has grown from 9.2 qt/ha in 2001/02 to 18.5 qt/ha in 2011/12 (CSA, 2012). During this period average productivity level has been doubled. Currently; the average productivity level of soy bean has been increasing both at national and regional levels. Accordingly; according to (CSA, 2016), the average productivity level were 21.29 qt/ha and 21.76 qt/ha; respectively.

The problems of producing soybean is not only limited to market access but also low productivity and production, lack of processing facilities, low use of improved varieties and disease. Therefore, this calls for demonstrating, validating and disseminating of the already released high yielding, disease tolerant and quality soy bean varieties that can make producers competitive in the today's competing markets.

Materials and Methods

Site and FREG selection

This activity was conducted in purposively selected districts Bako Tibe and Wayu Tuka. Selection of the districts were based on potentiality for soy bean production, accessibility for supervision and compatibility with the AGP II criteria. One potential PA from each district were selected. In each PA, 1 FREG unit comprising of 15 farmers were established. In each FREG unit 4 experimental farmers were selected with the rest being participant farmers. Development Agents and district experts were collaborating in site and farmer selection. The FREG member farmers were selected based on willingness to be held as member, accessibility for supervision of activities, good history of compatibility with group dynamics and willingness to share innovations to other farmers. After the establishment of the FREGs, a theoretical training session was arranged to farmers, DAs and district experts

Activity design and field management

Three soybean varieties; Katta and Korme as recently released varieties against Didessa as a standard check, were planted on adjacent plots of 10m*20m each. All the necessary recommended agronomic practices; spacing of 40cm and 5 cm between rows and plants; respectively was used for the demonstration. Besides; the recommended 60 kg/ha seed and 100kg/ha of NPS fertilizer rate were used. Every plot were supervised and managed jointly by researchers, extension workers and hosting farmers to check the status and to identify gaps. All other recommended agronomic practices were maintained equally for all plots. At maturity stage, participatory variety evaluation platform was arranged that attended by the experimenting farmers, neighboring farmers, researchers from BARC and other stakeholders.

Data Collection & Analysis

Both quantitative and qualitative data were collected. The collected data were: agronomic data (yield data), total number of farmers and other stakeholders' participated in field visits and field days, total number of farmers and other stakeholders' participated in training and farmers' perception on the attribute of the technology.

The collected qualitative data was analyzed and described using descriptive statistics such as mean, frequencies, tables and percentages. Also quantitative data collected were subjected to SPSS software to analyse mean, standard deviation, t-test and ANOVA table. Besides; ranking scale was used to evaluate and select best bet variety/ies and to rank their criteria according to real situation of the area. According to Sumai *et al*. (2000) technology gap and technology index were calculated using the following formula.

$$\text{Technology gap} = \text{Potential yield qt/ha} - \text{demonstration yield}$$

$$\text{Technology index} = \frac{\text{Potential yield- demonstration yield}}{\text{Potential yield}} * 100$$

Yield advantage was also calculated as:

$$\text{Yield advantage \%} = \frac{\text{Yield of new variety - Yield of standard check}}{\text{Yield of standard check}} X\ 100$$

Result and Discussion

Participatory Variety Evaluation and Selection

At maturity, the varieties were then be evaluated based on the farmers' selection criteria. Each variety was then be evaluated against the criteria ordered based on the weight attached to each parameter. FREG farmers scored each variety for individual traits considered important by them and ranking of varieties were done on a scale of 1-5, 1 being very poor and 5 being the highest score representing superiority.

BIn both districts, Katta was selected first by all its traits including yield except its late maturing, Didessa was second and then finally Korme (Table 1). This underlines the importance of testing of improved varieties in farmer's fields across districts.

Table 1: Total and mean score ranks for Soy bean technologies in the study areas

Variety	Bako Tibe			Wayu Tuqa			Overall Rank
	Total Score	Mean Score	Rank	Total Score	Mean Score	Rank	
Katta	29	4.83	1st	26	4.33	1st	1st
Korme	19	3.17	3rd	23	3.83	3rd	3rd
Didessa	24	4	2nd	25	4.17	2nd	2nd

NB: 1-6 Parameter set;1= Disease Tolerant, 2=early maturity, 3= Number of seed per pod, 4=Number of pod per plant, 5=Good stand, 6= Grain Size

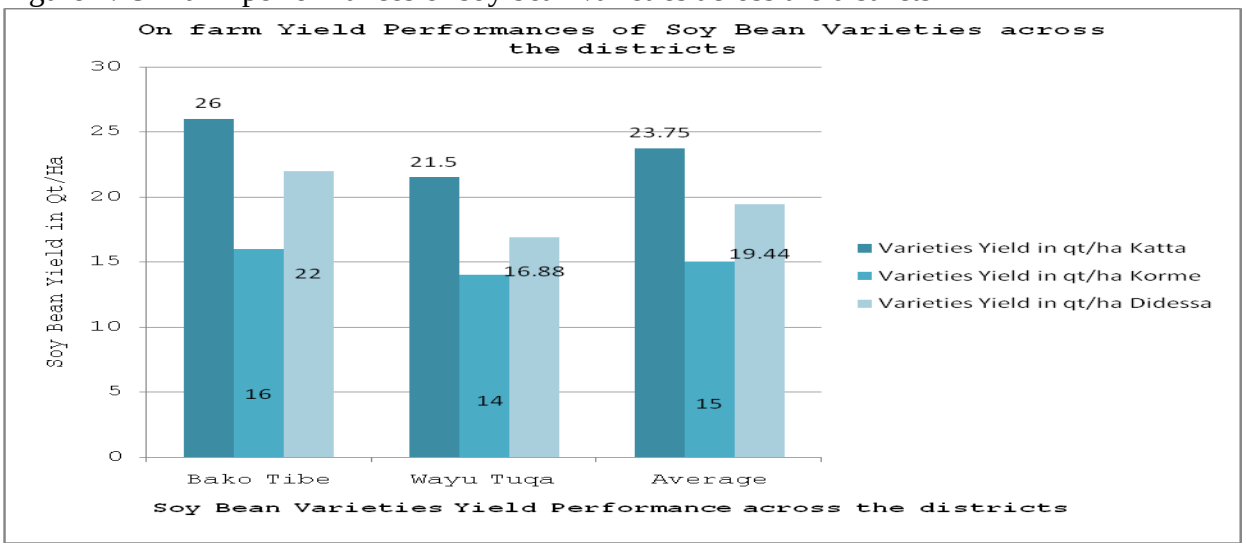
On-farm yield performance

The combined analysis for grain yield performances of the varieties demonstrated is summarized in table 2. To this end, mean yield of 23.75 ± 1.19 qt/ha, 15 ± 0.77 qt/ha and 19.44 ± 1.38 qt/ha were recorded for Katta, Korme and Didessa varieties, respectively.

Table 2: Mean yield of soy bean varieties across the districts

Variety	N	Mean	SD	Min	Max
Katta	6	23.75 ± 1.19	2.91	21.27	21.27
Korme	6	15 ± 0.77	1.88	12.71	12.71
Didessa	6	19.44 ± 1.38	3.39	15.49	15.49

Figure 1: On farm performances of soy bean varieties across the districts



Moreover, ANOVA showed significant difference at ($p<0.05$) between the varieties (Table 3). Furthermore; mean yield comparison (t-test) results indicated significant difference between the varieties demonstrated across the districts at ($p<0.05$) (Table 4).

Table 3: Analysis of Variance table for yield

Source	DF	SS	MS	F	P
Farmer	2	15.92	7.96	4.63	0.0323
District	1	81.24	81.24	47.27	0.0000
Variety	2	212.31	106.15	61.77	0.0000
Error	12	20.62	1.72		
Total	17	330.08			
Grand Mean		19.71			
CV		6.65			

Table 4: Mean yield comparison (t-test) for soy bean varieties across the districts

Varieties Mean yield comparison (t-test)	Mean	Std Error	T	P value
Katta *Didessa	4.54	0.43	10.47	0.0001
Korme* Didessa	3.86	0.89	4.35	0.0074

Yield advantage

Calculating yield advantage of the varieties helps to show the extra benefit in percentage that the farmers' obtained from producing improved variety. Besides, it helps to recommend based on the relative yield advantage over other varieties. Yield advantage gained for Katta and Korme over Didessa varieties were 22.17 % and -22.84 %; respectively. Accordingly; Katta variety had higher yield advantage than Didessa variety.

Table 5. Yield advantage of newly released soy bean varieties over the standard check

Demonstrated Varieties	Yield obtained (qt/ha)	Yield advantage over the standard check (Didessa)
Katta	23.75	22.17
Korme	15	-22.84
Didessa	19.44	

Technology gap and Technology index

Technology gap indicates that the gap in the demonstration yield over potential yield. The observed technology gap is attributed to dissimilarities in fertility, acidity, rainfall and other natural calamities (Dhaka *et.al*., 2010). According to Dhaka *et.al*., 2010 its contribution is to narrow down the gap between the yields of different varieties and to provide location specific recommendations. The yield gaps can be further categorized into technology index which is used to show the feasibility of the variety at the farmer's field. The lower the values of technology index the more the feasibility of the varieties.

Table 6: Technology gap and index for soy bean varieties across the districts

Parameter	Soy bean Varieties		
	Katta	Didessa	Korme
Technology gap (qt/ha)	-3.25	1.56	7
Technology index (%)	-15.85	7.43	31.82

The yield gap is -3.25 qt/ha, 1.56 and 7 qt/ha for Katta, Didessa and Korme varieties; respectively. This indicates that the lowest gap was observed on Katta and Didessa varieties which in turn show the demonstration yield is very close to the potential yield but in case of Korme variety there is higher reduction in yield from the potential inherited. Further; in terms of technology index -15.85 %, 7.43 % and 31.82 % for Katta, Didessa and Korme varieties; respectively. That means Katta and Didessa varieties have an average technology index of 4.21 % and this showed that the varieties are feasible to the farmers in the study area and other similar agro-ecologies.

Financial Analysis

In terms of profitability the financial analysis result show that an average return of 19,250 Birr, 15614 Birr and 9350 Birr per hectare can be gained from Katta, Didessa and Korme varieties; respectively per production season in the areas where the activity carried out.

Table7: Financial analysis for soy bean across the districts

Location: Bako Tibe				Location: Wayu Tuqa			
	Variety				Variety		
Parameters	Katta	Didessa	Korme	Parameters	Katta	Didessa	Korme
Yield qt/ha(Y)	26	22	16	Yield qt/ha(Y)	21.5	19.44	15
Price(P) per quintal	1200	1200	1200	Price(P) per quintal	1200	1200	1200
Total Revenue (TR)=TR=Y*P	31200	26400	19200	Total Revenue (TR)=TR=Y*P	25800	23328	18000
Variable costs				**Variable costs**			
Seed cost	1600	1600	1600	Seed cost	1400	1400	1400
Fertilizer cost	750	750	750	Fertilizer cost	750	750	750
Labor cost	4800	4800	4800	Labor cost	4800	4800	4800
Total Variable costs (TVC)	7150	7150	7150	Total Variable costs (TVC)	6950	6950	6950
Fixed costs				**Fixed costs**			
Cost of land	2000	2000	2000	Cost of land	2400	2400	2400
Total fixed costs (TFC)	2000	2000	2000	Total fixed costs (TFC)	2400	2400	2400
Total cost (TC)=TVC+TFC	9150	9150	9150	Total cost (TC)=TVC+TFC	9350	9350	9350
Gross Margin (GM)=TR-TVC	24050	19250	12050	Gross Margin (GM)=TR-TVC	18850	16378	11050
Profit=GM-TFC	22050	17250	10050	Profit=GM-TFC	16450	13978	8650

Training of stakeholders

Below table 8 summarizes stakeholder participants participated on training across districts.

Training Topic	Participants	Districts		Total
		Bako Tibe	Wayu Tuqa	
Soy bean production and Management	Experts	4	4	8
	DAs and supervisors	4	4	8
	Farmers	58	62	120
	Total	66	70	136

Field Visit

Field visit was also arranged across the districts so as to evaluate/select best performing varieties, to enhance farmers' knowledge on soy bean production and management and to collect feedback from all relevant stakeholders' for the way forward. On the field visit event organized, 110 participants; 96 farmers, 8 DAs and Supervisors and 6 experts were participated across the districts.

Farmers' perception to Soy bean technology

The farmers research groups have appreciated the demonstrated soy bean technology for the following merits: better yielder than the check, better resistance to disease, better number of pods per plant, better seed size and seed color.

Conclusion and Recommendation

Generally, the on-farm evaluation and demonstration result showed that kata variety was preferred by participant farmers for its better agronomic performance & thus further scaled-up. Many farmers were aware of the importance and quality of technologies as compared to the one under production.

References

Ambitsi, E. N.. Onyango and P. Oucho. "Assessment of Adoption of Soya Bean Processing and Utilization Technologies in Navakholo and Mumias Divisions of Western Kenya", Kenya Agricultural Research Institute, pp. 1434-1438.

Centre for Development Innovation (CDI). 2012. "Policy Brief Developing new value-chains for soybean in Ethiopia", Wageningen UR, Netherlands,pp. 1-10

Central Statistical Agency (CSA).2016. The Federal Democratic Republic of Ethiopia. Central Statistical Agency Agricultural Sample Survey 2015/2016 (2008 E.C.): Report on Area and Production of Major Crops (Private Peasant Holdings, Meher Season), Volume I. Addis Ababa, Ethiopia.

Collombet, R. N. 2013."Investigating soybean market situation in Western Kenya: constraints and opportunities for smallholder producers", Wageningen University, pp. 1-43.

Dhaka B. L., Meena B. S. and Suwalka R. L. 2010. Popularization of Improved Maize Production technology through Frontline Demonstrations in South-Eastern Rajasthan. Journal of AgriSci,1(1):39-42 (2010).

Dugje ,I. Y., Omoigui L. O. , F. Ekeleme, R. Bandyopadhyay, P. L. Kumar and A. Y. Kamara.2009. "Farmers' Guide to Soybean Production in Northern Nigeria", International Institute of Tropical Agriculture, Ibadan, Nigeria, pp. 1-16.

FAO. 2010. Food outlook. Oil Seeds Business Opportunities Ethiopia, 2009; J.H.M. Wijnands, J. Biersteker, E.N. van Loo.

Martin F. W. 1998."Soybean, Why Grow Soybeans", ECHO, 17391 Durrance Rd, North Ft. Myers FL 33917, USA,pp.1-5.

Hailegiorgis, B. (2010) Export performance of oilseeds and its determinants in Ethiopia. Haramaya University, College of Agriculture and Environmental Science, Department of Agricultural Economics.

Jagwe, J., Owuor, G. 2004. Evaluating the marketing opportunities for soybean and its products in the East African countries of ASARECA: Kenya Report. International institute of Tropical Agriculture- FOODNET.

Osho, S.M. 1995. Soybean processing and utilization research at International Institute of Tropical Agriculture. Processing from SOYAFRICA'95: Johannesburg, South Africa, 4-5 October 1995.

Samui S. K., Maitra S, Roy DK, Mondal AK and Saha D. 2000. Evaluation of front line demonstration of groundnut (*Arachis hypogeal L.)* in Sundarbans. J Indian SocCoastalAgric Res, 18(2): 180-183.

Thoenes, P. 2014. "Soybean International Commodity Profile, Markets and Trade Division Food and Agriculture Organization of the United Nations", pp. 1-25.

Whigham, D. K.1974. "Soybean Production, Protection, and Utilization", Proceedings of a Conf. for Scientists of Africa, The Middle East, and South Asia, University of Illinois International Soybean Program Urbana, Illinois 61801,pp.1-266.

Pre-extension Demonstration of improved Food Barely technology in selected AGP-II districts of Horro and East Wollega Zones

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Abstract

*This activity was conducted in Jarte Jardaga, Jimma Rare, Guduru and Gida Ayana districts of western Oromia with the objective of demonstrating food barley variety, HB-1307 to the farming community. These districts were purposively selected based on potentiality for food barley production; and one potential PA from each district were selected. After establishing and training one FREG unit in each PA, two varieties of food barley, commercial check and HB-1307 were planted on 20m*10m adjacent plots on 16 farmers' fields. All recommended agronomic practices were equally applied to all the plots and the fields were closely supervised and managed well. At maturity, the varieties were jointly evaluated with a team composed of researchers, Farmers and DAs. Disease tolerance, seed color, plant Height, yield, pest resistance, tillering capacity seed Size, lodging resistant, early maturity, spike length, thrash ability were the common farmers selection criteria across all locations. In almost the entire criterion HB-1307 exceed the local check and has met their criteria. With regard to yield, 43.44 qt/ha and 24.86 qt/ha were obtained from HB-1307 and commercial check, respectively. Therefore, HB-1307 variety has met the intended criteria of the farmers, & thus recommended for pre-scaling.*

Keywords: Food barley, FREG, selection index

Introduction

Barley is a cool-season crop that is adapted to high altitudes. It is grown in a wide range of agro-climatic regions under several production systems. At altitudes of about 3000 m.a.s.l or above, it may be the only crop grown that provides food, beverages and other necessities to many millions of people. Barley grows best on well-drained soils and can tolerate higher levels of soil salinity than most other crops. Food barley is commonly cultivated in stressed areas where soil erosion, occasional drought or frost limits the ability to grow other crops (Berhanu et al., 2005). Malting barley, however, requires a favourable environment to produce a plump and mealy grain. The diversity of barley ecologies is high, with a large number of folk varieties and traditional practices existing in Ethiopia, which enables the crop to be more adaptable in the highlands (Fekadu Alemayehu, Berhane Lakew and Berhanu Bekeleet at., 2002). Barley is the fourth most important crop in the world after maize, rice and wheat used mainly as feed for poultry, swine and cattle, and for preparing beverages. In Ethiopia, it is one of the top five cultivated cereal crops after tef, maize, wheat and sorghum with main use as food, local beverages and beer. From 9,974,316.28 hectares of land allocated for cereals in 2015/16 production season, barley (food and malt) covered 944,401.34 ha of

land from which 18,567,042.76 quintals of grain was produced with the productivity of 19.66 qt/ha (CSA, 2016).

Area coverage; which is 90,316.67 hectare in Horro-Guduru Wollega for barely productivity in Ethiopia (1.965 ton/ha) is low compared to world average of 3.095 ton/ha (barley commodity strategic plan document, 2016). Despite its enormous economic and nutritive importance its productivity is very low as compared to other cereals (1.2 ton/ha). There are a lot of factors that contributed to the lower productivity of the crop. Among which limited improved varieties, inappropriate agronomic and low crop management practices, low soil fertility, water logging, leaf and grain diseases, pests, weed competition are the major ones.

To tackle productivity problem the national and regional research systems in the country have been conducting a series of research activities on improvement of the crop and have been releasing many varieties. Among them HB-1307 has better productivity and disease resistance compared to local and other released commercial varieties. Despite the availability of this variety many farmers in the region haven't yet got access and still are using local varieties characterized by very low productivity and susceptibility to diseases. This project, therefore, is initiated with the objectives of demonstrating, evaluating and validating the variety so as familiarize the farming communities with the best variety that in turn will facilitate the adoption process and bridge the productivity gap.

Materials and method

Site and Farmers Selection

Four districts; Jarte Jardaga, Guduru, Jimma Rare and Gida Ayana, were selected based on AGP-II criteria, potentiality and accessibility for supervision. One representative kebele from the each district was selected based on the aforementioned criteria. In each kebele one FREG members comprising of 15 farmers was established and managed. Gender and youth balance in each FREG member was strictly considered. A total of 16 hosting farmers were participated.

Provision of training & Input

After establishing farmers research group (FREG) theoretical and practical training were given to farmers, Development agent and district experts. Training provided on the following areas: food barely technology transfer approaches, food barley production management, breeding aspect, post harvesting (seed quality. All necessary input (seed, fertilizers) was delivered to the farmers

Field design and management

One improved Food barely variety (HB-1307) was planted along with commercial check on adjacent plots of $200m^2$. The Plots were managed jointly by the researcher, extension workers and hosting farmers. Spacing of 20cm between rows was used. The recommended 125 kg/ha seed. 100 kg/ha NPS and 100 kg/ha UREA fertilizer rate were used. All other recommended agronomic practices were maintained equally for all plots.

Data Collected
Both quantitative and qualitative data were collected. The collected data were: agronomic data (yield data), total number of farmers and other stakeholders' participated in field visits and field days, total number of farmers and other stakeholders' participated in training and farmers' perception on the attribute of technology, costs and income gained.

Data Analysis
The collected qualitative data was analyzed and described using descriptive statistics such as mean, frequencies, tables and percentages. Also quantitative data collected were subjected to SPSS software to analyse mean, standard deviation, t-test and ANOVA table. Besides; ranking scale was used to evaluate and select best bet variety/ies and to rank their criteria according to real situation of the area. According to (Sumai *et al*., 2000) technology gap and technology could be calculated were calculated using the following formula.

$$\text{Technology gap} = \text{Potential yield qt/ha} - \text{demonstration yield}$$

$$\text{Technology index} = \frac{\text{Potential yield- demonstration yield}}{\text{Potential yield}} * 100$$

Results and Discussion

Participatory Variety Evaluation and Selection
At maturity, the varieties were then be evaluated based on the farmers' selection criteria. To this end; FREG farmers scored each variety for individual traits considered important by them and ranking of varieties were done on a scale of 1-5, 1being very poor and 5 being the highest score representing superiority.

Yield, disease tolerant, lodging tolerant, thillering capacity, spike length, number of seeds per spike, early maturing, seed color and other traits were considered as the most evaluation and selection criteria for each barley variety. Based on overall mean score, HB-1307 was selected first and then by commercial check (table 1) & thus will be proposed for further scaling up.

Table 1 : Score ranking for Food Barley variety by FREG farmers for the districts

Variety	Jimma Geneti			Jimma Rare			Overall Rank
	Total Score	Mean Score	Rank	Total Score	Mean Score	Rank	
Check	13	1.3	2nd	11	1.1	2nd	2nd
HB-1307	33	3.3	1st	32	3.2	1st	1st

NB: 1-9 farmers' selection criteria set;1= Lodging tolerant, 2=early maturity, 3= Spike length, 4= No. of seed/spike 5= Disease (Rust) tolerant, 6= seed color, 7=seed size, 8=Thillering capacity and 9=high yielder

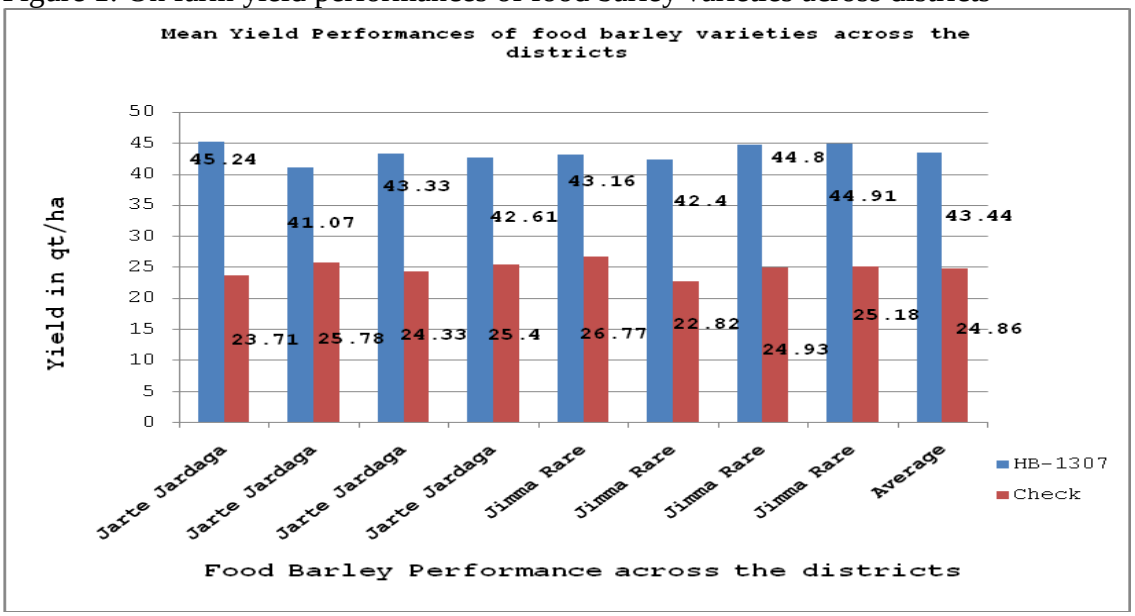
On-farm yield performance
Mean yield of 43.44 ± 0.51 qt/ha and 24.86 ± 0.44 qt/ha for HB-1307 and Commercial check varieties; respectively was gained.

Table 2: Mean yield of food barley varieties across the districts

Variety	N	Mean	SD	Min	Max
HB-1307	8	43.44 ± 0.51	1.45	41.07	45.24
Check	8	24.86 ± 0.44	1.23	22.82	26.77

Figure 1 summarized on farm mean yield performances of food barley varieties across districts.

Figure 1: On farm yield performances of food barley varieties across districts



Moreover, ANOVA significant difference at ($p<0.05$) between the varieties. This means that there is highly significant difference between the food barley varieties HB-1307 and Check.

Table 3: Analysis of Variance Table for Yield

Source	**DF**	**SS**	**MS**	**F**	**P**
Farmer	3	7.15	2.38	1.36	0.3094
District	1	0.77	0.77	0.44	0.523
Variety	1	1380.12	1380.12	789.87	0.0004
Error	10	17.47	1.75		
Total	15	1405.51			
Grand Mean		34.15			
CV		3.87			

Yield advantage

Yield advantage gained for HB-1307 over check was 74.74 %. Accordingly, HB-1307 variety had higher yield advantage than the commercial check (Table 5).

Table 5. Yield advantage of HB-1307 food barley variety over the check

Demonstrated Varieties	Yield obtained (qt/ha)	Yield advantage over the check
HB-1307	43.44	74.74
Check	24.86	

Technology gap and Technology index

Technology gap indicates that the gap in the demonstration yield over potential yield. The observed technology gap is attributed to dissimilarities in fertility, acidity, rainfall and other natural calamities (Dhaka *et al*., 2010). The yield gaps can be further categorized into technology index which is used to show the feasibility of the variety at the farmer's field. The lower the values of technology index the more the feasibility of the varieties. To this end, the technology gap and index of demonstrated variety (HB-1307).

Table 6: Technology gap and index for HB-1307 variety across the districts

Parameter	**Food barley Variety (HB-1307)**
	HB-1307
Technology gap (qt/ha)	4.56
Technology index (%)	9.50

The yield gap is 4.56 qt/ha for HB-1307 variety. This indicated that the lowest gap was observed on the variety that in turn shows the demonstration yield is very close to the potential yield. Further, the technology index for HB-1307 variety was 9.50 % and this dictates that the variety is feasible to the farmers in the study area and other similar agro-ecologies.

Financial Analysis

Profitability analysis result showed that an average return of 40,987 Birr and 19,582 Birr per hectare can be gained from HB-1307 and check; respectively per production season in the areas where the activity was carried out.

Table7: Financial analysis for food barley

Location: Jimma Rare			Location: Jarte Jardaga		
Parameters	Variety		Parameters	Variety	
	HB-1307	Check		HB-1307	Check
Yield qt/ha(Y)	43.82	24.80	Yield qt/ha(Y)	43.06	24.92
Price(P) per quintal	1200	1200	Price(P) per quintal	1200	1200
Total Revenue (TR)=TR=Y*P	52,584	29,760	Total Revenue (TR)=TR=Y*P	51,672	29,904
Variable costs			Variable costs		
Seed cost	2500	1600	Seed cost	2500	1600
Fertilizer cost	3150	3150	Fertilizer cost	3150	3150
Labor cost	3500	3500	Labor cost	3500	3500
Total Variable costs (TVC)	9150	8250	Total Variable costs (TVC)	9150	8250
Fixed costs			Fixed costs		
Cost of land	2000	2000	Cost of land	2000	2000
Total fixed costs (TFC)	2000	2000	Total fixed costs (TFC)	2000	2000
Total cost (TC)=TVC+TFC	11,150	10,250	Total cost (TC)=TVC+TFC	11,150	10,250
Gross Margin (GM)=TR - TVC	43,434	21,510	Gross Margin (GM)=TR-TVC	42,522	21,654
Profit=GM-TFC	41,434	19510	Profit=GM-TFC	40,522	19,654

Training of farmers, Experts and DAs

Table 8 showed the stakeholders participants participated on training across the districts.

Table 8: Stakeholders training participants across the demonstration districts

Training Topic	Participants	Districts				Total
		Guduru	Jimma Rare	Gida Ayana	Jarte Jardaga	
Food Barley production and Management	Experts	6	4	5	5	20
	DAs and supervisors	6	8	9	7	30
	Farmers	80	70	50	60	260
	Total	92	82	64	72	310

Field Visit

Field visit was also arranged across the districts to evaluate/select best performing varieties, to enhance farmers' knowledge on food barley production and management and to collect feedback from all relevant stakeholders' for further way forward. On the field visit event organized, 126 participants (93 farmers, 12 DAs and Supervisors and 9 experts) were participated across the districts.

Conclusion and recommendation

Generally, through this participatory evaluation and demonstration process, many farmers became aware of the importance and quality of food barely technologies as compared to the local one. Demand for the variety/ies was also created. Moreover; demonstration result showed that HB-1307 variety was recorded high yielder than the local at all location. It also was preferred by participant farmers for its better agronomic performance. Based on these facts actually, food barely variety HB-1307 was recommended for further scale up and scale out for demonstration districts and other similar areas.

References

Barley commodity strategic plan document, 2016. National Barley Research and Technology Promotion Team. Addis Ababa, Ethiopia.

Berhanu Bekele, Fekadu Alemayehu & Berhane Lakew. 2005. Food barley in Ethiopia. pp 53–82, *in*: S. Grando and H. Gomez Macpherson (eds.). *Food Barley: Importance,Use and Local Knowledge*. Proceedings of the International Workshop on Food Barley Improvement, 14–17 January 2002, Hammamet, Tunisia. ICARDA, Aleppo, Syria.

Central Statistical Agency (CSA). 2016. The Federal Democratic Republic of Ethiopia. Central Statistical Agency Agricultural Sample Survey 2015/2016 (2008 E.C.): Report on Area and Production of Major Crops (Private Peasant Holdings, Meher Season), Volume I. Addis Ababa, Ethiopia.

Dhaka B. L., Meena B. S. and Suwalka R. L. 2010. Popularization of Improved Maize Production technology through Frontline Demonstrations in South-Eastern Rajasthan. Journal of AgriSci,1(1):39-42 (2010).

Samui S. K., Maitra S, Roy DK, Mondal AK and Saha D. 2000. Evaluation of front line demonstration of groundnut (*Arachis hypogeal L.)* in Sundarbans. J Indian SocCoastalAgric Res, 18(2): 180-183.

Pre-extension demonstration of improved Sesame technology in selected AGP-II districts of East Wollega zones

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Abstract

*This activity was conducted in Diga and Guto Gida districts of Western Oromia with the objective of demonstrating the newly released sesame variety, Walin to the farming community in these districts. One potential PA was selected from each district on the basis of accessibility and potentiality. After establishing and training one FREG unit in each PA, three varieties of sesame, Obsa and Chalesa (as standard check); and Walin (as a new variety) were planted on 20m*10m adjacent plots on 8 farmers fields. At maturity, the varieties were jointly evaluated with a team composed of researchers, Farmers and DAs. In almost all of the selection criteria, Walin was better than the other varieties (Chalasa and Obsa). With regard to yield, 8.45qt/ha, 6.35qt/ha and.4.86 qt/ha were obtained from Walin, Obsa, and Chalasa, respectively. Besides, Walin has 33.07% and 73.87% yield advantage over Obsa and Chalasa; respectively. Furthermore; ANOVA table and mean yield comparison (t-test) analysis showed significant difference at* ($p<0.05$) *among the varieties demonstrate. In terms of profitability, financial analysis result of the study also showed that using Walin variety can make farmers' more profitable than Obsa and Chalasa.*

Keywords: FREG unit, Sesame, Yield Advantage

Introduction

Sesame is indigenous to countries on the Eastern shores of the Mediterranean, but widely cultivated in India, Egypt, Ethiopia, Morocco and occasionally in England (Polhil and Raven, 1981; Davoud *et al*., 2010). The world of sesame seed market is a billion dollar industry that supports the livelihoods of millions of farmers throughout the world (USAID, 2010). Currently, Ethiopia is among the top five producers of sesame seed in the world, ranked at fourth place by covering about 8.18 percent of the total world production (FAOSTAT, 2012). Next to coffee, sesame seed is the second largest agricultural export earner for Ethiopia, involving a number of small-holder farmers in its production throughout the nation (CSA, 2011). It served as a source of income at household level and a contributor for the country's foreign currency earnings, among others (CSA, 2016). In 2010/2011 production year, about 763, 893 smallholder farmers participate in sesame production; while in year 2011/2012 the number of participants has increased to about 893, 883 private peasants (CSA, 2011). This indicates as sesame sector has potential to involve more smallholders under its production, hence one way of linking them to domestic and international markets.

Sesame production ranks the first among oilseed crops (Noug, Groundnuts, Linseed, Rape seed and Sunflower) in area and volume of production in the country. From 859,110.39 hectares of land allocated for oilseed crops in 2015/2016 production season, Sesame covered 388,245.5 hectares of land from which 2,742,174.27 quintals of grain was produced with the productivity of 7.06 qt/ ha (CSA, 2016).

Tigray, Oromia, Amhara and Benshangul Gumuz National Regional States are the major producers in Ethiopia. Area coverage in East Wollega is 13, 345.91 ha. More specifically, the high oil content of the Wollega sesame gives it a major competitive advantage for edible oil production (USAID, 2010). According to different reports, sesame seed is an important export crop in Ethiopia, and the country has a substantial role in the global sesame trade. It is the third world exporter of the commodity after India and Sudan (Alemu and Meijerink, 2010). According to Aysheshm (2007), only about 5% is believed to be consumed locally. In this regard, in the last few years, sesame production and marketing has confirmed highly significant growth.

Sesame in Ethiopia is grown mainly for the export market (Aysheshm, 2007; Alemu and Meijerink, 2010). However, productivity per unit area is very low that hindering the farmers to exploit the advantage. Consequently, developing high yielding, disease tolerant and stable varieties are very important. To this end, BARC has recently released new variety; Walin with potential yield of 10-13.8 qt/ha and 9.5-11 qt/ha on research and on farm fields; respectively, to revert the scenario and alleviate the problem of low productivity. This calls for demonstrating, validating and disseminating of the already released high yielding, disease tolerant and quality sesame varieties that can make producers competitive in the today's competing markets.

Materials and methods

Site and FREG selection

This activity was conducted in purposively selected districts of Gida Ayana and Guto Gida East Wollega Zone. Selection of the districts was based on potentiality for sesame production, accessibility for supervision and compatibility with the AGP- II criteria. One potential PA from each district was selected based on accessibility and potentiality for sesame production. In each PA, 1 FREG unit comprising of 15 farmers were established. In each FREG unit 4 experimental farmers were selected with the rest being participant farmers. Development Agents and district experts were collaborating in site and farmer selection. The FREG member farmers were selected based on willingness to be considered as member, accessibility for supervision of activities, good history of compatibility with group dynamics and willingness to share innovations to other farmers.

Training of farmers, experts and DAs

After the establishment of the FREGs, a theoretical training session was arranged to farmers, DAs and district experts. Training was offered Multi disciplinary team of researchers drawn from BARC trained the farmers, DAs and experts. Training focus on issues like economic and nutritive importance of sesame, suitable ecologies and weather condition for its production, agronomic practices and post harvest managements. The aim of the training was to create awareness of farmers', Development agents and district experts on sesame technology production and management.

Activity design and field management

Three Sesame varieties; Walin as newtly released variety against Chalasa and Obsa as a standard check were planted on adjacent plots of 10m*20m each. All the necessary

recommended agronomic practices were equally applied for all of the plots and every field was supervised to check the status and to identify gaps.

Data Collected

Both quantitative and qualitative data were collected. The collected data were: agronomic data (yield data), total number of farmers and other stakeholders' participated in training and field visits and farmers' perception on the attribute of technology, costs and income gained.

Data Analysis

The collected qualitative data was analyzed and described using descriptive statistics such as mean, frequencies, tables and percentages. Also quantitative data collected were subjected to SPSS software to analyse mean, standard deviation, t-test and ANOVA table. Besides; ranking scale was used to evaluate and select best bet variety/ies and to rank their criteria according to real situation of the area. According to (Sumai *et.al*., 2000) technology gap and technology could be calculated were calculated using the following formula.

$$\text{Technology gap} = \text{Potential yield qt/ha} - \text{demonstration yield}$$

$$\text{Technology index} = \frac{\text{Potential yield- demonstration yield}}{\text{Potential yield}} * 100$$

Result and Discussion

Participatory Variety Evaluation and Selection

At maturity, the varieties were then be evaluated based on the farmers' selection criteria. To this end; FREG farmers scored each variety for individual traits considered important by them and ranking of varieties were done on a scale of 1-5, 1being very poor and 5 being the highest score representing superiority.

Yield, disease tolerant, number of capsule per plant, early maturing, number of branches per plant, seed color and other traits were considered as the most evaluation and selection criteria for each sesame variety. Therefore; across the districts Walin was selected first, Obsa second and then by Chalasa (as described in below table 1). This underlines the importance of testing of improved varieties in farmer's fields across districts. The overall mean score and rank for all the districts is summarized as below in table 1. Based on this the variety/ies selected, accordingly, will be proposed for further scaling up.

Table 1: Score ranking for Sesame by FREG farmers across the districts

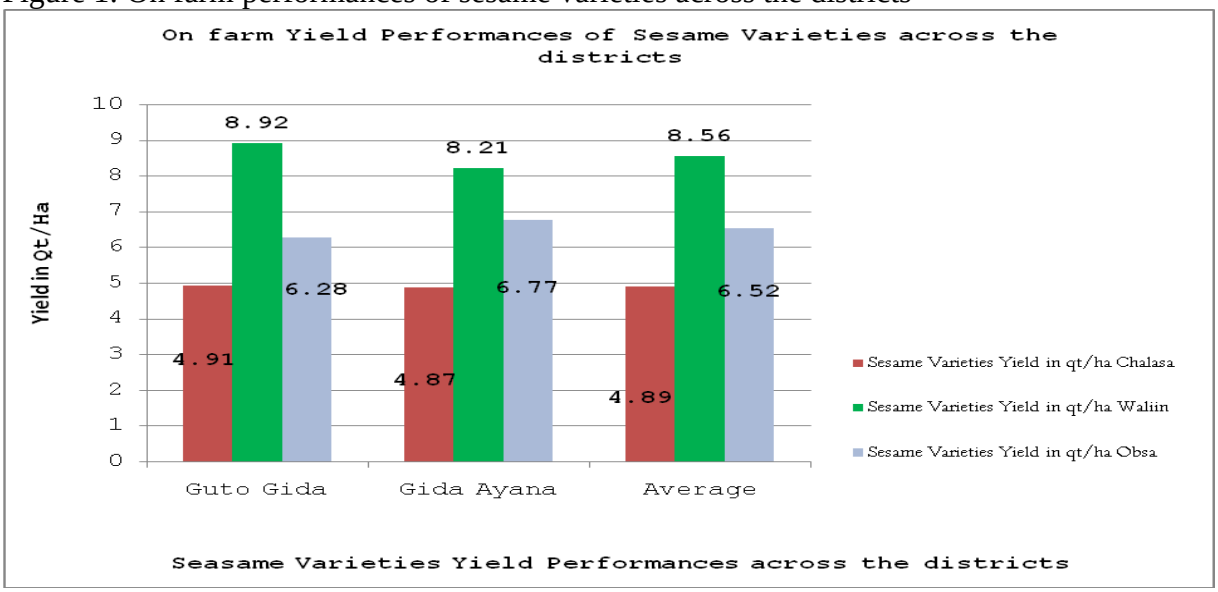
Variety	Guto Gida			Gida Ayana			Overall Rank
	Total Score	Mean Score	Rank	Total Score	Mean Score	Rank	
Obsa	22	3.67	2nd	22	3.67	2nd	2nd
Walin	29	4.83	1st	29	4.83	1st	1st
Chalasa	22	3.67	2nd	21	3.5	3rd	3rd

NB: 1-6 farmers' selection criteria set;1= Disease tolerant, 2=early maturity, 3= Number of capsules per branch, 4= Number of branches per plant 5= seed color, 6= Higher yielder

On-farm Yield performance

Grain yield of 8.45 qt/ha for Walin, 6.35qt/ha for Obsa and 4.86 qt/ha for Chalasa, respectively was obtained.

Figure 1: On farm performances of sesame varieties across the districts



Besides; mean yield of 8.46 ± 0.17 qt/ha, 6.35 ± 0.30 qt/ha and 4.86 ± 0.17 qt/ha for Walin, Obsa and Chalasa varieties; respectively was gained (Table 2)

Table 2: Mean yield of sesame varieties across the districts

Variety	N	Mean	SD	Min	Max
Chalasa	6	4.86 ± 0.17	0.42	4.21	5.36
Walin	6	8.46 ± 0.20	0.50	8.03	9.32
Obsa	6	6.35 ± 0.30	0.73	5.42	7.38

Moreover, ANOVA table result summarized in below table 3 shows that as there is highly significant difference at ($p<0.05$) between the varieties and among farmers. This means that there is highly significant difference among sesame varieties; Walin, Obsa and Chalasa and among the farmers at ($p<0.05$).

Table 3: Analysis of Variance table for yield

Source	DF	SS	MS	F	P
Farmer	2	1.52	0.76	2.95	0.0908
District	1	0.18	0.18	0.7	0.4197
Variety	2	39.38	19.69	76.37	0.0000
Error	12	3.09	0.26		
Total	17	44.17			
Grand Mean		6.56			
CV		7.74			

Furthermore; mean yield comparison (t-test) results summarized in table 4 below also verifies that as there exist highly significant difference between the varieties demonstrated across the districts at ($p<0.05$).

Table 4: Mean yield comparison (t-test) for sesame varieties across the districts

Varieties Mean yield comparison (t-test)	Mean	Std Error	T	P value
Walin*Obsa	2.11	0.41	5.14	0.0036
Walin*Chalasa	3.60	0.26	14.03	0.0000

Yield Advantage

Yield advantage gained for Walin over Chalasa and Obsa varieties were 73.87 % and 33.07 %; respectively. Accordingly; Walin variety had higher yield advantage than Chalasa and Obsa.

Table 5. Yield advantage of newly released sesame varieties over the standard checks

Demonstrated Varieties	Yield obtained (qt/ha)	Yield advantage over the standard checks (Chalasa, Obsa)
Walin	8.46	73.87
Obsa	6.35	33.07
Chalasa	4.86	

Technology gap and Technology index

Technology gap indicates that the gap in the demonstration yield over potential yield. The observed technology gap is attributed to dissimilarities in fertility, acidity, rainfall and other natural calamities (Dhaka *et.al*., 2010). According to Dhaka *et.al*., 2010, its contribution is to narrow down the gap between the yields of different varieties and to provide location specific recommendations. The yield gaps can be further categorized into technology index which is used to show the feasibility of the variety at the farmer's field. The lower the values of technology index the more the feasibility of the varieties. To this end, the technology gap and index of demonstrated varieties (Walin, Obsa and Chalasa).

Table 6: Technology gap and index for sesame varieties across the districts

Parameter	Sesame Varieties		
	Walin	Obsa	Chalasa
Technology gap (qt/ha)	1.79	2.33	6.02
Technology index (%)	17.46	26.84	55.33

As calculated in the above table the yield gap is 1.79 qt/ha, 2.33 qt/ha and 6.02 qt/ha for Walin, Obsa and Chalasa varieties; respectively. This indicates that the lowest gap was observed on Walin and Obsa varieties which in turn show the demonstration yield is very close to the potential yield but in case of Chalasa variety there is higher reduction in yield from the potential inherited. Further; in terms of technology index 17.46 %, 26.84 % and 55.33 % for Walin, Obsa and Chalasa varieties; respectively. That means the demonstrated; Walin, variety is feasible to the farmers in the study area and other similar agro-ecologies.

Financial Analysis

In terms of profitability the financial analysis, an average return of 17,785 Birr, 11,665 Birr and 6,670 Birr per hectare can be gained from Walin, Obsa and Chalasa varieties; respectively per production season in the areas where the activity carried out.

Table: Financial analysis for sesame

Location: Guto Gida				Location: Gida Ayana			
	Variety				Variety		
Parameters	Walin	Obsa	Chalasa	Parameters	Walin	Obsa	Chalasa
Yield qt/ha(Y)	8.92	6.28	4.91	Yield qt/ha(Y)	8.21	6.77	4.81
Price(P) per quintal	3000	3000	3000	Price(P) per quintal	3000	3000	3000
Total Revenue (TR)=TR=Y*P	26760	18840	14730	Total Revenue (TR)=TR=Y*P	24630	20310	14430
Variable costs				**Variable costs**			
Seed cost	300	300	300	Seed cost	300	300	300
Fertilizer cost	3110	3110	3110	Fertilizer cost	3110	3110	3110
Labor cost	2500	2500	2500	Labor cost	2500	2500	2500
Total Variable costs (TVC)	5910	5910	5910	Total Variable costs (TVC)	5910	5910	5910
Fixed costs				**Fixed costs**			
Cost of land	2000	2000	2000	Cost of land	2000	2000	2000
Total fixed costs (TFC)	2000	2000	2000	Total fixed costs (TFC)	2000	2000	2000
Total cost (TC)=TVC+TFC	7910	7910	7910	Total cost (TC)=TVC+TFC	7910	7910	7910
Gross Margin (GM)=TR - TVC	20850	12930	8820	Gross Margin (GM)=TR-TVC	18720	14400	8520
Profit=GM-TFC	18850	10930	6820	Profit=GM-TFC	16720	12400	6520

Training of stakeholders

Below table 7 summarizes all stakeholders' participated on the training across the districts.

Table7: Stakeholders training participants across the demonstration districts

Training Topic	Participants	Gender disaggregated number of participants		
Sesame Production and management		Male	Female	Total
	Experts	8	-	8
	DAs and supervisors	6	2	8
	Farmers	123	11	134
	Total	137	13	150

Field Visit

Field visit was also arranged across the districts so as to evaluate/select best performing varieties, to enhance farmers' knowledge on sesame production and management and to collect feedback from all relevant stakeholders' for further way forward. On the field visit event organized a total of 107 participants; 93 farmers, 8 DAs and 8 agricultural experts were participated across the districts.

Farmers' perception on sesame technology

The farmers' research groups have appreciated the selected sesame technology for the following merits; perceived better yielder than the standard checks, perceived better resistance to disease, perceived better number of capsules per plant and perceived better seed color.

Conclusion and recommendation

Generally, the on-farm evaluation and demonstration result showed that the demonstrated sesame varieties were preferred by participant farmers for their better agronomic performance. Through the participatory evaluation and demonstration process, many farmers became aware of the importance and quality of technologies as compared to the one under production. Based on these facts, the study recommended Walin variety for further scale up and scale out for Gida Ayana and Guto Gida districts and other similar areas.

References

Alemu, Dawit and Gerdien W. Meijerink (2010); Sesame Traders and the ECX: An Overview with Focus on Transaction Costs and Risks, VC4PPD Report #8, Addis Ababa.

Aysheshm, Kindie. 2007. Sesame market chain analysis: the case Metema Woreda, north Gondar zone, Amhara national Regional State, M.Sc. Thesis, Haramaya University.

Central Statistical Agency (CSA). 2011. Agricultural Sample Survey 2010/2011 (2003 E.C.); Report on Area and Production of Major Crops, Volume I, Statistical Bulletin.

Central Statistical Agency (CSA). 2016. The Federal Democratic Republic of Ethiopia. Central Statistical Agency Agricultural Sample Survey 2015/2016 (2008 E.C.): Report on Area and Production of Major Crops (Private Peasant Holdings, Meher Season), Volume I. Addis Ababa, Ethiopia.

Dhaka B. L., Meena B. S. and Suwalka R. L. 2010. Popularization of Improved Maize Production technology through Frontline Demonstrations in South-Eastern Rajasthan. Journal of AgriSci,1(1):39-42 (2010).

FAOSTAT: http://www.FAOSTAT.Com -Top Five Sesame Seed Producing Countries, 2011, Addis Ababa.

Ministry of Agriculture and Natural Resource (MoARD). 2015. Variety Registration Book. Addis Ababa, Ethiopia.

USAID-Ethiopia Agribusiness and Trade Expansion; Market Bulletin, 2010: No. 9

Ministry of Agriculture and Natural Resource (MoARD). 2015. Variety Registration Book. Addis Ababa, Ethiopia.

Samui S. K., Maitra S, Roy DK, Mondal AK and Saha D. 2000. Evaluation of front line demonstration of groundnut (*Arachis hypogeal L.)* in Sundarbans. J Indian SocCoastalAgric Res, 18(2): 180-183.

LIVESTOCK RESEARCH

Pre-extension Demonstration of Grazing Land Improvement Technology through Top dressing with Nitrogen and Phosphorus Fertilizer in Selected Districts of Western Oromia, Ethiopia

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Abstract

Pre-extension demonstration of grazing land improvement technologies were conducted in 2017/18 in six Agricultural growth program (AGP II) districts, namely, Boneya Boshe, Wayu Tuka, Guto Gida and Diga from East Wollega and Horro and Guduru districts from Horro Guduru Wallega zones to evaluate, select and popularize farmers' preferred technologies based on their selection criteria and to create awareness on the importance of the approved technologies. One representative potential peasant association (PA) was selected purposively from each district based on grazing land and livestock population potential and accessibility for field monitoring and visit. Farmers' selection was done based on interests of farmers in trial management, willingness and ownership of sufficient grazing land to accommodate the trials and gender equality. In each PA, one farmer's extension research group (FREG) comprising 16 farmers were established to evaluate and select the technologies. Training was given to farmers, DAs and experts. Three treatments namely, T1 = Control (farmer practice), T2 = 150 kg/ha urea and T3 = 110 kg/ha urea and 100 kg /ha NPS were evaluated and demonstrated on 4 farmers' fields on plot size of 400 m^2 in each study districts. The collected data were analyzed using descriptive statistics (mean and standard deviation) and qualitative narrations. The agronomic result showed that T3 performed better in average herbage dry matter yield (12.44 t/ha) followed by T2 (8.71 t/ha) and T1 (5.5 t/ha). The two treatments (T3 and T2) had a yield advantage of 55.76 % and 36.83 %, respectively over the control in all the study districts. The overall technology preference score of all districts showed that T 3 (110 kg/ha urea and 100 kg /ha NPS) and T 2 (150 kg/ha urea) were the most preferred technologies and ranked as first and second respectively, by participants because of high biomass, fast growth habit, early maturing for harvesting, plant height, leafiness and species diversity. Therefore, the combination of Urea and NPS fertilizer at a rate of 110 kg and 100 kg/ha respectively, was recommended to be promoted in large scale in the study areas and other places with similar agro-ecologies.

Keywords*: Demonstration, Evaluation, Grazing land, Herbage dry matter, Technologies*

Introduction

Sub-Saharan livestock production and productivity are very low; one of the major constraints is the poor quality and inadequate quantity of feed available (Kindomihou *et al*, 2014). Given decreasing grazing land and increasing production of cash crops , agro industrial by-products could become important inputs in feed rations for different classes of livestock but it is highly costly and not easily available everywhere. Hence, livestock production can be improved through good management of natural grasslands and introduction of improved fodder species with the supply of fertilizer and water to maintain high productivity (Anneessens, 1989).

Lack of nutrients, inadequate management of pastures, and inappropriate cultural practices are responsible for pasture degradation (Werner 1994). Low nitrogen availability has been identified as a major cause of degradation of tropical pastures (Werner 1994), and the constant removal of forage without proper supply of nutrients extracted by plants emphasizes the problems of grazing land degradation. The application of nitrogen has proved to be effective in maximizing the leaf area and the production of dry matter and nutritional status of grasses (Bonfim-Silva and Monteiro, 2006; Batista and Monteiro, 2008). Habtemichael (2010) and Habteslassie (2009) reported that nitrogen deficiency in the grazing areas could be the leading constraint for limited plant growth and reduced biomass yield. Hence, application of nitrogen seems imperative to enhance plant growth and increase herbage biomass production. This study was, therefore, conducted to evaluate, demonstrate and promote grazing land improvement technology through top dressing with nitrogen and phosphorous fertilizer.

Materials and Methods

Site and Farmers Selection

The study was conducted in Boneya Boshe, Wayu Tuka, Guto Gida and Diga districts of East Wollega, zone; Horro and Guduru districts of Horro Guduru Wollega zone of Oromia Region during 2017/2018 cropping season. To apply the technologies, grazing areas under cut and carry grazing system was purposively selected in each district. Selection of the districts was based on accessibility for field monitoring and visit and potentiality for grazing land, livestock population and compatibility with the AGP II criteria. One potential peasant association (PA) was selected from each district. In each PA, one farmer research extension group (FREG) comprising 16 farmers were established.

In each FREG four hosting farmers were selected with the rest being participant farmers. Development Agents and district experts collaborated in site and farmer selection. The FREG member farmers were selected based on willingness; accessibility for supervision of activities; good history and experience in working in group and willingness to share innovations to other farmers. Besides; the experimenting farmers were selected based on availability of sufficient grazing land to accommodate the trials; vicinity to roads so as to facilitate the chance of being visited by other farmers; good history of handling experiments in the past; genuineness and transparency to explain the technology to others.

Stakeholders' training
After the establishment of the FREGs a theoretical training was given to farmers, Development agent (DAs) and district experts. The training was given by researchers on management and utilization of grazing land.

Field design and management
Three treatments (T1 = Control, T2 = 150kg/ha urea and T3 = 110kg/ha urea and 100kg /ha NPS) were applied side by side on adjacent plots with a plot size of 20 m x 20 m with 3 m distance between plots at each experimental sites. The amount of nitrogen in T2 and T3 is the same. Then, the difference between T2 and T3 is expected to be due to P. Nitrogen was applied in the form of urea as a split dressing (one-third at seven days of the first rain and two-thirds after about a month of the first rain and P was applied at seven days of the first rain together with the nitrogen applied at seven days after the first rain.

Participatory evaluation of the technologies
Experience sharing programs (field days) were arranged to supplement the theoretical training. The technologies were then evaluated based on the farmers' selection criteria for grazing land. At the end of the evaluation process, results of the evaluation were displayed to the evaluators, and discussions were made on the way forward.

Data Collection and Analysis
Agronomic data like, growth habit (fast/ slow), plot cover, plant height, leafiness and yield data (herbage dry matter yield), total number of farmers participated in training, field visits and field days, farmers' perception on the characteristics of technology, stakeholders participation were collected and analyzed using SPSS statistical package software. Descriptive statistics such as mean, standard deviation (SD), frequencies, and percentages were used to analysis the data.

Results and discussion

Training of farmers and other stakeholders

Training was given by researchers on issues such as grazing land improvement techniques, general grass land management and utilization system to farmers, district experts and development agents (DAs) to improve their knowledge and skills on the technologies. Accordingly, a total of 187 participants (153 farmers, 12 experts, 6 supervisors and 22 Das) were trained (Table 1). Of the total trainees, 62.03 % were male and the rest 37.96 % were females.

Table 1. Training participants across five demonstration districts

Farmers		Experts		DA's		Total
Male	Female	Male	Female	Male	Female	
94	59	8	4	14	8	187

Farmers' technology evaluation and selection

Technical groups (Researchers, Experts and DA's) and farmers jointly evaluated the technologies based on set criteria. Growth habit (fast/slow), early maturing at 50 % blooming stage, biomass (plot cover), plant height, leafiness, logging, weed offensive and species diversity were identified as the most important selection criteria by the participants. A total of 108 farmers composed of men and women participated in the selection process. Participant farmers scored each technology by each trait that was considered important by them and ranking of technologies were done on a scale of 1-5; 1 being the highest score, representing superiority and 5 representing very poor. Biomass yield and growth habit were considered as the most important selection criteria for each grazing land improvement treatments. The total and mean score result showed that T3 (application of 110 kg/ha urea and 100 kg /ha NPS) and T2 (application of 150 kg/ha urea) were the most preferred technologies and ranked as first and second, respectively, by participants at all districts (Table 2).

Table 2: Total and mean score ranks for Grazing land management technologies in the study areas

Treatments/ Technologies	Guduru			Guto Gida			Bonaya Boshe			Diga			Overall Rank
	Total Score	Mean Score	Rank	Total Score	Mean Score	Rank	Total Score	Mean Score	Rank	Total Score	Mean Score	Rank	
Control	31	3.44	3rd	23	3.56	3rd	27	3.00	3rd	26	2.89	3rd	3rd
UREA	36	4.00	2nd	35	3.89	2nd	36	4.00	2nd	36	4	2nd	2nd
U+NPS	41	4.56	1st	43	4.78	1st	44	4.89	1st	43	4.78	1st	1st

Key: Scoring of farmer's selection criteria was made against: 1=growth habit (fast/ slow), 2= Early reach at 50% blooming stage, 3= Biomass (plot cover), 4= Plant height, 5= Leafiness, 6= Logging, 7= weed offensive and species diversity

On-farm herbage yield performance

The following figures show the analysis result on herbage yield performance of the technologies demonstrated across study districts. Accordingly, the highest average herbage dry matter yield (12.44 t/ha) was recorded in T3 (110 kg Urea/ha + 100 kg NPS/ha) and followed by T2 (150 kg urea/ha) with 8.71 t/ha yield and the T1 (control/farmers' practice gave lower yield, 5.5 t/ha (fig 1 and 2). The two technologies had a yield advantage of 55.76 % and 36.83 %, respectively, over the control one across the study districts.

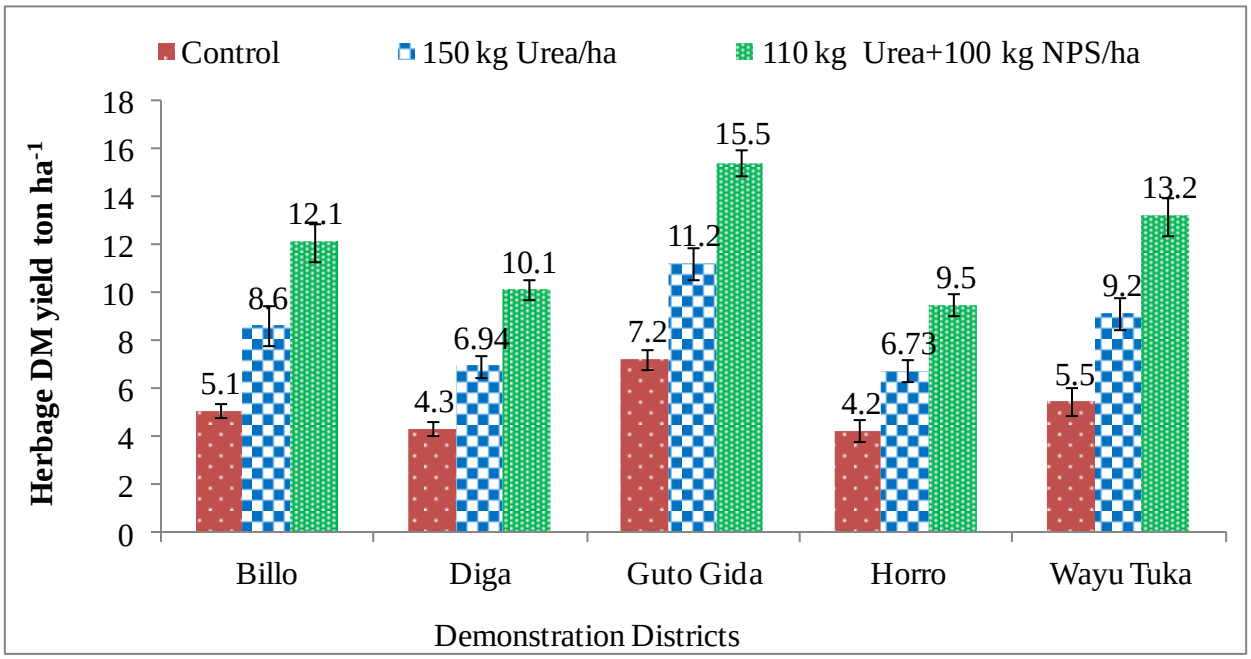

Fig 1.Mean of herbage DM yield ± SE (ton ha^{-1}) of natural grazing land across locations during 2017.

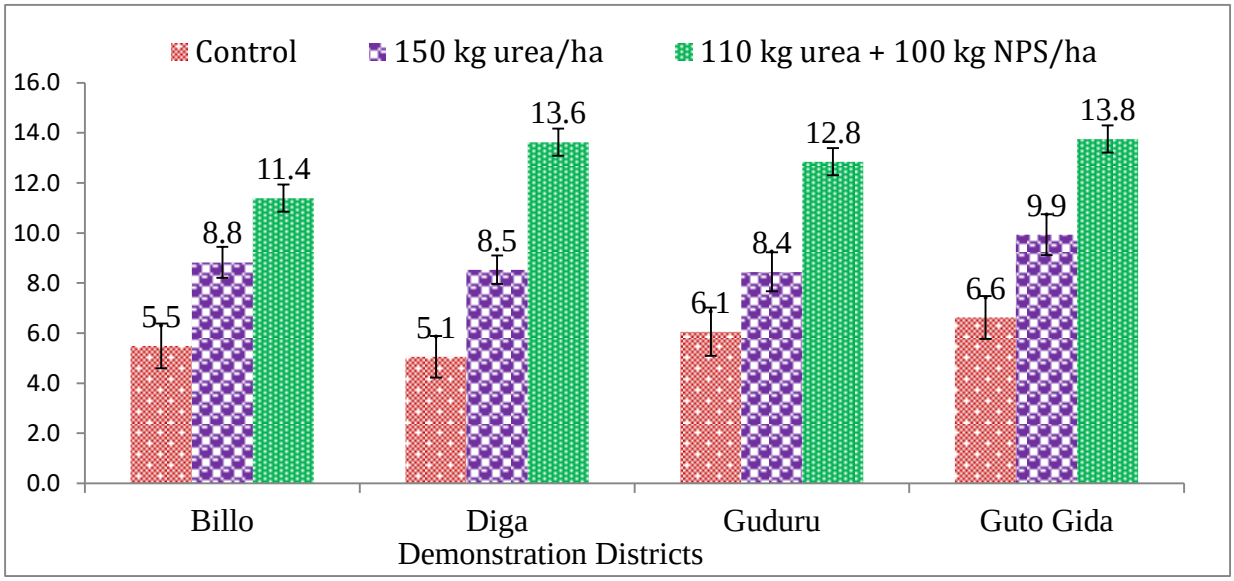

Fig 2.Mean of herbage DM yield ± SE (ton ha^{-1}) of natural grazing land across locations during 2018.

Conclusions and Recommendations

The demonstration activity was conducted in five AGP II districts using FRG approach in two consecutive years, 2017-2019. Two inorganic fertilizers (Urea and NPS) in sole and in combination and farmers' practices were used for demonstration. The results indicated that application of fertilizer either sole urea or mixed with NPS gave promising herbage DM yield at all demonstration sites. The participant farmers and other stakeholders got better knowledge and skill of using the technologies. Based on the yield and participatory evaluation results, combination of urea and NPS at a rate of 110 kg and 100 kg/ha, respectively, were selected as a best technology at all locations followed by T2 (150kg Urea/ha). Therefore, the combination of Urea and NPS fertilizer at a rate of 110 kg and 100 kg/ha respectively, was recommended to be promoted to a large scale in the study areas and other places with similar agro-ecologies.

References

Anneessens M.,1989. Penissetumclandestinum fertilization trial in Cameron: Qualitative and quantitative aspects. Tropicultural 7(2), pp.54-59.

Batista k. and Monteiro F.A., 2008. Nitrogen and sulphur on morphogenic characteristics of marandu palisade grass replacing signal grass under degradation in a low organic matter soil. Brazilian Journal of Animal Science 7, pp 1151-.1160.

Bonfim-Silva E.M. and Monteiro F.A., 2006. Nitrogen and sulphur for productive characteristics of Signal grasses from degradation pasture area. Brazilian Journal of Animal Science 4, pp 1289-1297.

HabtemichaelMezgebe , 2010. Perception of Community on Grazing land Management and Impacton Soil and Vegetation Parameters in the Ethiopian Highlands: The Case of Atsbi-Wenberta in Eastern Tigray. Msc. Thesis presented to Mekelle University, June, 2010.

HabteselassieAsssefa, 2009. Community perceptions and effect of different levels of grazing on vegetation and soil degradation of communal grazing lands in North west Tigray, Northern

Ethiopia. Msc. Thesis presented to Mekelle University, June, 2009.

KindomihouMissiakôValentin, SaidouAliou, Sinsin Brice Augustin, 2014. Response to Fertilizer of Native Grasses (Pennisetumpolystachionand SetariaSphacelata) and Legume (Tephrosiapedicellata) of Savannah in Sudanian Benin.Agriculture, Forestry and Fisheries. Vol. 3, No. 3, 2014, pp. 142-146. doi: 10.11648/j.aff.20140303.11

Werner J.C., 1994. Fertilization of Brachiaria spp.In symposium on pasture management.Pp 209-266. Piracicaba: FEALQ.

Pre-extension Demonstration of Improved Lablab purporeous Varieties in Selected Districts of East Wollega Zone of Oromia, Ethiopia

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Abstract

*Pre-extension demonstration of improved Dolichose lablab varieties was conducted in five Agricultural growth program (AGP II) districts, namely, Boneya Boshe, Wayu Tuka, Diga (Arjo), Bako Tibe and Guto Gida (Uke) of East Wollega zone to evaluate, demonstrate, select and popularize farmers' preferred varieties and to create awareness on the importance of the improved varieties. One representative potential peasant association (PA) was selected purposively from each district based on forage production potential and accessibility for field monitoring and visit. Farmers' selection was done based on interests of farmers in forage production and trial management, ownership of suitable land, ability to perform cultural practices as per recommendation and gender equality. In each PA, one farmers' research and extension group (FREG) comprising 16 farmers was established to evaluate and select the varieties. Training was given to farmers, DAs and experts. Two lablab varieties, namely, Gebis-17 and Beresa-55 were evaluated and demonstrated on 4 farmers' fields with plot size of 20 m * 10 m (200 m^2) in each study districts. Participatory evaluation and rankng was done based on farmer selected criteria. Accordingly, Gebisa-17 was ranked first for all traits except seed yield. Interms of seed yield, Gebisa-17 variety gave lower yield (17.6 qt ha^-1) than Beresa-55 (20.7 qt ha^{-1}) but gave higher herbage DM yield of 8.5 ton ha^{-1} than Bressa-55 which gave 6.93 ton ha^{-1}. Therefore, further scaling up/out of the two improved Dolichos lablab varieties should be conducted in the study areas and to other places with similar agro-ecologies.*

Keywords: Demonstration, Herbage dry matter, Lablab purporeous, Varieties

Introduction

Dolichos lablab (*Lablab purpureus)* is an herbaceous, climbing, warm-season annual or short-lived perennial fodder legume with a vigorous taproot. It is sown for grazing and conservation in tropical environments with a summer rainfall. It has a thick, herbaceous stem that can grow up to 3 feet, and the climbing vines stretching up to 25 ft from the plant (Maass *et al*., 2010). It has low salinity tolerance with symptoms being chlorotic leaves, reduced growth and plant death (Cook *et al*., 2005); but it grows better than most legumes under acidic conditions. It can continue to grow in drought or shady conditions, and will grow in areas with an average annual rainfall regime of 650-3,000 mm, altitude of up to 2000 m.a.s.l. in tropical environments and also more drought resistant than other similar legumes like common beans (*Phaseolus vulgaris*) and cowpea (Maass *et al*., 2010), owing to its ability to extract soil water from at least 2 m depth, even in heavy-textured soils. It grows best where average daily

temperature ranges between 64 and 86°F. In fact, it can grow at 37°F for short period and can tolerate light frosts. *Lablabpurpureus* better adapted to cold compared to other warm-season forages such as velvet bean (*Mucunapruriens)* or cowpea (Cook *et al*., 2005).

Lablab purpureus is used as commercial crop, animal feed and cover crop/green manure. Maass *et al*. (2010) observed that LP can be used as green vegetable (green bean, pod, leaf) and protein isolate from the bean can be used as a food additive for improving cake quality. As forage, it produces significantly more forage dry matter both as a pure crop and as a planted intercrop simultaneously (Abubeker *et al*., 2003). The leaf has about 21 to 38% and seed contains about 20 to 28% crude protein (Cook *et al*., 2005). *Lablab purpureus* is used as a nitrogen-fixing green manure to improve soil quality. Lablab's prolific root system remains in the soil after harvest and enriches the soil with organic carbon (Pasternak, 2013). It not only produces nitrogen through fixation, but returns nitrogen through leaf decay (FAO, 2012).

In western part of Oromia livestock depend on natural pasture and crop residues, which are grossly low in quantity and quality to sustain production. To solve the problem farmers used agro-industrial by-products such as different oil seed cakes and brans from edible oil and flour processing industries to supplement their animals. However, they are expensive and not readily available everywhere. Therefore, production and feeding of herbaceous legumes through integration with food crops were suggested as some of the potential options to improve the nutrient supply to livestock (Solomon, 2001). One of such potential forage legume species for integration into the existing livestock feeding system is Dolichos lablab. Demonstration and evaluation of Dolichos lablab varieties were conducted at different districts of East Wollega and West Shawa zones and promising herbage dry matter (9.32-11.86 ton ha^{-1}) and seed (19.84-22.44 qt ha^{-1}) yield were recorded (Mekonnen *et al*., 2018). Therefore, the objective of the current study was to evaluate, demonstrate and popularize *Lablab purpureus* varieties at farmers' level through participatory approaches.

Materials and Methods

Description of the study area

The study was conducted in Boneya Boshe, Wayu Tuka, Diga and BakoTibe districts, which are dominated by midland with altitude that ranges between 1500 and 1800 m.a.s.l. The area receives an annual rainfall of about 1200 - 1800 mm, 90% of which falls between June and September. Farming system of the districts is characterized by mixed crop-livestock farming. The major crops grown in the districts are maize, sorghum, hot pepper, finger milet, sugar cane, sesame, soybean, common bean, field pea, banana, mango, papaya etc. Important livestock species abundantly reared in the districts include cattle, shoat, equines and chickens.

Sites and farmers selection

Three districts from East Wellega zone (Boneya Boshe, Wayu Tuka and Diga) and one district from West Shewa zone (Bako Tibe) were selected for the implementation of the activity in collaboration with experts and development agents. One representative potential peasant association (PA) was selected from each district. Accordingly, Chafe Konchi PA

from Boneye Boshe, Gute Badiya from Wayu Tuka, Firomsa from Diga and Oda Haro from Bako Tibe were selected.

Farmers' selection was done based on interests of farmers in forage production, ownership of suitable land, willingness and ability to perform cultural practices as per recommendation and gender equality. One farmers' research and extension group (FREG) comprising of 16 farmers was established in each PA. In each FRGs, four hosting farmers were selected with the rest being participant farmers. Hosting farmers were selected based on ownership of suitable and sufficient land to accommodate trials, proximity to roads so as to facilitate the chance of being visited by many stakeholders, ability to manage experimental plots and willingness to share their knowledge and experience to others.

Training and experience sharing

Prior to the establishment of FREGs, a theoretical training was given to farmers, development agents (DAs) and district experts by researchers on production, management and forage utilization as well as issues like economic and nutritive importance, suitable ecologies and weather condition for forage production. Experience sharing and field day were arranged to supplement the theoretical training.

Field design and management

Two improved Dolichose lablab varieties (Gebis-17 and Beresa-55) were planted side by side on adjacent plots of 20 m * 10 m each. The demonstration plots were replicated on 16 different hosting farmers' plots. NPS Fertilizer was applied at rate of 100 kg/ha and all other agronomic practices were applied equally to the demonstration plots as per the recommendation and every experimental plots were supervised jointly by the researchers, extension workers and farmers.

Participatory evaluation of the varieties

Farmers' participatory evaluation was conducted across the study sites. Both technical groups and farmers evaluated the varieties based on their own preferences and preset criteria. At the end of the evaluation process, results of the evaluation were displayed to the evaluators for final approval. The demonstrated varieties were ranked against the selection criteria by participating farmers through discussion across districts.

Data Collection and Analysis

Herbage dry matter and seed yield data, total number of farmers participated in training, field visits and field days, farmers' perception on the characteristics of the varieties, stakeholders participation were collected and analyzed using SPSS statistical software. Descriptive statistics such as mean, standard deviation (SD), frequencies, and percentages were used to analyze the data.

Results and Discussion

Training of farmers and other stakeholders

Theoretical and practical trainings were given to FREGs, on improved Dolichos lablab varieties' production and utilization to improve their knowledge and skills on the newly introduced varieties. Accordingly, a total of 100 participants (80 farmers, 8 experts and 12 DAs) were trained (Table 1). Out of the total trainees, 70 % were male and the rest 30 % were females.

Table 1. Training given to farmers and extension workers

Farmers		**Experts**		**DAs**		
Male	Female	Male	Female	Male	Female	Total
56	24	6	2	8	4	100

Farmers' varieties evaluation and selection

Researchers, Experts, DAs and farmers jointly evaluated the varieties based on the identified criteria which include Herbage DM yield, plot cover, leafiness, disease, weed offensive, pod per plant and wild life attack. A total of 100 farmers composed of men and women participated in the selection process. Accordingly, Gebisa-17 was ranked first in all traits except seed yield in which it was ranked second. Beresa-55 variety was ranked first in seed yield and ranked second in other selection criteria's set by the evaluators (Table 2). Finally, the participating farmers selected both varieties, Gebis-17 and Beresa-55, according to their special attributes.

Table 2: Total and mean score ranks for Delichos Lablab varieties in the study areas

Variety	**Wayu Tuqa**			**Guto Gida**			**Diga**			**Bonaya Boshe**			**Overall Rank**
	Total Score	Mean Score	Rank	Total Score	Mean Score	Rank	Total Score	Mean Score	Rank	Total Score	Mean Score	Rank	
Gebis-17	42	4.67	1st	43	4.78	1st	42	4.67	1st	43	4.78	1st	1st
Beresa-55	38	4.22	2nd	40	4.44	2nd	39	4.33	2nd	36	4	2nd	2nd

NB: 1-7 farmers' set selection criteria: 1= Herbage DM yield/plot cover, 2= high seed yielder, 3= Disease tolerant, 4= leafiness, 5= pod per plant, 6=early maturity and 7= weed offensive

Yield performance of the demonstrated varieties

Figures, 1 and 2 shows the yield performances of the demonstrated varieties across the study districts. According to the results the mean herbage DM yields of 8.5 ton ha^{-1} and 6.93 ton ha^{-1} were harvested from Gabis-17 and Beresa-55 varieties, respectively (fig. 1).The demonstration result also showed that Beresa-55 variety performed better in seed yield than Gebis-17 with an average seed yield of 20.7 qt ha^{-1} while that of Gebisa-17 was 17.6 qt ha^{-1}in all the districts (fig. 2). The mean herbage dry matter yield value obtained in this study is lower than the 11.86 and 9.32 ton ha^{-1} reported by Mekonnen *et al*. (2018) for Gebis-17 and

Beresa-55, respectively, in the same districts. The same authors also reported higher average seed yield values of 22.44 and 19.84 ha^{-1} for Beresa-55 and Gabis-17 respectively. The lower result in the current study is probably due to climatic condition of the study area; mainly rain fall, soil moisture and soil temperature.

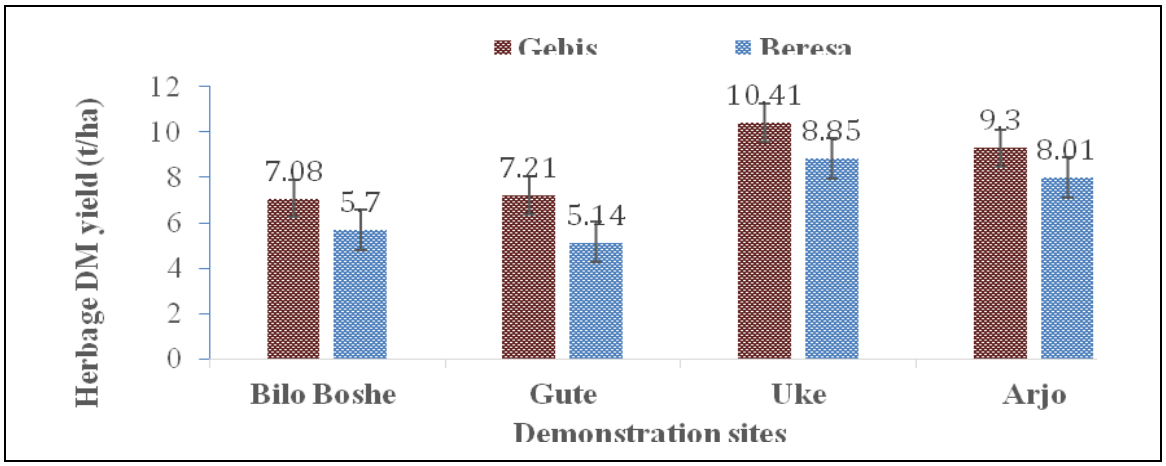

Figure 1: Mean of herbage DM yield ± SE (t/ha) of Gebis-17 and Beresa-55 varieties across study districts.

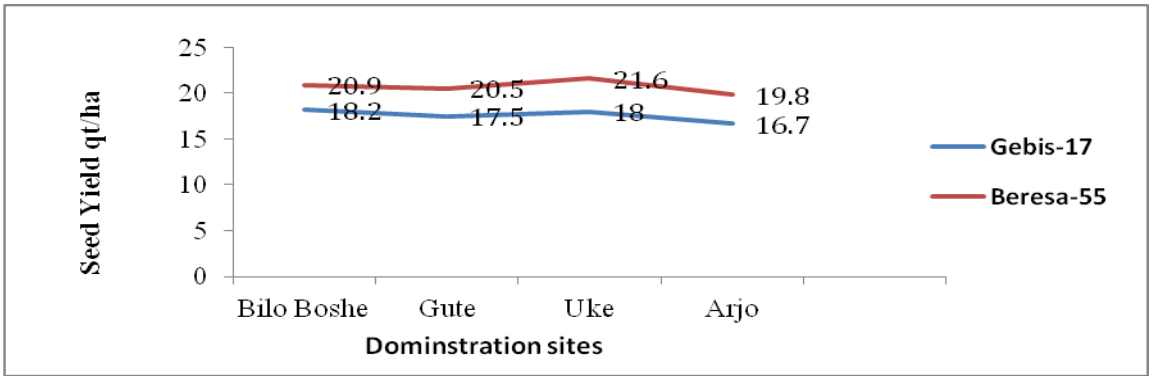

Figure 2: Mean of seed yield (qt/ha) of Gebis-17 and Beresa-55 varieties across study districts.

Conclusions and Recommendations

Pre-extension demonstration of promising Lablab varieties, namely, '*Gebis-17* and *Beresa-55*' was conducted in selected districts of East Wollega zone to evaluate, demonstrate, select and popularize farmers' preferred varieties and to create awareness on the importance of the improved varieties. The demonstration result reaveled that both Gebisa-17 and Beresa-55 Dalichos lablab varieties had good herbage DM and seed yield in all the locations. Moreover, both varieties were preferred by farmers in all the selection criteria. Based these evidences, both Gebis-17 and Beresa-55 were for further scaling up in the study areas for alleviating feed shortage in terms of quantity and quality.

References

AbubekerHassen, Lemma Gizachew and N.F.G. Rethman, 2003. Effect of *Lablab purpureus*and *Viciaatropurpuria*as an intercrop, or in a crop rotation, on grain and forage yields of maize in Ethiopia. *Tropical Grasslands*,40: 111–118.

Cook, B.G., Pengelly, B.C., Brown, S.D., Donnelly, J.L., Eagles, D.A., Franco, M.A., Hanson, Mullen.J., B.F., Partridge.I.J., Peters, M and Schultze-Kraft, R., 2005. Tropical forages: an interactive selection tool Australia. *Journal of Environmental Management*, 113: 341-346.

FAO (Food and Agricultural Organization), 2012. Grassland species index. *Cajanuscajan*. http://www.fao.org/ag/AGP/AGPC/ doc/Gbase/DATA/PF000150.HTM.

Maass, B.L., Knox M.R., Venkatesha, S.C., Angessa, T.T., Ramme, S., and Pengelly, B.C., 2010. *Lablab purpureus*-a crop lost for Africa? *TropicalPlant Biology*, 3(3):123–135.

Pasternak, D., 2013. Lablab (*Lablab purpureus*): A New Staple Crop for the Sudano Sahel ECHO. *Agricultural development in dry regions Technical*. 73p.

MekonnenDiribsa, Abuye Tulu, WaqgariKeba, WarkuTemesgenandGutuFekeda, 2018. Pre-extension and Demonstration of Improved Lablab purporeous Technology. (TahaMume, TilahunGeneti, TesfayeGemechu, DagnachewLule and KefyalewAssefa (eds), 2018. Workshop Proceeding for Completed Research Activities of Pre-extension Demonstration of Agricultural Technologies supported by AGP-II, 25-27 June 2018, Adama, Ethiopia. 99p.

Solomon Melaku, 2001. Evaluation of selected multipurpose trees as feed supplements in tef (*Eragrostistef*) straw based feeding of Menz sheep. PhD. dissertation. Humboldt University, Berlin, Germany. 88p.

Pre-extension Demonstration of Dolichos lablab (*Lablab purpureus*) Under sown in Maize at Dugda and Lume Districts, East Shoa Zone, Ethiopia

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Abstract

*The activity was conducted in Bekele-Girisa and Bika kebeles of Dugda and Lume districts respectively. The objectives were to demonstrate forage production from lablab under sown in maize and to evaluate the lablab-maize intercropping practices with farmers' participation. Accordingly, Farmers' Research and Extension Groups (FREGs) with 18 and 15 members were established at Bekele Girisa and Bika kebeles, respectively. Four trial farmers were selected from each FREGs for forage production based on the criteria including interest of the farmers in producing forage on their land, farmer having enough land for forage production and farmer who have milking cows. BH-540 maize variety was intercropped with Lablab purpureus on plot a size of 32*32m. Pure stands of maize with similar plot size were also established for comparison. Farmers were used as replication. Lablab purpureus was intercropped in maize at two weeks period after maize planting. The results revealed that the total biomass (Stover + lablab) and maize grain yields were significantly different ($P<0.05$) among the practices at Dugda site while the reverse is true for Lume site. The mean maize grain yield and agronomic performances recorded at Lume site were lower than that of the Dugda site. There was total biomass and maize grain yield increment in lablab under-sown in maize than pure stand of maize in both sites. Similarly, crude protein content of the maize stover under sown with lablab was improved. Farmers were also very interested in forage production from intercropping of lablab with maize as compared to sole maize production practice. Therefore, it is recommended to further promote the lablab-maize intercropping technology to enhance the production of high biomass of forage with good quality in the study area.*

Keywords: Biomass yield, FREG , Intercropping, Lablab,

Introduction

In mixed crop-livestock systems, livestock feed supply is mainly dependent on crop residues, natural pastures, and other agricultural by-products. However, the quantity and quality of the available feed resources is declining from time to time as most of the available land is cultivated for crop production (Tolera *et al*., 2012). Forage legumes integrated with food crops and livestock is often advocated to minimize external inputs as well as to improve the productivity and sustainability of crop-livestock production in developing countries (Giller, 2001; Peters and Lascano., 2003). Forage legumes provide food, feed and facilitate soil nutrient management.

Intercropping is a type of mixed cropping agricultural practice of cultivating two or more crops in the same space at the same time. Intercropping of cereals with legumes has been

popular in tropics (Hauggaard-Nielsen *et al*., 2001; Tsubo *et al*., 2005) and rain-fed areas of the world (Banik *et al.,* 2000; Ghosh 2004; Agegnehu *et al.,* 2006; Dhima *et al.,* 2007) due to its advantages for soil Conservation (Anil *et al.,* 1998), weed control (Poggio 2005; Banik *et al.*, 2006), lodging resistance, yield increase (Anil *et al.,* 1998; Chen., 2004), and legume root parasite infections control (Fenandez-Aparicio *et al.,* 2007). Different studies also indicated that forage legumes integration through intercropping did not have a significant effect on maize grain and biomass yield (Mergia Abera, 2014). The feasibility of intercropping lablab in maize for additional feed source was investigated and promising results were obtained and recommended for the end users (Diriba Geleti and Lemma Gizachew 2003). However, this intercropping practice was not demonstrated to small scale farmers and evaluated at on-farm condition with farmers' participation. Therefore, this study was designed to evaluate and demonstrate the practice of lablab intercropping in maize to improve livestock feed production in the study area.

Materials and Methods

Description of the study area

The study was carried out in Dugda and Lume districts of East Shoa zone. Two kebeles; Bekele-Girisa and Bika were selected from Dugda and Lume districts, respectively based on the livestock population potential, severity of feed shortage and cropping system (maize dominant cropping). Geographically Dugda district is located between $8^0$01'N to $8^0$10'North latitude and $38^0$31'E to $38^0$57'E longitude. Meki, the capital city of Dugda district, is located 134 km to the South East of Addis Ababa on the main road to Ziway town. Lume district is located at 74 km from Addis Ababa at Longitude between 38^o56'E to 39^o17'E and Latitude 8^o34'N to 8^o34'N. The altitude of the study area ranges from 500 to 2000 (m.a.s.l). The area receives an erratic, unreliable and low rainfall, averaging between 500 and 900 mm per annum. The rain fall is bi-modal with the long rain lasting from June to September (Abule *et al*., 1999).

Farmers' selection

The activity was carried out using Farmers' Research and Extension Groups (FREGs) formed of smallholder farmers. FREGs with 18 and 15 members were established at Bekele Girisa and Bika kebeles, respectively. Detailed analysis of the problem and potential benefits of improved forage production and utilization were discussed with farmers. Four trial farmers were selected from each site for the forage production based on the criteria including interest of the farmers in producing forage on their land, farmer having enough land for forage production and farmers who have milking cows.

Trial establishment and management

BH-540 maize variety was planted on plot size of 32*32m with the forage (*Lablab purpureus)* sown under the maize. Pure stands of maize of the same variety were planted on similar plot size as farmers' practice for comparison. Seed rate of 25 kg/ha with 75cm of spacing between the rows, and 25 cm among the plants were used for maize crop. *Lablab purpureus* was intercropped between the maize rows at seed rate of 15kg/ha (half of the recommended seed rate for sole production) two weeks after maize planting. Trial farmers were used as replication. NPS fertilizer was applied at rate of 100kg/ha at planting. All other recommended agronomic practices were done for all plots uniformly.

Farmer's training and evaluation of forage development technologies

Theoretical training was given for group members on forage production and utilization before planting. Then practical training was given for the group at each farm; where the trial was conducted to address the crop establishment, general management, harvesting and feeding system. Neighbors were encouraged to attain the training. Farmers carried out qualitative evaluation of the forage intercropping system through matrix ranking. They critically evaluated forage production strategy based on their criteria. Farmers of the two districts used almost similar criteria for evaluation of the forage production strategy. The major criteria considered in the evaluation includes; herbage biomass yield, multipurpose use of the technology, protection of soil erosion, ability of drought tolerance, improvement of soil fertility and compatibility of the technology with the existing production system, Finally they selected forage production strategies suitable to their farming condition.

Data collection and analysis

Relevant agronomic and yield including plant height, biomass yield of lablab, maize stover and seed yield were collected. The data was organized and analyzed to describe various variables using Microsoft Excel and Statistical Package for Social Sciences (SPSS 20). The student t-test was used for mean separation.

Results and discussions

Agronomic and yield performances of Lablab under-sown in maize

Agronomic and yield performances of lablab under-sown in maize at Bekele Girisa site of Dugda district and Bika site of Lume district are presented in table 1 and 2 respectively. The result showed that there was significant difference ($p>0.05$) among the treatments in total biomass yield and maize seed yield at Dugda district. The highest total biomass yield (7.20 t/ha) and maize grain yield (52.7quintal/ ha) were recorded for maize-lablab intercropping practice at Bekele-Girisa site of Dugda district. This could be mainly due to the better rainfall availability at Dugda as compared to Lume district. Due to the lablab intercropping the total biomass was increased by 9.1% at Bekele-Girisa site and by 14% at Bika site. Generally, the performance variability across the sites might be due to the soil differences and whether conditions of the study area.

The higher maize grain yield recorded for the intercropping could be due to the better maize crop management since the recommended seeding rate and spacing were used for the intercropping practice. In farmers practice (sole maize production), farmers used lower spacing between rows and plants that could be a cause for lower maize grain yield recorded. In addition, the under sown forage legumes help in suppressing the growth of unwanted weeds and conserve moisture in the soil. This result is in agreement with Mergia Abera (2014), where inclusion of vetch, cowpea and lablab increased grain yield of maize by 7.4%, 5.9%, and 5%, respectively. However, the results of this study is contrary to those reported by Aklilu *et al.* (2007) and Mpairwe *et al.* (2002) where the inclusion of forage legumes depressed grain yield of companion cereals by 3.6 to 9%. Abubeker (2006) also reported that simultaneous planting of lablab significantly ($P < 0.05$) reduced grain and stover yield but increased forage dry matter (DM) yield. However, delayed planting, did not affect ($P > 0.05$) grain, Stover, forage dry matter (DM) or total fodder yields.

Even though it is not significantly ($p>0.05$) different, at the two sites, crude protein content of maize stover under sown with lablab was greater than that of maize Stover from pure stands. Similarly, Mergia Abera (2014) also stating that the crude protein content was not significantly different ($p>0.05$) among the maize stovers samples taken from maize-lablab intercropping and sole maize treatments. Crude protein content of most cereal crop residues are lower than 7 % which is the critical level of microbial protein synthesis of feed intake (Adugna *et al*., 1999). However, due to lablab-intercropping in maize the crude protein content of maize stover was above the critical level. This indicates that maize under-sown with forage legumes improve the crude protein quality of stover than pure stand maize sown.

Table1: Agronomic and yield performance of maize-lablab intercropping at Bekele Girisa site of Dugda district.

Practices	PH(cm)	DMY (tone/ha)			MSY(qt/ha)	CPMS (%)
		Stover	Lablab	Total		
Sole maize	226.50	6.60	-	6.60	51.40	7.47
Maize –lablab intercropping	227.70	6.15	1.05	7.20	52.7	7.67
Mean	227.10	6.38	-	7.18	52.05	7.57
Standard Error	5.22	0.36	-	0.35	0.41	0.21
Sig. level	Ns	Ns	-	*	*	Ns

Key: PH=plant height of Maize; DMY= Dry matter yield; MSY= Maize seed yield; CPMS= Crude protein of maize Stover.

Table 2: Agronomic and yield performance of maize-lablab intercropping at Bika site of Lume district.

Practices	PH (cm)	DMY (tone/ha)			MSY(Qt/ha)	CPMY (%)
		Stover	Lablab	Total		
Sole maize	246.6	5.93	-	5.93	29.1	6.17
Maize –lablab intercropping	244.6	6.20	0.57	6.77	32.2	7.08
Mean	245.6	6.06		6.35	30.65	6.625
Standard Error	12.04	0.51	-	0.15	0.57	0.55
Sig. level	Ns	Ns	-	Ns	Ns	Ns

Key: PH=plant height of Maize; DMY= Dry matter yield; MSY= Maize seed yield; CPMS= Crop protein of maize Stover.

Training

Theoretical and practical training was given for FREGs and neighbors farmers on forage production and utilization before forage technology establishment and during forage harvesting. A total of 50 farmers (32 males and 12 females) participated in training on forage production and utilization practices. The training was mainly focused on forage crop establishment, general management, harvesting, storage and feeding system. The reaction of participating farmers in terms of the advantages and drawbacks of the forage production by under-sowing forage legumes in maize crop as compared to pure maize production practice (monoculture) were indicated in table 3. According to the participant farmers, district animal feed experts and development agents maize-lablab intercropping was found as better strategy

for forage and maize production as compared to sole maize cropping. This is mainly due to the benefits of under-sowing forage legumes in maize crop including additional quality feed production from lablab, soil fertility improvement, protection of soil erosion, ability of drought tolerance and compatibility of the technology to the existing production system.

All participant farmers were very much impressed and interested to grow lablab forage in maize crop after they have realized the benefits of the intercropping practice. They also understood that one can produce forage crops by under-sowing without competing land for crop production. Farmers also had obtained good awareness regarding improved forage production and utilization practices. They were encouraged in participation of the forage production and promotes the adoption of improved forage technologies in the study area. On the other side, there was increased realization on the part of researcher and extension workers that the technology became effective and acceptable by the farmers when the farmers themselves are involved in the research and extension program. It also benefited the researchers and extension workers in gaining and understanding of farmer's evaluation criteria and created good opportunity to communication with farmers.

Table 3: Farmer's criteria for evaluation of lablab legumes under sown in maize and pure stand maize production practices (High score = 5 and least score = 1) and number of evaluating farmers =50

Evaluation parameters	Sole maize	Maize + lablab
Biomass yield.	4	5
Multi-purpose use as food & feed.	3	5
Protection of soil(water runoff protection)	3	5
Drought tolerance.	4	5
Moisture conservation and soil fertility improvement	3	5
Maize grain yield improvement	3	4
Total score	20	29
Rank	2nd	1st

Conclusions and Recommendations

The result of the current study indicated that the total biomass (maize + lablab) and maize seed yields of lablab forage legume under-sown in maize were performed better than the pure stand of maize production. Similarly, the changes in crude protein of forage were more pronounced in maize-legume intercrops than in pure cropped maize. Even though, the amount of biomass yield obtained from lablab legumes was low, the fact that the yield obtained was without affecting maize grain yield makes the technology of lablab under-sowing in maize strategy attractive. Hence, those farmers practicing maize-legume intercropping could obtain more benefits in terms of food and animal feed than those practicing mono cropping. Farmers' evaluation result showed that the participating farmers were also very much interested in lablab under-sowing in maize crop as forage development strategy to solve animal feed shortages of the study area. Hence, small holders farmers are encouraged to produce lablab by under sowing in maize to enhance dry season feed availability and quality. Moreover, further studies on other forage legume species should be conducted to evaluate their compatibility when under-sown/intercropped in food crops.

References

Abubeker Hassen., Lemma, G., and N.F.G. Rethman.2006. Effect of Lablab purpureus and Vicia atropurpuria as an intercrop, or in a crop rotation, on grain and forage yields of maize in Ethiopia. Tropical Grasslands (2006) Volume 40, 111–118.

Abule E, Gremew E, Aliye H 1999. Adami Tulu Agricultural research Center, Bulletin No.1, Oromia Agricultural Development Bureau. Fifnfine, Ethiopia.

Adugna Tolera, T. Berg and F. Sundstol, 1999. The effect of variety on maize grain and crop residue yield and nutritive value of the stover. Animal Feed Science and Technology. 79: 165-177.

Agegnehu, G., Ghizam, A. and Sinebo, W. 2006. Yield Performance and Land-Use Efficiency of Barley and Faba Bean Mixed Cropping in Ethiopian Highlands. European Journal of Agronomy, 25, 202-207.

Aklilu Mekasha, Ashebre Tegegn, Abrham Abera and Mandefro Nigussie, 2007. Compatibility and performance of different annual forage legumes under-sown to different maize varieties. Pastoral livestock systems: opportunities and challenges as a livelihood strategy. Proceedings of the 15th annual conference of the Ethiopian Society of Animal Production, Addis Ababa, Ethiopia.

Anil, L., Park, J., Phipps, R.H. and Miller, F.A. 1998. Temperate Intercropping of Cereals for Forage: A Review of the Potential for Growth and Utilization with Par- ticular Reference to the UK. Grass and Forage Science, 53, 301-317. https://doi.org/10.1046/j.1365-2494.1998.00144.x

Banik, P., Midya, A., Sarkar, B.K. and Ghose, S.S. 2006. Wheat and Chickpea Intercropping Systems in an Additive Series Experiment: Advantages and WeedSmothering. European Journal of Agronomy, 24, 325-332.

Banik, P., Sasmal, T., Ghosal, P.K. and Bagchi, D.K. 2000. Evaluation of Mustard (Brassica campestris var. Toria) and Legume in 1:1 and 2:1 Replacement Series Sys- tem. Journal of Agronomy and Crop Science, 185, 9-14. https://doi.org/10.1046/j.1439-037X.2000.00388.x

Chen, C., Westcott, M., Neill, K., Wichman, D. and Knox, M. 2004. Row Configu- ration and Nitrogen Application for Barley-Pea Intercropping in Montana. Agronomy Journal, 96, 1730-1738. https://doi.org/10.2134/agronj2004.1730

Dhima, K.V., Lithourgidis, A.A., Vasilakoglou, I.B. and Dordas, C.A. 2007. Com- petition Indices of Common Vetch and Cereal Intercrops in Two Seeding Ratio. Field Crops Research, 100, 249-256.

Diriba Geleti and Lemma Gizachew 2003. Integration of forage legumes in to maize based cropping systems in Western Ethiopia: Effect of intercropping of *Lablab purpureus* and *Vicia atropurpurea* on maize grain and total forage yields. Challenges and Opportunities of Livestock Marketing in Ethiopia. Yilma Jobre and Getachew Gebru (Eds). In: Proceedings of 10th Annual conference of the Ethiopian Society of Animal Production (ESAP) held in Addis Ababa, Ethiopia, August 22-24, 2002. ESAP, Addis Ababa. 407pp

Fenandez-Aparicio, M., Josefina, C. and Sillero, D.R. 2007. Intercropping with Ce-reals Reduces Infection by Orobanche crenata in Legumes. Crop Protection, 26, 1166-1172.

Ghosh, P.K. 2004 Growth, Yield, Competition and Economics of Ground- nut/Cereal Fodder Intercropping Systems in the Semi-Arid Tropics of India. Field Crops Research, 88, 227-237.

Giller, K.E. 2001. Nitrogen fixation in tropical cropping systems, 2nd ed. Wallingford, UK: CAB International.

Hauggaard-Nielsen, H., Ambus, P. and Jensen, E.S. 2001. Evaluating Pea and Bar- ley Cultivars for Complementary in Intercropping at Different Levels of Soil N Availability. Field Crops Research, 72, 185-196. https://doi.org/10.1016/S0378-4290(01)00176-9

Mergia Abera2014. The Effect of Under Sowing of Forage Legumes in Maize on Dry Matter Yield and Nutritional Value of the Fodder in Baresa Watershed, Ethiopia. International Journal of Science and Research (IJSR) ISSN (Online): 2319-7064. Volume 3 Issue 8, August 2014.

Mpairwe, D.R., Sabiitti, E.N., Ummina, N.N., Tegene, A. and Osuji, P., 2002. Effect of intercropping cereal crops 17. with forage legumes and source of nutrients on cereal grain yield and fodder dry matter yields. African Crop Science Journal 10(1): 81-97.

Peters, M., and E.C. Lascano 2003. Forage technology adoption: linking on-station research with participatory methods. Tropical Grasslands 37: 197-203.

Poggio, S.L. 2005. Structure of Weed Communities Occurring in Monoculture and Intercropping of Field Pea and Barley. Agriculture, Ecosystems & Environment, 109, 48-58.

Tolera Adugna, Yami Alemu, Alemu Dawit 2012. Livestock feed resources in Ethiopia: Challenges, Opportunities and the need for transformation. Ethiopia Animal Feed Industry Association, Addis Ababa, Ethiopia.

Tsubo, M., Walker, S. and Ogindo, H.O. 2005. A Simulation Model of Ce- real-Legume Intercropping Systems for Semi-Arid Regions. II. Model Application. Field Crops Research, 93, 23-33.

Pre-extension Demonstration of Improved Vetch (Veciavillosa) Variety under sown in Maize Crop at Kofele District of West Arsi Zone, Oromia, Ethiopia

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Abstract

The activity was conducted at Hula-bera kebele of Kofale district with the objetctive demonstrating forage production from vetch-maize intercropping system to smallholder farmers of the area. Accordingly, one Farmers Research and Extension Group (FREG) having 20 members was established at Hula-bera kebele. Among the group members, 4 farmers who have interest and accessible land for forage production were selected as trial farmers. Vetch was intercroped with maize on land size of 32m x 32m on each farmer land. Sole maize was also planted on adjacent plot of the same size as control. The result indicated that intercropping vetch with maize crop didnt significantly affect ($p>0.05$) the grain yield of maize. The total biomass yield (14.39 t/ha) obtained was significantly higher ($p<0.05$) for the intercropping practice than the sole maize. Almost all participant farmers appreciated performances of the vetch-maize intercropping especially in obtaining aditional forage legumes and in soil fertility improvement. Hence, to solve the feed shortage problems resulted from land scarcity, forage legumes (vetch) intercropping in maize plays a great role by creating an opportunity of producing additional forage from the vetch with out affecting the yield of maize crop. In addition, the benefits of forage legumes in soil fertility improvement make the system very attractive for the farmers. Thus, there is a need to promote the technology in maize production areas. Moreover, vetch seed should be multiplied and distributed to farmers to enhance adoption of the technology.

Key words: Biomass yield, Compatibility, FREG, Intercropping, Vetch

Introduction

Livestock production contributes up to 80 percent of farmers' income in Ethiopia and about 17% of GDP and 39% of the agricultural GDP. This raised to about 21% of the national GDP and 49% of the agricultural GDP (Shapiro *et al*., 2017). Nutritional factors are the binding constraint to sustaining livestock production in the country. During the latter part of the dry season, livestock feed is normally in short supply and is also of poor quality (Alemayehu*et al.*, 2016). Livestock mainly depends on natural pastures and crop residues which are often limiting in quantity and nutritional quality (Hassan *et al*., 2014). The limiting feed supply to animals results in low production and productivity.

Due to the expansion of crop land cultivation and settlement, there is shortage of grazing land that can be used as animal feed resources. Hence, forage production by integration with

cereals crop can plays a great role in reducing such land shortage problem. The method of integration used for a specific farming system mainly depends on the type of forage crops, food crops, soil type, rainfall pattern and other social and economic factors (Alemayehu*et al.,* 2016).Intercropping of improved forages legumes in cereal crops were found to be useful practices in area where land resource for forage production is very critical. Mixed cropping especially with legumes can improve both forage quality and grain yield of main crops because legumes are good source of protein. In addition, forage legumes intercropping improve soil fertility by fixing nitrogen, reduce pest incidence and improve forage quality by increasing crude protein yield of the forage.

Use of improved forage species can be one option to tackle the aggravated feed shortage in the country in general and in the study areas in particular. Improved forages species provide a good source of nutrients almost throughout the year. Accordingly, adaptability and yield potential of different forage species have been studied in different agro-ecologies of the study area and various forage legumes and grasses were identified and recommended to the end users. Vetch makes high quality hay, either grown alone or mixed with small grain. It is well-adapted to moderately to well-drained, fertile soils.Dry biomass of forage yield of 2485 kg/ha was reported from row intercropped vetch with maize (Getachew*et al.*, 2013). The protein content of vetch hay ranges from 12 to 39%, depending on the stage of development of the crop. Total forage protein yield of intercropped of vetch with maize was more advantageous than sole cropping (Getachew *et al*., 2013).

At Adami Tulu, experiment was conducted at on-station and on-farm condition to evaluate and identify compatible vetch varieties for intercropping with maize crop. Accordingly the best compatible vetch (*Viciavillosa)* variety for intercropping with maize was identified and recommended for the mid and highland agro-ecologies of the study areas (Dawit and Nebi, 2017). However, the recommended vetch-maize intercropping practice was not yet demonstrated to the smallholder farmers. Hence, this activity was initiated with the objective of demonstrating forage production from vetch-maize intercropping system with its appropriate production and utilization packages to smallholder farmers in the area.

Material and methods

The activity was carried out at Hula-bera kebele, Kofele district of west Arsi zone. The administrative town of the district was at a distance of 300 km from Addis Ababa and located at a longitude of $7^{o}10'00"$ N 38^{o} 45 E and Latitude of $7^{o}00$ N $38^{o}75$ E. The altitude of the study area ranges from 2640-3150m.a.s.l (West Arsi zone socio-economic data, 2007 unpuplished). The area receives anaverage annual rain fallof about 1232 mm^2 with a mean monthly rainfall of 102.6mm. In addition, the mean monthly minimum and maximum temperatures are about $5.40^{o}C$ and $19.80^{o}C$, respectively.

Farmers Research and Extension Group (FREG) establishment

FREG with 20 members (15 male and 5 female) was established to facilitate farmers' participation in demonstration and training on the forage production and utilization. Four trial farmers who have dairy animals and interested to produce forage were selected from members of the FREG to be used as replications and for forage establishment.

Farmers' training

Theoretical and practical training was given for FREG members on forage production and utilization practices. The training addressed aspects such as crop establishment, general crop management, and harvesting, feeding and different options of forage development strategies. Of the forage development strategies, intercropping was prioritized for this activity due to the scrarcity of farm land. The advantages of intercropping practices were demonstrated to the farmers. All agronomic production practices and utilization systems were demonstrated to the farmers. The development agents were involved in the demonstration and training. Moreover, the farmers evaluated the forage intercropping practice using thier own criteria.

Forage establishiment

Improved maize variety (BH-660) was planted on 32m x 32m plot size with vetch (*Viciavillosa)* under sown after 15 days of maize planting. Pure stands of maize crop were established on the adjacent plot of the same size for comparison. All the necessary field manageents was carried out as per the recommendation.

Biomass yield advantage determination

Biomass yield advantages of the forages were determined by comparing the biomass yield obtained from forage intercropped (maize-vetch) and sole maize farming practices using the following formula:

$$\text{Biomass yield advantage \%} = \frac{\text{Yield of intercrop (t/ha)} - \text{Yield of sole (t/ha)} \times 100}{\text{Yield of sole (t/ha)}}$$

Data collection and analysis

Relevant agronomic and yield data including plant height, biomass yield of vetch, maize stover, seed yield, farmers perception towards the technology, total number of participant on the training , challenges and opportunities of the technology were collected. The collected data were organized, summarized and analyzed by using SPSS version 20. The student t-test was used for mean comparision.

Results and discussions

Performance of maize-vetch intercropping

Agronomic and yield performances of vetch undersown in maize at Hula-bera site of Kofele district are presented in Table 1. The result indicated that intercropping of vetch with maize crop was not significantly ($p>0.05$) affect the grain yield of maize. The highest mean value of maize grain yield (76.79qu/ha) was recorded from maize-vetch intercropping practice. The higher maize grain yield from the intercropping practice could be due to the use of recommended agronomic practices including optimum seeding rate and spacing between rows and plants. In farmers practice (sole maize), farmers used lower spacing between rows and plants that could be a cause for lower maize grain yield recorded. Moreover, forgae legumes (vetch) might have also contributed through conserving soil moisture under the maize crop. The number of combs per plant which contributes for maize grain yield was also significantly higher ($p>0.05$) for the intercropping practice as compared to sole maize cropping.

The highest total dry matter yield (14.39 tone/ha) was recorded from the intercropping prtactices as compared to sole maize production. This was mainly due to the additional forage dry matter yield (3.69t/ha) obtained from the biomass of vetch forage which was produced in intercropping system. Hence this additional biomass could be of a great advantage for farmers' allowing them to get good quality forage with out affecting the grain yield of maize. Numerically the highest mean value of maize plant hight and crude protien of maize stover were recorded for the intercropping practices.

Table 1.Agronomic and yield performances of maize-vetch intercropping at Kofele district

Practices	Plant height (cm)	Dry matter yield (t/ha)			No of combes /plant	Maize seed yield Qu /ha	Crude protein of maize stover (%)
		Stover	Vetch	Total			
Sole maize	276.5	10.22		10.22	1.57	65.55	8.03
Maize –vetch intercropping	284.4	10.70	3.69	14.39	2.0	76.79	8.63
Mean	280.45	10.45		12.31	1.785	71.17	8.33
Standard Error	11.2	0.59		0.59	0.088	4.1	2.29
Sig. level	Ns	Ns		0.019	0.039	Ns	Ns

Biomass yield advantages

The biomass yield advantage of maize vetch intercropping practices was 40.80%. This indicates that the intercropping practice was more advantagious than sole maize cropping practice. Intercropping of forage legumes with cereals generally results in higher fodder protein yield than cereal alone. However, fairly high yielder and quality forage legumes are needed to augment the cereal residues in order to produce a feed which would be capable of meeting the basal nutritional requirements of ruminants.

Farmers training

Training was give for the 20 farmers (15 male and 5 female) and 3 development agents on improved forage production and utilization.

Farmers' evaluation and perceptions about the technology

From the farmers' evaluation of the maize-vetch intercropping and sole maize production practices, farmers gave the highest rank for vetch-maize intercropping pracitce as compared to sole maize production. The main resaons for them to choose maize-vech practice include the higher performance of miaze grain yield, additional forage biomass from vetch and the other benefits of vetch such as soil fertility improvement. Therefore, intercropping of forage legumes with maize crop were preferred than sole maize cropping. Farmers were very much interested to use intercropping of vetch in maize crop so as to get the benefits from food and feed crops.

Conclusions and recommendations

Intercroping vetch in maize crop has shown a great advantege as compared to sole maze production practice in the study area. By intercropping vetch in maize crop, farmers got additional quality forage biomass from forage legumes (vetch) without affecting the grain yield of maize. Morover, farmers also appreciated the forage legume biomass, maize grain yield increament and soil fertility improvement due to intercropping of vetch with maze crop. Hence, to solve the feed shortage problems resulted from land scarcity, forage legumes (vetch) intercropping in maize can play a great role in the study area. In addition, the benefits of forage legumes in soil fertility improvement make the system very attractive for the farmers. Thus, there is a need to promote the technology in maize production areas. Moreover, vetch seed should be multiplied and distributed to farmers to enhance dissemination and adoption of the technology.

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References

AlemayehuMengistu, GezahagnKebede, GetnetAssefa and FekedeFeyissa, 2016.Improved forage crops production strategies in Ethiopia: A review. *Academic Research Journal of Agricultural Science and Research*,Vol. 4(6), pp. 285-296,DOI: 10.14662/ARJASR2016.036

Belel.M. D,.Halim. R. A, Rafii. M. Y.And. Saud.H. M, 2014. Intercropping of Corn With Some Selected Legumes for ImprovedForage Production: A Review. *Journal of Agricultural Science*; Vol. 6(3).

Dawit and Nebi, 2017. Effect of Vetch Varieties Intercropped with Maize on Forage and Maize Yield Performance in Different Agro-Ecologies of West Arsi and East Showa Zone of Oromia , Ethiopia. *Journal of Biology, Agriculture and Healthcare,Vol.7, No.19*

GetachewBekele, KetemaBelete and J.J. Sharma 2013. System Productivity of Forage Legumes Intercropped with Maize and Performance of the Component Crops in Kombolcha, Eastern Ethiopia. East African Journal of Sciences (2013) Volume 7 (2) 99-108

Hassan, M. R. Amodu. J. T,. Muhammad. I. R,.Jokthan. G. E, Abdu S. B, B. Abdullahi, Adamu H. Y.,Musa. A, SaniI.andAkpensuen. T. T.,2014. Forage Yield and Quality of Lablab (Lablab purpureus L. Sweet) Intercropped With Maize (Zea mays L.) With Flooded Irrigation System in the Semi-Arid Zone of Nigeria.*Journal of Agricultural Science*; Vol. 6, No. 11

Shapiro, B.I., Gebru, G., Desta, S., Negassa, A., Nigussie, K., Aboset G. and Mechale. H. 2017. Ethiopia livestock sector analysis. ILRI Project Report. Nairobi, Kenya: International Livestock Research Institute (ILRI).

Pre-extension Demonstration of Oat-Vetch Mixture for Forage Production in Dodola District of West Arsi Zone

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Abstract

The activity was conducted in Keta Berenda kebele of Dodola district of West Arsi Zone, Oromia, in 2018 cropping season with the objectives of demonstrating oat-vetch mixture for quality forage production for smallholder and increasing framers awareness on improved forage production. Twenty farmers (17 males and 3 females) who have willingness to accept and disseminate the technology and own adequate land for forage demonstration were selected and organized intos Farmers Research Group (FRG). Four trial farmers were selected from the members for hosting the demonstration. Training was given to 20 farmers and 3 development agents on oat-vetch mixture technology with full production, management and utilization practices. Oats- vetch mixture and sole oat were planted on land size of 32 m x 32 m. The higher biomass yield (8.93t/ha) was obtained from oat-vetch mixture. The mixed system had 11.625% bio-mass yield advantage over sole oat cropping. Oat-vetch mixture system also improved crude protein content from 8.87 to 16%. This indicated that oat-vetch mixture improves quality of oat with higher biomass yield than sole oat cropping. Hence, the technology should be further promoted in wide scale to address feed shortage/scarcity in the study area.

Keywords: Demonstration, Forage, Oat-vetch mixture, Pre-extension

Introduction

In Ethiopia, crop residues and native pasture are the major sources of animal feed. However, these feed resources are characterized by high fiber (>55%), low digestibility, low crude protein (<7%) contents, and poor mineral composition (Derejeet *al.*, 2010). The available grazing lands are also decreasing in size and productivity due to the expansion of cropping lands and high population pressure. Moreover, in many areas of the country, animals are kept on poor quality natural pasture that commonly found in permanent grasslands, roadsides, pathways and spaces between crops' plots (Tewodros and Meseret, 2013). Hence, the production and productivity performance of animals fed on poor crop residues and pastures lands are very low (Tsige, 2000).

Fodder oat is very palatable when compared to the other forage types and considered as an excellent feed for all livestock species. It is one of the improved cereals forage crop with good biomass yield and easy to produce under smallholder farmers condition. However, fodder oat is relatively low in protein content as compared to leguminous forage species. One way to optimize utilization of available feed resources is strategic supplementation of low quality feeds with plant protein sources such as leguminous forage crops. (Hove *et al*, 2001). Hence, to further improve the nutritional value of fodder oats, supplementation of fodder oats with

protein source feeds are very important. Leguminous forage species can be used as supplementation to low quality feeds for their high protein content. Since legume forages have relatively lower dry matter yield, acceptable forage yield and quality can be obtained from production of cereals and legumes forages in mixture as compared with their sole crops (Hamdollah*et al.,* 2009). Leguminous forage crops have been investigated as potential supplements for ruminants because of their beneficial effect of increasing metabolizable energy intake, N intake and feed efficiency (Teferedegne, 2000). Animals with access to leguminous forage crops perform better than those kept on natural pasture in milk yield, weight gain, reproductive performances and survival rates (Elbasha*et al.,* 1999).

Intercropping of legumes and cereals has produced higher yields than sole cereal crops primarily on soils with no N-fertilizer (Lauk, 2005). Nutrient composition of legume-cereal intercrops on a soil without any supply of N-fertilizer produced considerably larger protein yields than sole cereal crops (Lauk, 2009). Wide use of intercropping with forage legumes is minimizing the rate of fertilizer used. Small holder farmers of our country are practicing sole crop production than integrating with improved forage legumes. Forage biomass yield of 13 - 15 ton/ha was produced from oat- vetch combinations while 6 - 9 ton/ha DM yield was obtained from pure stands of oat (Dost, 1997). In production of oat-vetch mixtures, oats can provide support to climbing vetch. Different studies also indicated that the combination of vetch with oat was an excellent strategy for better quality and total forage dry matter yield production (Tekleyohannes *et al.,* 2003**).** Therefore, this activity was designed with the objectives of demonstrating oat-vetch mixture for quality forage production and improving framers' awareness on improved forage production in the study area**.**

Methodology

Description of the study area

West Arsi Zone has eleven (11) rural and one (1) town Districts. The Zone extends from 6012'29" to 7042'55" latitude and 38004'04" to 39046'08" longitude. *Shashamanne* town is the capital town and the administrative center of the Zone. The total area of West Arsi Zone is about 12409.99 km^2 (1,240,999 ha). About 76.19% of the Zone is flat plain, while about 23.81% are ragged or unutilized terrain that includes valley, gorges, hills and dissected plateaus.

Farming system of the zone is characterized by mixed crop-livestock farming. About 95% of the population is engaged in agriculture. Most parts of the zone have elevations of ranging from 1500 to over 2300 m.a.s.l. The mean annual temperature of the zone is found between 10oc -25oc. On average, the zone gets annual mean rainfall of 1300 mm. The total length of the boundary line is about 174 km. It shares bounder line with East Shewa Zone to the North, South Nations, Nationalities and People National Regional State (SNNPRS) to the West, Arsi Zone to the Northeast, Guji Zone to the South and Bale Zone to the East (WAZANRO, 2016)
The study was conducted at KetaBerendakebele of Dodola District of West Arsi Zone, Oromia.KetaBerendakebele is found between Dodola and Hadaba districts. The elevation of the site ranges from 2362 to 2493 m.a.s.l.

Site and farmers' selection

One livestock potential kebele was selected with the participation of district livestock expert and development agents. Then 20 farmers (17 male and 3 female) having willingness to accept and disseminate the technology were purposively selected and grouped into FRGs. Four trial farmers having adequate land for forage production were selected from the members for forage establishment.

Research design

Improved fodder oat (Bonsa) and vetch *(*Gebisa*)* were used in the experiment. Oat-vetch mixture and sole oat were planted on plot size of 32 m x32 m of selected farmer's fields. The seed rate used for oat and vetch were 40kg/ha and vetch 15kg/ha, respectively, with row spacing of 20 cm apart. The seed was sown by drilling in the prepared rows. All experimental fields have received a DAP at a rate of 100kg/ha. Forage sample were taken to estimate the biomass yield from the center of experimental plot at dough stage for oats and at about 50% flowering stage for vetch. The harvested forage samples were manually chopped into small pieces using sickle and a sub-sample of 250 gm fresh weight were taken and oven dried at 65^{o}C for 72 hrs for herbage dry matter yield determination.

DM yield (t/ha) = (10 x TFW x SSDW) / (HA x SSFW) (James *et al.*, 2008).
Where: 10 = constant for conversion of yields in kg/m^2 to tone/ ha;
TFW = total fresh weight from harvesting area (kg);
SSDW = sub-sample dry weight (g);
SSFW= sub-sample fresh weight (g).
HA= Harvesting area (m^2)

Biomass yield advantages (BYA) of established forages were determined by comparing the total biomass yield obtained from the mixed forage production (vetch-oat) and oat sole farming practices in percentage as,

$$BYA\% = \frac{\text{Yield of intercrop (t/ha) - Yield of sole (t/ha) X 100}}{\text{Yield of sole (t/ha)}}$$

Data Collection

The major yield parameters including herbage yield, plant height, number of tiller per plant, biomass yield advantages, leaf to stem ratio and crude protein were collected. Farmer's perception towards the technology, and total number of field day participants, challenges and opportunities related with the technology were also recorded.

Data Analysis

Collected data was organized, summarized and analyzed to describe various variables using Excel and SPSS software, ver. 20.

Results and Discussions

Training of farmers and other stakeholders

A total of 20 farmers (17 male and 3 female) and 3 development agents(2 male and 1 female) were participated on training of forage production and utilization system. Theoretical and practical training were given to the participants on how to produce forage with high biomass yield and quality, specifically on input preparation, land preparation, forage establishment, important forage management practices such as weeding, harvesting, quality hay conservation methods, feeding systems, precaution required during utilization and the like..

Role of farmers' and other stakeholders in technology demonstration

The role of the farmers, extension workers, researchers and other stockholder during the technology demonstrationwere indicated in the table.

Table 1. Role of Farmers' and other stakeholders' participation in demonstrated technology

Actors	Roles
FRG members	Involved in land preparation, sowing, management and yield evaluation
FRG trail farmers	Trail land provision, record keeping, facilitating of members involvement, field monitoring and reporting in the case of emergency
Research teams	Provision of training for FRG members and other actors, data collection, format preparation, input provision, field monitoring, scientific data collection and analysis, preparation extension materials
Extension workers	Monitoring, feedback and information transfer, facilitating and organizing community
Other stakeholders	Funding input supply, technical backup, community facilitating, information dissemination, etc.

Farmers' evaluation of the technology

Participatory evaluation of forage production from sole oats and oat-vetch mixture practices was undertaken with farmers, DAs, and researchers at 50% flowering stage of forages Accordingly, the evaluation result indicated that oat-vetch mixture forage production was selected as the best forage production approach due to high biomass and quality forage, soil fertility improvement, low infestation of unwanted weeds and the like.

Table 2. Rank of the forage production practiced based on farmers' selection criteria

Forage production Practice	Rank	Reason
Oat-vetch mixture	1st	Produce quality forage, improve soil fertility and make good soil, increase biomass yield, reduce emergence of unwanted weeds, reduce seed rate and fertilizer and produce more leave: stem ratio.
Oat sole	2nd	Low forage dry matter yield, more appearance of weeds in sole farming, low quality of forage, require more seed and fertilizer rate

Agronomic and yield performance

The result of agronomic parameters and dry matter yield of sole oats and oat-vetch mixture practices are presented in table 3. Even though the mean values recorded was not significantly different, yet higher biomass yield (8.93t/ha) was obtained from oat-vetch mixture forage production practice than the yield (8.0t/ha) obtained from the pure stands of oat. The mixed system had 11.625% more bio-mass yield advantage over sole oat cropping. Moreover, the oat-vetches mixture practice performed well in number of tillers (12.33) and leaf stem ratio (.07) while the highest value of plant height (122.87 cm) was recorded for sole oat practice. The highest value of crude protein content (16.0 %) was recorded from oat-vetch mixture as compared to sole oat (8.87%) production. The current result was similar with Melkamu *et al. (*2016) who reported 15% of CP value from oat vetch mixture.

Table 3. Agronomic and quality performances of sole oat and oat-vetch mixture practices

Practices	Plant height (cm)	Number of tiller/plant	Leaf to stem ratio	Dry matter yield (t/ha)	Crude protein (%)
Sole oat	122.87	12.00	1.93	8.00	8.87
Oat-vetch mixture	120.20	12.33	2.07	8.93	16.00
Mean	121.54	12.16	2.00	8.46	12.43
Standard error	1.27	0.66	0.31	0.96	1.17
Sig. level	Ns	Ns	Ns	Ns	*

Conclusion and Recommendation

Pre-extension demonstration of oat-vetch mixture was conducted in Dodola district of West Arsi Zone. The result of study indicated that oat-vetch mixture forage production practice improves quality of oat with higher biomass yield than sole oat cropping system. The better performance observed from oat-vetch mixed practice attracted smallholder farmers to choose this technology. Hence, the technology should be further promoted in wider scale to address feed shortage escalating from time to time in the study area. Moreover, strengthening the linkage among forage producers and other stakeholders is I,portant to address feed shortage at farmers' level.

References

Dereje, F., Seyoum, B., Zinash, S. 2010. Characterizing and predicting chemical composition and *in vitro* digestibility of crop residue using near infrared reflectance spectroscopy (NIRS). Livestock Research for Rural Development.8.Volume 22, Article #29. Retrieved January 9, 2014, from http://www.lrrd.org/lrrd22/2/feka22029.htm

Dost, M. 1997.Technical Reports of Fodder Components, Pak/86/027- Gilgit, Pakistan.

Elbasha, E., Thornton, P. K. and Tarawali, G. 1999. An Ex Post Economic Impact Assessment of Planted Forages in West Africa, International Livestock Research Institute Impact Assessment Series *2*, International Livestock Research Institute, Nairobi. http://hdl.handle.net/10568/502

Hamdollah, E., Ahmad G. and Abdollah, J. 2009. Intercropping of Cereals and Legumes for Forage Production

Hove, L., Topps, J. H., Sibanda, S. and Ndlovu, L. R. 2001. Nutrient intake and utilization by goats fed dried leaves of the shrub legumes *Acacia angustissima*, *Calliandracalothyrsus*n and *Leucaenaleucocephala* as supplements to native pasture hay. Animal Feed Science and Technology 91: 95- 106

James, K., Mutegi, D. N., Mugendi, L. V., Verchot, J. B. and Kung'u. 2008. Combining Napier grass with leguminous shrubs in contour hedgerows controls soil erosion withoutcompeting with crops. *Agroforestry Systems*, 74**:** 37–49

Lauk, E. 2005. The yields of legume – cereal mixes in years with high precipitation vegetation periods. *Latvian Journal of Agronomy*, 8, 281-285.

Melkamu, B., Kindu M., Aberra A. and Peter T. 2016. Guidelines on the utilization of cultivated oatvetch and tree lucerne fodder in the Africa RISING sites of the Ethiopian highlandsLauk R. 2009, Dual intercropping of common vetch and wheat or oats, effects on yields and interspecific competition.

Teferedegne, B. 2000. New perspectives on the use of tropical plants to improve ruminant nutrition.Proceeding of the Nutrition Society 59(2): 209-214.

Tekleyohannes, B., Teshome A., Solomon B. and Dagnachew, W. 2003.On-farm evaluation of different seeding rates of Oat and Vetch mixtures in barley-based double cropping system of the Bale highlands.Challenges and Opportunities of Livestock Marketing in Ethiopia.YilmaJobre and GetachewGebru (Eds). In: Proceeding of 10th Annual conference of the Ethiopian Society of Animal Production (ESAP) held in Addis Ababa, Ethiopia, August 22-24, 2002. ESAP, Addis Ababa. pp 293

Tewodros, M. and Meseret, M. 2013. Production Constraints, Farmers Preferences and Participatory on Farm Evaluation of Improved Forage Technologies in Selected Districts of Southern Ethiopia, Greener Journal of Agricultural Sciences ISSN: 2276 7770 Vol. 3 (9), pp. 628-635, September 2013.

Tsige, Y. H. 2000. Livestock feed security and associated impacts on sustainable agricultural development. In: Proceedings of the Seventh Annual Conference of Ethiopian Society of Animal Production (ESAP), Addis Ababa, Ethiopia, 26–27 May 1999. pp 51–61.

Pre-extension Demonstration of Concentrate Based Arsi-Bale Sheep Fattening at Dodola and Kofele Districts in West Arsi-Zone, Oromia

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Abstract

Concentrate feed based yearling Arsi-Bale sheep fattening demonstration was conducted at Keta-Bareda and Wabe Gefersa kebeles of Dodola and Kofele districts, respectively. The objectives of the study were to demonstrate concentrate based rams fattening technology and to evaluate of its economic profitability at on-farm level. Two youth and one women research extension groups were formed purposely with collaboration of development agents. Seventy yearling Arsi-Bale rams were purchased from the surrounding markets and tagged with animal identification number. The experimental rams were then provided with anti-parasite treatments before commencing feeing. All rams were supplemented with a fattening ration of wheat straw + 65% wheat bran + 35% cotton seed cake for seventy five days. The body weight of rams was taken in fifteen days interval. Finally a mini field day was organized. The initial body weight of rams is 19.5 ± 0.29 kg. The final body weight, total weight gain and daily average weight gains of the rams were 27.4 kg, 7.9 kg and 100.33 gram, respectively. The *farmers also appreciated the final body condition of the rams. After seventy five days, fattened rams were then sold at farm gate with a gross margin of 309.09 ETB/ram. Rams fattening technology make the youth and women profitable. Thus, rams fattening technology is need to r scaling up.*

Key words: Arsi-Bale sheep, Rams fattening, Growth performance, on-farm, Demonstration

Introduction

Ethiopia has above 30 million heads of sheep (CSA, 2017). However, sheep productivity is very low. Carcass yield of local small ruminants remained at about 8 kg per head which was below the East African (11 kg) and the world (12 kg) average (Getahun, 2008). In Ethiopia, the current per capita consumption of meat is 13.9 kg/year, being lower than the African and the world per capita averages, which are 27 kg/year and 100 kg/year, respectively (Tsigereda *et al*., 2016).

In Ethiopia, livestock fattening practices by farmers mostly lay on the natural pasture (Belay and Menale, 2017). Traditional fattening practices might not take in to account the nutrient requirement of animals, the level of feeding being either above or below the animal requirements. In such conditions, livestock production mainly depends on increase of animal numbers rather than productivity per animals. Production increment through increase of sheep numbers only may not meet the meat demand of growing population (Shapiro *et al*., 2015).

The productivity of animals could be increased through improving daily body weight gain of the animals.

Fattening animals is an opportunity for employment and is a means of income generation for the poor, especially the landless, poor and widowed women (Zemene *et al.,* 2016). Fattening rams is an efficient income-generating option for small-scale farmers and is a source of family employment. Ethiopian female exhibited better skills in sheep husbandry compared to male household (Samuel *et al.,* 2016). However, they are unable to realize substantial benefits due to their low level of business experience, access to technology and participation in local markets. Female are confronted by heavy domestic workload and subsequently face time constraints as well as limited access to resources such as land, credit and production inputs.

Currently, youth employment is also a pressing issue in Ethiopia where almost two-thirds of the population is younger than 25 years (Berhanu *et al.,* 2005). High level of youth unemployment creates critical socio-economic problems in a country. Rural youth have less access to agricultural land since it is occupied by their family. Hence, there is a need to demonstrate agricultural technologies that need less land and increase productivity as well as income.
However, sheep fattening is one of the options that rural youth and women confronted with the mentioned challenges can improve their incomes. As fattening technologies require less land and increase productivity as well as income, demonstration of such agricultural technologies is important. Studies also indicate that rams fattening is a relatively easy and profitable system of animals rearing to reduce poverty, unemployment and generate income for the rural people (Kassahun *et al.,* 2017). In line with this idea, growth performance evaluation experiments were done at Adami Tulu Agriculture Research Centre using different dietary rations on Arsi-Bale sheep rams in the process of developing sheep fattening technologies. Rams fed wheat bran and cotton seed cakes gained 104 grams daily weight gain (Aman *et al.,* 2019). Hence, this study was designed to demonstrate the concentrate based yearling rams fattening and to evaluate the economic profitability of yearling Arsi-Bale sheep fattening at Dodola and Kofele districts of West Arsi Zone.

Materials and Methods

Description of the area
The demonstration was conducted in Dodola and Kofele district of West Arsi Zone. Sheep fattening history, access to road and market and water availability were some of the criteria used during kebeles selection. Accordingly, Keta-Bereda and Wabe Gefersa kebeles were purposively selected in collaboration with livestock experts from Dodola and Kofele districts, respectively. Keta-Bereda is located at 90 km and Wabe-Gefersa at 56 km East of Shashamane towards Bale-Robe town; Oromia regional state, Ethiopia.

Sheep fattening group formation
Fattening the rams was conducted following a Farmer Research Extension Group (FERG) approache. Youth and women selection was carried out based on the information collected from development agents and the discussion held with them. Relatively jobless youth and women were selected to create income for them. The main selection criteria were willingness

to undertake the sheep fattening and willingness to do in group. Accordingly, one youth group (both sexes) was formed in Keta-Bereda while youth and women only groups were formed in Wabe-Gefersa kebele. Each group members agreed to work together till the end of the fattening. Moreover, all groups selected their leader and cashier.

Roles and Responsibilities of participants

Each group purposely selected an area which is near the home of one member for construction of the sheep fattening house. Each group members then contributed materials for the house construction. The sheep houses were built by group members. Each group members were also responsible to look after the rams, clean shade, mix concentrate feed and provide feed for the animals turn by turn. Adami Tulu Agriculture Research Center (ATARC) provided concentrate feed, plastic for roof covering, nails, wood for preparing feeding troughs, medicaments, money for purchase of rams and technical support during the fattening exercise.

Capacity building

Theoretical training was provided for youth, women, famers, kebele leaders, livestock experts and development agents at kebele Farmers Training Center (FTC). Practical training was also provided mainly on dietary ration preparation (mixing concentrate feeds in appropriate ratio), feeding management, housing and health care at their fattening spot. Furthermore, they were trained on criteria of ram selection for fattening by observing at market.

Sheep House Construction

Rams house was constructed from local wood (bamboo and eucalyptus). Its roof was covered by plastic material to protect the animals from sun and rainfall. Feeding troughs were constructed from eucalyptus wood. The troughs were set in the feeding house at 50 cm above the ground and attached to the wall. The door of the house was made from iron sheet.

Animal purchase and feeding

A total of seventy yearling rams were purchased from the surrounding markets. Age of rams was determined by dentition techniques. The rams were then treated against internal and external parasites before commencement of the feeding. The animals were supplied with their daily dietary ration (3% of their body weight); half in the morning and the remaining half in the afternoon. The dietary ration was formulated from wheat bran and cotton seed cake. The total ration was grazing + 65% wheat brain + 35% cotton seed cake. One kilogram salt was mixed in 100 kg dietary ration. Before mixing the concentrate, the cotton seed cake was down sized to small sizes to be easily fed by the rams.

Chemicals composition of feed

The Table 1 indicates the chemical composition and total digestible nutrients of the wheat bran and cotton seed cake used in the ration.

Table 1: Chemical composition and total digestible nutrients of the concentrate ingredients

Ingredient	DM %	CP %	TDN %
Wheat bran (13, 67)	65	8.45	43.55
Cottonseed cake (28, 75)	35	9.80	**18.25**
Total	**100**	**18.25**	**69.8**

DM = Dry matter, CP = Crude protein, TDN = Total digestible nutrient, number in parenthesis indicate that CP and TDN percentage in individual feed

Growth performance assessment

Animal body weights were taken at 15 days interval using spring balance. The total and average daily body weight gains were calculated as follows:

$$ADW = \frac{(FBW - IBW)}{D} \qquad \textbf{TWG = FBW – IBW}$$

Where, ADG = Average daily weight gain, TWG = Total weight gain, FBW = Final body weight, IBW = Initial body weight and D = Total fattening days

Field day

Field day is a method of encouraging people to adopt new practices. Mini field was arranged to create awareness on new rams fattening technology, to share knowledge of fattening to other farmers and to compare their experience with the current technology. FREG members, other model farmers, development agents, livestock experts and invited guests participated on the field day.

Financial analysis

All costs incurred during the fattening period were recorded. Total variable costs such as animal purchase, transportation, feed costs, labor and veterinary costs were included in analysis. Shade and feeding trough construction costs were also included in the cost benefit analysis. At the end of the fattening period, the gross revenues were obtained based on the prices of the oxen sold at farm gate.

Statistical analysis

Collected data were coded and entered in micro soft excel 2007 and checked for any error. Data on all live weight changes and economic parameters were analyzed using descriptive statistics.

Results and Discussion

Participant on demonstration

Table 2 shows the number of youth and women grouped for fattening the rams. It also shows the number of farmers, development gents, livestock experts and other who participated on training and mini field day. A total of 20 male and 18 females involved directly in sheep fattening whereas a total of 86 individuals attended the mini on the mini field day.

Table 2: Number of stakeholders participated on the technology demonstration

	FERG members			Training participants			Field day participants		
Participants	M	F	Total	M	F	Total	M	F	Total
Farmer	20	18	38	33	25	58	40	24	64
DA	-	-	-	5	1	6	5	1	7
Experts	-	-	-	3	1	4	5	1	6
Others	-	-	-	3	-	3	8	2	10
Total	20	18	38	44	27	71	58	28	86

FREG: Farmers Research and Extension Group, DA: development agent, others: invited guests, M: male, F: female, Farmers term includes youth and women

Growth performance of Arsi-Bale Rams

Growth performances of the sheep were analyzed the end of the fattening period. Final body weight, total and average daily weight gains of the sheep at both districts are depicted in Table 3.

Table 3: Growth performance of rams at different location

	Experimental site		
Biological parameter	Dodola (keta Bereda)	Kofele (Wabe-Gefersa)	Overall
Initial body weight	19.2±0.34	19.7±0.29	19.5±0.29
Final body weight	27.1±0.43	27.6±0.41	27.4±0.41
Total weight gain	7.8±0.31	7.9±0.26	7.9±0.26
Daily weight gain	105.3±4.09	96.6±2.8	100.3±2.81

Keta-Bereda kebele located at Dodola while Wabe-Gefersa kebele at Kofele district

According to the growth performance result**,** there is no statistically significant difference in final body weight, total weight gain and daily weight gain between the rams allocated to the Dodola and Kofele districts. Both experimental sites found in similar agro-ecology. This might be similar effect on the rams' growth performance. Moreover, all the rams were fed similar dietary ration for the same seventy five fattening days. Also both participants applied the same management as they were given similar training and technical support as to how they should conduct the work.

Current average daily weight gain of the rams is more or less similar to the on-station result (104 gram) at Adami Tulu Agriculture Research Center (Aman *et al.,* 2019). The Arsi-Bale sheep supplemented with 300 gram/day linseed cake and wheat bran gained up to 104 gram/day (Abebe *et al.,* 2010). Current average daily weight gain higher than Arsi-Bale sheep (55-88 gram/day) fed faba bean haulms as basal diet and supplemented with different proportion of barley and linseed meal (Ermias, 2013). Study conducted at Debrezeit Agricultural Research Center (Getahun, 2014) indicated that Black Head Ogaden rams which were fed teff straw ad libtum and 450 g concentrate per head per day registered lower average daily weight gain of 65.2 g/day. Rams reared in Raya–Alemata district which were fed air dried Ziziphus leaf had also gained lower average weight of 90.5 g/head/ day/ (Tesfaye *et al.,* 2015).

The current rams fattening technology demonstration results indicated that Arsi-Bale rams reached export market weight demanded at a range (between 25-30 kg) in seventy five feeding days. This finding is also in accordance with the report of Aman *et al.,* (2019). Other studies report that Afar lambs reached the minimum live weight (25kg) in demand for export market at about 70 days of feeding while Black Head Ogaden rams that took 112 days (Getahun, 2014).

Financial analysis

The result of the financial analysis of concentrate based Arsi-Bale sheep fattening at on-farm level is given in Table 4. The youth and women invested about **1573.73 Birr** for one ram in seventy five fattening days. The average total gross output for a ram was about **309.92** ETB during the fattening period. Financial results generally indicated that youth and women benefited from the fattening exercise. This study was similar to Aman *et al.,* 2019, where the Arsi-

Bale rams, which received cotton seed cake, gave positive gross margin. Numerically, youth in Dodola district got better gross margin per ram than the youth and women groups in kofele district. Overall, the financial analysis indicates that the sheep fattening has positive gross margin.

Table 4: Economic return at different location

	Experimental site		
List of Items (ETB)	Dodola(Keta-Bereda)	Kofele(Wabe-Gefersa)	Overall
Feed cost /ram	360.50	337.40	348.95
Labor cost /ram	87.50	65.61	76.55
Veterinary cost /ram	50.00	50.00	50.00
Purchasing price /ram	950.00	1000.00	975.00
Transport cost/ram	15.10	14.80	14.95
Feeding trough cost /ram	72.00	78.80	75.40
Total cost/ram	**1535.10**	**1612.37**	**1573.73**
Total revenue /ram	1866.66	1825.00	1845.83
Gross margin/ram	**336.66**	**283.19**	**309.92**

ETB: Ethiopian Birr, Keta-Bereda kebele located at Dodola while Wabe-Gefersa kebele at Kofele district

Youth and women opinion on the technology

Youth and women shared their opinion on the ration basing their own observation on differences between their traditional fattening experience and current the demonstration. The animals were fattened in short period of time. They appreciated the processes involved animal selection criteria, feeding management, dietary ration preparation and the house construction. The fattening technology demonstrated perceived as easily manageable and profitable. They also considered the fattening work as an income source and job creation as the sheep can be fattened in short period of time.

Conclusion and Recommendation

A total of seventy Arsi-Bale sheep were kept on feeding for 75 days at on-farm level. The demonstration result indicated that the daily weight gain of the animals obtained at the end of the fattening period was similar to the on-station result. The participant youth and women were easily managing the sheep as well as the fattening technology in the way they are told by guiding researchers. As a result, the youth and women were benefited a lot from fattening exercise. The sheep fattening demonstrated showed that its one option to create job opportunity for rural landless and it could be an alternative source of income for the community. Therefore, further scaling up of this fattening technology is recommended to reach rural youth and women in the process of creating employment opportunity.

References

Abebe, T., Solomon, M., Kurt, J.P., (2010). Supplementation with linseed and wheat bran on feed utilization and carcass characteristics of Arsi-Bale sheep. Tropical Animal Health Production. Vol. 42, 677-655

Aman Gudeto, Mieso Guru, Tesfaye Alemu, Ashebir Worku, Genet Dadi (2019).. Evaluation of different feeding options for yearling Arsi Bale sheep rams to attain export market body weight. Basic journal of Agricultural Science and Review ISSN 2315-6880 Vol.7 (4), pp.35-39

Belay Zeleke, Minale Getachew (2017). Traditional Cattle Husbandry Practice in Gamo Gofa Zone, Southern Western Ethiopia. International Journal of Novel Research in Life Sciences Vol. 4, Issue 5, pp: 1-7

Central Statistical Agency (CSA), (2017). Agricultural sample survey, Report on livestock and livestock characteristics, 2017, Addis Ababa, Ethiopia

Berhanu Denu, Abraham Tekeste, Van der Deijl, Hannah., (2005). Characteristics and Determinants of Youth Unemployment, Underemployment and Inadequate Employment in Ethiopia.

Ermias, T., Solomon, M., Mengistu, U. (2013). The effect of barley bran, linseed meal and their mixes supplementation on the performances, carcass charactertics and economic return of Arsi-Bale sheep. Small ruminant research. Vol.114, 35-40

Getahun L. (2008). Productive and Economic performance of Small Ruminant production in production system of the Highlands of Ethiopia. PhD dissertation, University of Hohenheim, Stuttgart-Hoheinheim, Germany.

Getahun Kebede, (2014). Effect of Concentrate Supplementation on Performances of Ethiopian Lowland Afar and Blackhead Ogaden Lambs. Animal and Veterinary Sciences Vol. 2, pp. 36-41.

Kassahun Ahmed, Berhan Tamir and Ashenafi Mengistu, (2017). Constraints, opportunities and motives of cattle fattening practices in urban and peri-urban kebeles of Kombolcha town, South Wollo Zone, Ethiopia. Agriculture and Biology Journal of North America ISSN Print: 2151-7517, ISSN Online: 2151-7525

Samuel Kiflay , Jane Wamatu , Yeshambel Mekuriaw, Getachew Animut, Ashraf Alkhtib , Barbara Ann Rischkowsky, (2016). Participation of Female-Headed Households in Sheep Fattening in Ethiopia. Tropentag, September 18-21, 2016, Vienna, Austria "Solidarity in a competing world - fair use of resources

Shapiro B., Getachew G., Solomon D., Asfaw N., Kidus N., Gezahegn A., Henok M., (2015). Ethiopia livestock master plan, Roadmaps for growth and transformation

Tesfay Hagos, Teshale Teklue, Dawit Gebregziabiher, Yohannes T, (2015). On farm evaluation of the growth and economic benefit of afar breed rams supplemented with different protein sources: The case of Raya-Alamata District. African Journal of Agricultural Research, Vol. 10(21), pp. 2248-2253.

Tsigereda Fekadu, Mengistu Urge, Emebet Moreda, (2016). Assessment of Traditional Cattle Fattening Practices in Hararghe Highland Parts of Ethiopia. World Journal of Agricultural Sciences 12 (2): 149-160, 2016 ISSN 1817-3047

Zemene Worku, Samuel Tilahun, Taye Tolemariam, Worku Jimma, (2016). Assessment of the Prevailing Cattle Fattening Practices in Jimma Zone, South-Western Ethiopia. Jimma University, Ethiopia

Pre-extension Demonstration of Oxen Fattening Technology at Dodola District, West Arsi-Zone, Oromia

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Abstract

Pre-extension demonstration of fattening technology was conducted at Keta-Bareda kebele of Dodola district on six to eight years old Arsi oxen. The objectives of the study were to demonstrate oxen fattening technology and to evaluate its profitability at on-farm level. Two farmer research extension groups (FREG) were formed in collaboration with development agents. Each FREG constructed animal shades near one of their member home. Sixteen oxen were purchased and moved to fattening shades. Identification number and anti parasite treatment were provide for all oxen. The animals were supplemented with the feed ration composed of 65% wheat bran and 35% cotton seed cakes for seventy days. Half of their daily dietary ration was provided in the morning and the remaining half in the afternoon. Mini field day was organized at the final body condition of the animals to collect farmers' feed backs. The body weights of animals were taken with fifteen day interval using heart girth chart tape. Collected data were analyzed using descriptive statistics. Final body weights, total weight gains and average daily weight gains of the oxen were 292.5, 45.75 and 0.653 kg respectively. An average gross margin of 3160.50 ETB was obtained per the experimental animal while the total gross margin of sixteen oxen was 50567.70 ETB. Since, this fattening technology was found to be profitable, further demonstration and scaling up is recommended to reach more.

Key words: Arsi cattle, Demonstration, on-farm, Oxen fattening, Pre-extension

Introduction

Ethiopia holds the largest livestock population in Africa, which is estimated at 59.5 million heads of cattle, 30.7 million heads of sheep and 30.2 million heads of goats (CSA, 2016/17). The livestock sector contributes about 15% of the total export earnings and 30% of agricultural employment. However, the livestock sector has remained underdeveloped and in many cases underutilized (Mezgebe *et al*., 2017). For instance, Ethiopia's beef productivity per head/annual is 108.4 kg which is far less than 119 kg for Sudan, 146 for Kenya and 205 kg for the whole world (Negassa *et al.*, 2011). The current per capita consumption of meat is 13.9 kg/year, being lower than the African and the world per capita averages, which are 27 kg/year and 100 kg/year, respectively (Tsigereda *et al*., 2016).

The meat currently produced from livestock production in the country could not satisfy the high increasing demand of people. On the other hand, the traditional livestock practices are not mostly market oriented (Belay and Menale, 2017). Cattle fattening practices by farmers in highland are mostly dependents on natural pasture and crop residues with few or no

supplements. The practices did not also account for the nutrient requirement of animals, the level of feeding being either above or below the animal requirements.

Modern cattle fattening is a newly growing activity in Ethiopia. It needs selection of animals, dewoming and feeding effectively to achieve a considerable level of live weight gains for reach the target market. Fattening is relatively an easy and profitable system of rearing cattle to reduce poverty, unemployment and generate income for the rural people (Kassahun *et al.*, 2017). In Ethiopia, meat demands mostly increase during Christen, Muslim and New Year holidays (Gebreselassie, 2018).

In the highlands of Ethiopia, cattle are kept to supply draft power for crop production. Smallholder famers fatten their oxen traditionally after the completion of tillage by feeding grass for one to three months (Gebreselassie, 2018). To such technology gaps, the Adami Tullu Agriculture Research Center has developed a fattening technology for old oxen. But, the technology was not demonstrated to the farmers in the study area. Hence, the study was designed to demonstrate six to eight years old oxen fattening technology and to evaluate the economic profitability of the fattening at Dodola district.

Materials and Methods

Description the area

The study was conducted in Dodola district of West Arsi Zone. Astromically the district is located at $6^0$58'45"N latitude and $39^0$10'49"E longitude. Cattle fattening history, access to road, market and water availability for cattle were some of the criteria used during kebele selection. Accordingly, Keta-Bereda kebele was purposely selected with livestock expert of Dodola district. It is found near Herero town of Dodola district and located at 90 km East of Shashamane towards Bale-Robe town.

Oxen fattening group formation

Farmers were selected based on willingness to participate and do the work in group and previous experience in cattle fattening. The demonstration was conducted based on farmer research extension group (FREG) approaches. Two farmer research extension groups were organized in collaboration with development agents. All groups were selected their leader and cashier.

Roles and Responsibilities of participating farmers

Each FREG selected one site based on appropriateness for oxen shade construction. Participant farmers contributed local woods and labor for constructing the fattening shade (house). Further mores, they contributed money for oxen purchase and transport oxen from market to feeding shade. Farmers were also responsible to look after oxen, clean shade, mix concentrate feed and provide feed for animals. They were doing the work in orderly fashion. Adami Tulu Agriculture Research Center (ATARC) provided dietary ration (concentrate feeds), plastic for roof covering, nails, wood for feeding trough, medicaments and technical supports during the fattening period.

Farmers training

Theoretical training was given to farmers, kebele leaders, livestock experts and development agents at Farmers Training Center (FTC). Practical training which focused mainly on dietary ration preparation (mixing concentrate feeds with its ratio), feeding management, housing and health keeping was also given to selected farmers. Furthermore, the farmers were trained on how to select appropriate animals for fattening.

Experimental animals' selection and feeding

Ages of the bulls were determined by dentition technique. A total of sixteen oxen were ppurchased from Bale-Robe town of Bale Zone. The criteria for oxen selection were old age, body condition, skeletal size and healthy. Animals were treated against internal and external parasites before the commencement of the fattening trial. The animals were supplied with their daily dietary ration amount; half in the morning and the remaining half in the afternoon. Animals were fed in individual bases. Wheat straw was provided as *ad-libtum.*

Dietary rations and its ingredients

Dietary rations were formulated from different feed ingredients; wheat bran and cotton seed cake. The dietary ration was formulated of wheat straw + 65% wheat brain + 35% cotton seed cake. One kilogram salt was mixed in 100kg dietary ration. Before mixing ingredients of the concentrate feeds, group participants came together and beat the cotton seed cake by wooden sticks to decrease its size. Feed mixing was done in group once per week.

Chemicals composition of experimental feed

The Table 1 indicates the chemical composition of the wheat bran and cotton seed cake and their
total dry matter, crude protein and total digestible nutrient.

Table 1: Chemical composition of wheat bran and cotton seed cake

Ingredient	**DM%**	**CP%**	**TDN%**
Wheat bran (13, 67)	65	8.45	43.55
Cottonseed cake (28, 75)	35	9.80	**18.25**
Total	**100**	**18.25**	**69.8**

DM = Dry matter, CP = Crude protein, TDN = Total digestible nutrient

Measuring body weight gain

Body weight measurements were taken within fifteen days interval by heart girth chart developed by JICA project. Oxen were fed on the dietary ration for 70 days and then sold at surrounding market. The total and average daily body weight gains were calculated as follows:

$$ADW = \frac{(FBW - IBW)}{D} \qquad \textbf{TWG = FBW – IBW}$$

Where, ADG = Average daily gain, TWG = Total weight gain, FBW = Final body weight, IBW = Initial body weight and D = Total fattening days

Farmer field day

Mini field was arranged to create awareness on new cattle fattening technology, to share knowledge of fattening to other farmers and to compare their experience with their current technology. FREG members, others model farmers, development agents, livestock experts and others were participated in the field days.

Financial analysis

All costs incurred during demonstration of the fattening technology were properly recorded. Total variable costs such as costs of animal purchase, transportation, feed costs, labor and veterinary costs were included in partial budget analysis. Shade and feeding trough construction costs were also included in cost benefit analysis. At the end of the fattening period, gross revenues were calculated by deducting total variable costs from total revenues.

Statistical analysis

Collected data were coded and entered to micro soft excel 2007 and checked for any error. Data on live weight changes and economic parameters were analyzed using descriptive statistics.

Results and Discussions

Training and field days

The Table 2 shows the numbers of farmer and other stakeholders participated on training and field days. The training was given at the demonstration site by multidisciplinary team (animal nutritious, animal production, animal breeder and animal health) of Adami Tulu Agriculture Research Center researchers for a total of 71 participants. In addition to the training, a field day on which 86 participants have participated was organized towards the end of the fattening period.

Table 2: Stakeholder participated on training and field day

	FERG members			Training participants			Field day participants		
Participants	M	F	Total	M	F	Total	M	F	Total
Farmers	16	8	24	33	25	58	40	24	64
DA	-	-	-	5	1	6	5	1	6
Experts	-	-	-	3	1	4	5	1	6
Others				3	-	3	8	2	10
Total	16	8	24	44	27	71	58	28	86

FREG=Farmers Research Extension Group, DA=development agent, others=invited guests, M=male, F= female

Effect of dietary ration on growth performance of the oxen

Final body weight, total and average daily weight gains of the experimental animals are depicted in Table 3. The average daily body weight gain of the oxen over seventy days fattening period was 0.65 kg. The demonstration result indicated that body weight of the animals was well improved and reached for market.

Table 3: Effect of dietary ration on growth performance of the oxen (Mean ± SE)

Biological parameter	Site one	Site two	Overall
Initial body weight (kg)	245.1±3.5	248.4±8.9	246.7±4.6
Final body weight (kg)	289.4±3.2	295.6±12.3	292.5±6.2
Total weight gain (kg)	44.2±2.9	47.2±4.1	45.75±2.4
Daily weight gain (kg)	0.632±0.41	0.675±0.58	0.653±0.03

Notice: Oxen fattening carried out at two different site in the same kebele, SE = standard error

The current average daily weight gains of the animals are higher than the one reported by Mieso *et al.,* (2017) who reported that daily weight gain (0.51kg) for Arsi oxen fed on urea treated wheat straw and 4 kg concentrate per day for ninety days at Negelle-Arsi district. ILCA (1992) reported that 7- 8 years old highland zebu oxen fed concentrate feeds based on body requirement (2.5%) had attained 0.51 kg daily weight gain. The current domonstration results is lower than the one reported by Tesfaye *et al.,* (2019) who reported an average daily weight gains 0.77 kg for 2-2.5 years old Arsi bulls fed on similar dietary ration at on-station level.

Current oxen average daily weight gain was also lower than the average daily weight gain for old Fogera oxen (0.91kg) but similar to the old Adet area oxen (0.65 kg) which was fed on concentrate feeds for 90 days at Andassa Livestock Research Center (Adebabay *et al.,* 2013). However, the results of the current study was fairly similar in daily weight gain to fattening of similar age oxen under on-station condition. The mean total weight gain of all the sixteen oxen was above 45 kg in the seventy days of feeding period. The good body condition of the animals at the end of fattening period indicate that the dietary ration (wheat straw + 65% wheat brain + 35% cotton seed cake) have good effect on the growth performance on the oxen.

Financial analysis

The result of partial budget analysis of fattening the six to eight old oxen at on-farm level is given in Table 4. The cost incurred per ox was about 12577.27 ETB in seventy days fattening. The total gross output for an ox was about 3160.48 ETB. The average gross revenue obtained from one ox was about 3160.48 ETB. Financial results indicated that famers who fatten sixteen old oxen could get 50567.68 ETB in seventy days. The financial analysis result indicates that fattening oxen at on-farm level have positive gross margin is worth investing.

Table 4: Economic return from on-farm oxen fattening

List of Items	Site one (ETB)	Site two (ETB)	Overall (ETB)
Feeds costs per ox	3027.04	3097.5	3062.27
Purchasing price per ox	8150	8400	8275.00
Transport cost per ox	70	70	70.00
labor cost per ox	437.5	437.5	437.50
Shade and feeding trough cost	612.5	612.5	612.50
Veterinary cost per ox	120	120	120.00
Total cost per ox	**12417.04**	**12737.5**	**12577.27**
Total gross output per ox	15163	16313	15737.75
Gross margin per ox	2745	3575.5	3160.48
Total gross margin	**21963.68**	**28604**	**50567.68**

Notice: Oxen fattening carried out at two different sites in the same kebele ETB: Ethiopia Birr

Farmers' opinion on the technology

Farmers have their own opinion on the oxen fattening technology. They have own observation on difference between their traditional fattening experience and the current fattening. In this study, participant farmers have appreciated the efficiency of the fattening ration in changing body condition of the animals. The fattening technology was also found to be profitable and easily manageable by farmers.

Conclusions and Recommendations

Pre-extension demonstration fattening technology was conducted at Keta-Bareda kebele of Dodola district on six to eight old age Arsi- oxen with the objectives of demonstrating oxen fattening technology evaluating its profitability at on-farm level. A total of sixteen Arsi cattle oxen were fed for 70 days. The demonstration result indicated that fattening six to eight years old Arsi oxen using ration composed of 65% wheat bran and 35% cotton seed cakes for seventy days is so effective and profitable. Hence, it is important to further scale up the technology to reach more farmers over wider geographical areas.

References

Adebabay Kebede, Addisu Bitew, Tewodros Bimrew, Asresu Yitayew, Yihalem Denekew, Yeshiwas Ferede, Getinet Zeleke, 2013. Comparative Evaluation of the Fattening Performance of Fogera and Adet Old Oxen at Andassa Livestock Reseach Center, Ethiopia. Int. J. Pharm. Med. & Bio. Sc. Vol. 2, No. 4

Belay Zeleke, Minale Getachew, 2017. Traditional Cattle Husbandry Practice in Gamo Gofa Zone, Southern Western Ethiopia. International Journal of Novel Research in Life Sciences Vol. 4, Issue 5, pp: 1-7

Central Statistical Agency (CSA) (2017). Agricultural sample survey, Report on livestock and livestock characteristics, 2017, Addis Ababa, Ethiopia

Gebreselassie N, 2018. Review on Beef Cattle Production and Marketing System in Ethiopia. Journal of Fisheries & Livestock Production. J Fisheries Livest Prod, 6:3 DOI: 10.4172/2332-2608.1000277

Kassahun Ahmed, Berhan Tamir, Ashenafi Mengistu, 2017. Constraints, opportunities and motives of cattle fattening practices in urban and peri-urban kebeles of Kombolcha town, South Wollo Zone, Ethiopia. Agriculture and Biology Journal of North America ISSN Print: 2151-7517, ISSN Online: 2151-7525

ILCA 1992. Effect of Age On-fattening and Body Condition of Draught Oxen Fed Teff Straw Baseddiets. International Livestock Center For Africa. Tropical Animal Health Prod. 24(2).103-8

Mezgebe G, Gizaw S, Urge M, Chavhan A, 2017. Begait cattle production systems and production performances in northern Ethiopia. Int. J. of Life Sciences. 5(4): 506-516.

Mieso G, Girma D, Tesfaye A, Aman G, Ashebir W, Frehiwot M, 2017. On-farm demonstration of urea wheat straw based cattle fattening at Negelle- Arsi district of West Arsi Zone . Procceding of review workshop on completed research activities of livestock directorate held at Agricultural research center, Adami Tulu, Ethiopia.

Tesfaye Alemu, Ashebir Worku, Genet Dadi, Mieso Gurru, Aman Gudeto, 2019. Evaluation of different feeding options for growing two years old Arsi-Bulls to attain export market weight. Basic Research Journal of Agricultural Science and Review ISSN 2315-6880 Vol. 7(1) pp.

NATURAL RESOURCE MANAGEMENT

Pre-Extension Demonstration and Evaluation of Soil Test Based Lime Application in Reclamation of Acid Soil for Cereal-Legume Productivity in Selected Districts of Western Oromia

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Abstract

The experiment was executed for three years (2016-2018) in three Districts of Western Oromia (Diga, Jimma Geneti, and Horro Districts). The objective of the research was to demonstrate and evaluate soil test based lime application with recommended fertilizer for acidic soil reclamation in enhancing cereal-legume productivity of the smallholder farmers. Two cereal crops (maize, wheat) and one legume crop (faba bean) were used as test materials throughout the experimental periods. The experiment had two treatments(lime and with out lime) established on two separate plots of 10m x10m laid side by side for ease of comparision. The demonstration result indicated that, except for faba bean, there was significant mean difference in grain yield for the tested crops. The evaluation results of some physico-chemical properties of the soil (pH, Ca, Mg, K, Av`. P (ppm), %TN, %OC, %OM) also showed that there is progressive change in lime reated soil than untreated plots. The availability soil nutrients were increased for crop growth and development lime application which consequently increased crop yield besides keeping soil health for long term utilization. Thus, scaling up of the integrated soil test based fertilizer and lime application technology is very crucial.

Key words: Acid soil, Cereal-legume, Grain yield, Lime, Participatory approach

Introduction

Soil acidity is a serious constraint for crop production in many regions of the world. Especially it is now a serious problem to crop production in most highland area of Ethiopia in general and in southern and western parts in particular. Currently, it is estimated that about 40% of the total arable land of Ethiopia is affected by soil acidity (Abdenna *et al*., 2007; Taye, 2007). From these 27.7% moderately to weak acids with pH 5.8-6.7 and 13.2% covered by strong to moderate acidic soils with pH less than 5.5 (Schlede, 1989). Acidic soils occupy approximately about 60 % of the land area of the earth. They arise under humid climatic conditions of the earth from carbonaceous less soil forming rocks in all thermal belts of the earth. Soil acidification is partly a consequence of the depletion of calcium and magnesium. This occurs through the leaching of cations of calcium and magnesium by infiltrating water and through uptake by crops. Acidification of soil is intensified by the application of mineral

fertilizers, primary nitrates as well as by acid rains and climate change. Acidic soil reaction and the associated negative characteristics reduce the productivity of the soil and quality of crops as well as adversely affecting ecological balance in farm land.

Soil acidity affects the growth of the crop because acidic soil contains toxic levels of aluminum, manganese and characterized by deficiency of essential plant nutrients such as P, Ca, K, Mg, and Mo (Wang *et al.,* 2006). At pH below 5, aluminum is soluble in water and becomes the dominant ion in the soil solution. In acid soils, excess aluminum primarily injures the root apex and inhibits root elongation. The poor root growth leads to reduced water and nutrient uptake, and consequently crops grown on acid soils are confronted with poor nutrients and water availability. The net effect of which is reduced growth and yield of crops (Wang *et al*., 2006). Soil acidity is expanding both in scope and magnitude in Ethiopia even though it varies from location to location and severely limiting crop production (Abdenna *et al*., 2007).

The strongly acid soils are found in ecologies which receive or have historically received high incidence of rainfall and have warm temperatures much of the year. They are often found in Oxisols, Nitisols, and Ferralsols. Thus, the most strongly acidic soils are found in Western and South Western parts of Ethiopia, the central highlands, the high rainfall areas of North Western part of the country. Nevertheless, moderately acidic soils (pH 5.5- 6.5) are distributed through much of the rest of the country (Taye, 2008). In moving from central (West Shoa) to Western Ethiopia (West Wellega), the degree of soil acidification that is measured in terms of acid saturation percentage is increased (ASP>60). In Western and Eastern Wollega Zones, the large proportions exchangeable acidity was due to exchangeable Al while at West Shoa Zone it was due to exchangeable Hydrogen.

The acidity problem in East and West Wellega Zone of Oromia Region is critical (Abdenna *et al.*, 2007) and deserved immediate intervention to amend the soils for crop production. As a case in point, a site specific study of soils around Asosa and Wellega revealed that in aggregate, some 67 percent had pH values less than 6 and were very strongly to strongly acidic (Mesfin, 2007). In some cereal crop growing areas (barley and wheat) of central and Southern Ethiopia, farmers have shifted to producing oats which is more tolerant to soil acidity than wheat and barley (Desta, 1988). Considering this fact, the Federal Government of Ethiopia has identified soil acidity as a key agricultural problem and directed the concerned stakeholders to find integrated and sustainable solution to address the problem (Abdenna *et al*., 2007). Lime application to acidic soils is one of the solutions to address soil acidity problem (Brady and Weil; 2002). There are voluminous research findings indicating that liming raises the pH of soil there by making unavailable nutrients in to available form to crops. Accordingly, for the last three years pre-extension demonstration and participatory evaluation of soil test based lime application in reclamation of acid soil for cereal-legume productivity was conducted on three Districts of Western Oromia. Therefore, the present study was initiated to demonstrate and evaluate soil test based lime application with recommended fertilizer for soil acidity reclamation for enhancing cereal-legume productivity of the smallholder farmers of Western Oromia.

Material and Methods

Site selection and FRGs formation

The experiment was carried out for three consecutive years during 2016, 2017 and 2018 main cropping seasons in purposively selected districts of Diga, Jimma Geneti and Horro. The districts were selected based on their crop production potential for wheat, maize and faba bean, suitability of the environment for that specific commodity, accessibility for supervision and compatibility with the AGP criteria. Improved maize variety (BH-661) and faba bean were used as test materials in Diga and Jimma Geneti districts while improved bread wheat variety (Buluk) and faba bean were used for Horro district. From each district 15-20 farmers were organized in FRGs and participated in all activities starting from land preparation until harvesting and threshing. For ease of evaluation and comparison by FRGs and other stakeholders, the treatments (limed and unlimed) were established on adjuscent plots of 10 m x 10 m ($100m^2$) for all tested crops. Trainings were provided for all FRG members regarding the importance of soil reclamation with lime and the proper management and monitoring required for the experiment. All commodities were sown keeping respective recommendation and proper agronomic management practices (fertilizer rates and its application methods, spacing between rows and plants, weeding time etc.).

Data collection & analysis

Grain yield data were collected through own field observation. Total number of farmers participated on extension events such as training, field visit and mini-field days were recorded by gender composition. Feedback assessments on farmers' preference (likes and dislikes) and farmers' perception towards the performance of the technologies were also recorded. The data was analyzed using descriptive statistics such as mean and standard deviations.

Results and Discussions

Training and field day

Mini-field day was organized in each district (Horro, Jimma Geneti and Diga). Both theoretical and practical training were provided to the farmers, woreda experts and for DA's on the importance of acidic soil reclamation with lime for sustainable crop production. The training covered a total of 108 farmers (88 males and 20 females), 9 woreda experts, 21 DA's and 7 subject matter specialists.

Table 1: Training of farmers, experts and DAs

Participants	Number of participants by districts			
	Horro	Jimma Geneti	Diga	Total
Experts	3	3	3	9
DA's	7	7	7	21
Farmers	38	40	30	108
Researchers	-	-	-	7
Total	48	50	40	145

Yield performance

Maize

The mean grain yield of maize is presented in figure 1. The results of the study demonstrated that there was a significant increase in yield and yield components of maize due to the application of recommended nitrogen and P fertilizer with liming acidic soil over the control. The mean grain yield of 44 qt ha^{-1} and 56 qt ha^{-1} were obtained in Diga and Jimma Geneti Districts, respectively. The mean grain yield obtained has a yield advantage of 24.29% and 70% for Diga and Jimma Geneti Districts, respectively over the control. Since maize is a huge feeder of nutrients, application of recommended dose of mineral P and N fertilizer together with lime has paramount importance in reclaiming soil acidity and enhancing soil fertility, and improving maize yield and yield components. From this study, it is possible to deduce that integrated application of mineral fertilizers with lime amended the acidic soils and improved its fertility which in turn increased crop yield and yield components. Hence, application of lime based on the degree of soil acidity and mineral fertilizers is very crucial and could be recommended for reclaiming soil acidity and improve nutrients for maize as it enhanced grain yield and yield components of maize plant in strongly acidic soils. This result is in agreement with Okalebo *et al*. (2009) who stated that combined application of lime with nitrogen and phosphorus significantly increased maize yield in Kenya.

Faba Bean

As shown in figure 1, higher mean yield of 11.6qt ha^{-1}, 16.5qt ha^{-1} and 6.2qt ha^{-1} was obtained for limed plots in Diga, Horro and Jimma geneti Districts, respectively while the mean yield for non treated plots was 7qt ha^{-1}, 3qt ha^{-1}, and 4.1qt ha^{-1}. This result is in line with (Mesfin *et al*., 2014) that stats growth parameters, yield and yield components were significantly increased with increasing rates of liming for Haricot Bean.

Wheat

The mean rain yield of wheat is presented in figure 1 below. According to the result, the lime treated plots gave higher mean grain yield (32.5qtha-$^{1)}$ than the non-treated plots which gave 27qtha^{-1}. Labetowicz *et al.* (2004) and Fageria and Baligar (2001) reported that liming is the most common soil management practice and effective for reducing soil acidity related problems and it may be beneficial as plant nutrients.

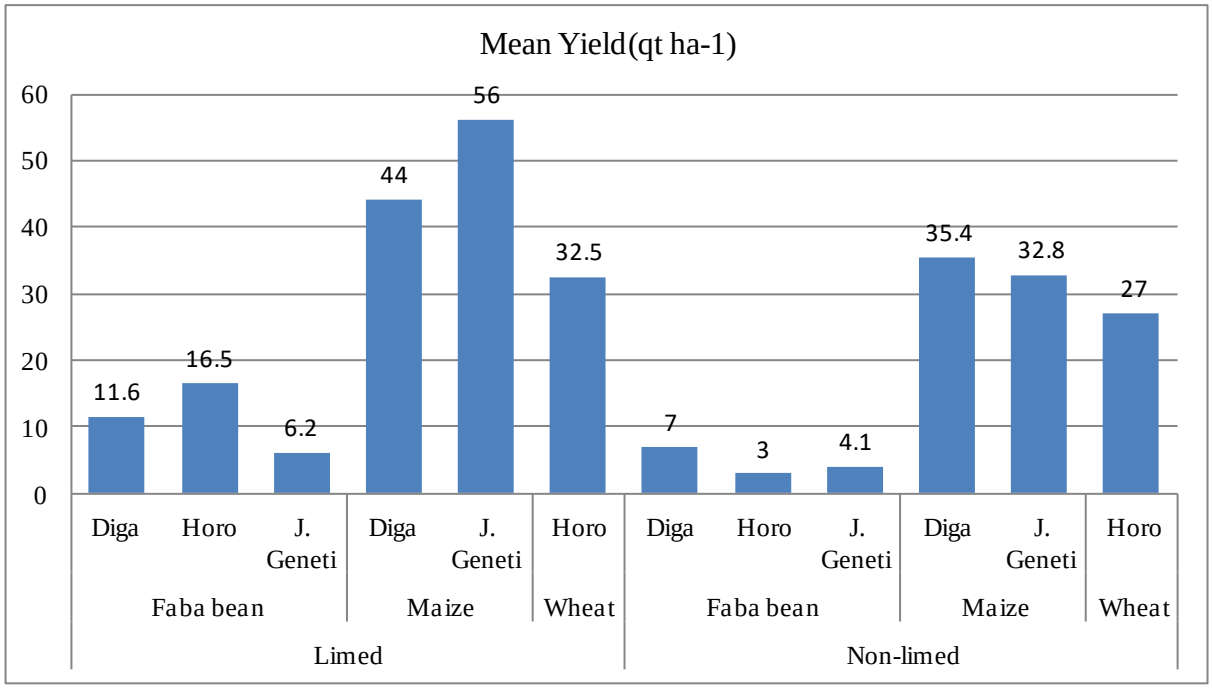

Fig 1*: Over all mean yield data obtained for three years from over locations qtha^{-1}(2016-2018)*

Soil properties

As shown in table 2 below, there is progressive change in soil parameters during the experimental period for lime-treated plots than non-treated. This is an indicator of the availability of most soil nutrients for measured parameters were increased and available for crop growth and development which consequently increased crop yield (biomass and grain yield). However, it was practically observed that crop yield numerically decline gradually from the year of lime application more on the third year which indicates that the soil need additional liming after the third year of lime application for renewal. Similar studies by Fageria and Baligar (2008) also concluded that liming improved the use efficiency of a number of elements by upland rice genotypes. Liming reduces Al^{3+} and H^{+} ions as it reacts with water leading to the production of OH^{-} ions, which react with Al^{3+} and H^{+} in the acid soil to form Al $(OH)_3$ and H_2O. The precipitation of Al^{3+} and H^{+} by lime causes the pH to increase, enhances microbial activity and nutrient availability (Onwonga et al., 2008).

Table 2: Over all summaries of 3 years soil parameters (2016-2018)

Location	Horro				
	Crop type	**Pre-sowing**	**Post harvest**	**Post harvest**	**Descriptions**
Treated plot	F.Bean			Wheat	**Source: Tekalign (1991)**
Paraeters					
pH(1: 1.25 H2O)		4.84	5.47	5.55	Moderately Acidic
Av.P(ppm)			-	-	
% OC			3.76	3.41	
% OM			6.47	5.88	
% TN			0.33	2.29	
Untreated plot					
pH(1:1.25 H2O)		4.84	5.37	5.42	Moderately Acidic
Av.P(ppm)			-	-	
% OC			3.60	2.97	
% OM			6.22	5.12	
% TN			0.31	0.25	

Key: pH- power of hydrogen, Av.P(ppm) Available Phosphorus, %OC(Organic Carbon), % OM(Organic Matter), %TN(Total Nitrogen)

Location	J.Geneti				
Parameters	**Crop type**	**pre-sowing**	**Post harvest**	**Post harvest**	**Discription**
Treated plot	F.Bean			Maize	**Source: Tekalign (1991)**
pH(1: 1.25 H2O)		4.59	5.26	5.28	Strongly Acidic
Av.P(ppm)			-	-	
% OC			4.19	2.34	
% OM			7.23	4.03	
% TN			0.36	0.20	
Untreated plot					
pH(1: 1.25 H2O)		4.59	5.15	5.17	Strongly Acidic
Av.P(ppm)			-		
% OC			2.44	2.15	
% OM			4.20	3.70	
% TN			0.21	0.18	

Key: pH- power of hydrogen, Av.P (ppm) Available Phosphorus, %OC (Organic Carbon), % OM (Organic Matter), %TN (Total Nitrogen)

Location	Diga				
Parameters	**Crop type**	**pre-sowing**	**Post harvest**	**Post harvest**	**Descriptions**
Treated plot					**Source: Tekalign (1991)**
pH(1: 1.25 H2O)		4.58	5.28	5.32	Moderately Acidic
Av.P(ppm)			-	-	
% OC			3.56	3.10	
% OM			6.13	4.70	
% TN			0.31	0.23	
Non-treated plot					
pH(1: 1.25 H2O)		4.58	5.19	5.19	Strongly Acidic
Av.P(ppm)			-	-	
% OC			2.92	2.76	
% OM			5.04	4.28	
% TN			0.25	0.21	

Key: pH- power of hydrogen, Av.P (ppm) Available Phosphorus, %OC (Organic Carbon), % OM (Organic Matter), %TN (Total Nitrogen)

Conclusion and Recommendations

Pre-Extension demonstration and evaluation of soil test based lime application was conducted in Diga, Horo and Jimma Gannati districts with the objective of demonstrating integrated soil test based fertilizer and lime application for reclaiming acidic soil and increasing crop yield. The results of the study demonstrated that there was a significant increase in yield and yield components of the test crops due to the application of recommended nitrogen and P fertilizer with liming acidic soil over the control. From this study, it is possible to deduce that integrated application of mineral fertilizers with lime amended the acidic soils and improved its fertility which in turn increased crop yield and yield components. Hence, scaling up of the integrated soil test based fertilizer and lime application is very crucial.

References

Abdenna, D. Negassa, C.W. and Tilahun, G. 2007. Inventory of Soil Acidity Status in Crop Lands of Central and Western Ethiopia."Utilization of diversity in land use systems: Sustainable and organic approaches to meet human needs" Tropentag, October 9-11, 2007, Witzenhausen.

Brady, N.C. and R.R. Weil. 2002. *The Nature and Properties of Soils* (13th Ed). Pearson.

Desta, B.1988. Soil Science Research in Ethiopia: A Review. Proceedings of the first Soil Science Research Review Workshop, 11-14 February 1986, Addis Ababa, IAR, Addis Ababa. Pp

Fageria N.K., and Baligar, V.C. 2008. "Ameliorating soil acidity of tropical Oxisols by liming for sustainable crop production". In *Advances in agronomy*, edited by: Sparks, DL. Vol. **29**, 345–399. Amsterdam: Elsevier Academic Press.

Mesfin, K., Belay Y. and Abera H. 2014. Liming Effects on Yield and Yield Components of Haricot Bean (*Phaseolus vulgaris* L.) Varieties Grown in Acidic Soil at Wolaita Zone, Ethiopia. *International Journal of Soil Science, **9**: 67-74.*

Mesfin, A. 2007. Nature and Management of Acid Soils in Ethiopia. Alamaya University of Agriculture. 18 pp.

Okalebo JR, Othieno CO, Nekesa AO, Ndungu-Magiroi KW, KifukoKoech MN (2009). Potential for agricultural lime on improved soil health and agricultural production in Kenya. Afr. Crop Sci. Conf. Proc. 9:339-341.

Onwonga RN, Lelei JJ, Freyer B, Friedel JK, Mwonga SM, Wandhawa P. Low cost technologies for enhance N and P availability and maize (*Zea mays* L.) performance on acid soils. World J Agric Sci. 2008;**4:**862–73.

Schlede, H., 1989. Distribution of acid soils and liming materials in Ethiopia. Ethiopian Institute of Geological Surveys, Ministry of Mines and Energy. Addis Ababa, Ethiopia.

Taye, B. (2007): An overview of acid soils their management in Ethiopia paper presented in the third International W0rkshop on water management (Wterman) project, September,19-21, 2007, Haromaya, Ethiopia.

Taye, B. 2008. Estimation of Lime Requirement. Training Manual for Regional Soil Testing Laboratory Heads and Technicians. National soil Testing Center, Ministry of Agriculture and Rural Development.

Wang, J., Raman, H., Zhang, G. Mendham, N. and Zou, M. 2006. Aluminum tolerance in barely (Horidium vulgarie L.): Physiological mechanisms, genetics and screening methods. Journal of Zhejiang University Science. **7:** 769-787

Pre-Extension Demonstration of Soil Test Based Phosphorus Recommendation on Teff Crop in Werra Jarso District of North Shewa Zone, Oromia

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Abstract

Soil fertility depletion presents a major challenge for sustainable productivity in order to feed the ever increasing population of the country. In view of this, pre-extension demonstration trail was conducted at Werra Jarso district of North Shewa zone during 2018 cropping season using optimum amount of nitrogen (92kgN/ha), critical P-value (10ppm) and Phosphorus requirement factor (16.33) determined during soil test and crop response based phosphorus calibration study in the year 2015. The treatments included were T1= (control no NP fertilizer), T_2= (Blanket recommendation NP fertilizer), T_3= (soil test based P recommended rate) and T4= (soil test based P recommended rate with local Teff variety) considering farmers as replication. The improved teff variety (Kora) and local teff variety (Bora) were used as a test crop for the study. Analysis of Variance indicated that there was significant difference ($P<0.05$) for the treatments tested. The highest mean grain yield (1603 kg/ha) was recorded with the soil test based P fertilizer recommendation rate (T3). The soil test based P fertilizer recommendation rate had 32.63% and 13.90 % grain yield advantage over the blanket type of fertilizer recommendation both for improved and local variety. Based on this result, soil test based fertilizer recommendation is economically feasible for teff production in the district. Therefore, scaling up of the technology (determined Pc and Pf) should be undertaken to reach more farmers with the technology.

Keywords: *Demonstration, Soil test based, Blanket Recommendation, critical P-value, Phosphorus requirement factor*

Introduction

Teff (Eragrostistef), a cereal crop that belongs to the grass family Poaceae, is endemic to Ethiopia and has been widely cultivated in the country for centuries (Tekluand Tefera 2005). The crop harbors several useful traits both for farmers and consumers. Some of these beneficial traits are; the plant is tolerant to extremely environmental conditions; the seeds are not attacked by storage pests; and the seeds are gluten-free, and hence considered as a healthy food (Kibebew *et al.*, 2011)

Almost two thirds of the Ethiopian population use teff as their daily staple food. It is estimated that per capita consumption grew by 4 percent over the last 5 years (ATA, 2013c). Growth in average incomes and faster urbanization in Ethiopia are likely to increase the demand for teff over time (Berhane *et al*. 2011). Even though, Ethiopia is a center of

origin and diversity of tef and has the above-mentioned importance and coverage of large area, its productivity is very low to feed the demand of its people and market. These is due to low soil fertility and suboptimal use of mineral fertilizers in addition to weeds, lack of high yielding cultivars, erratic rainfall distribution in lower altitudes, lodging, water logging, low moisture, and low soil fertility conditions (Fufa, 1998).

On the other hand, under conditions where most growth requirements are available and in organic matter rich soils, application of fertilizers without knowing its fertility status causes yield and fertilizer losses (Tekalign et al., 2001). There are different blanket fertilizer recommendations for various soil types of Ethiopia for tef cultivation. This is due to its cultivation in different agro ecological zones and soil types, having different fertility status and nutrient content. Accordingly, N/P recommendation rates by the Ministry of Agriculture were set at 55/30, 30/40, and 40/35 N/P kg ha^{-1} for tef crop on Vertisols, Nitosols, and Cambisols, respectively across the country (Seyfu, 1993). However, 100 kg DAP ha^{-1} and 100 kg urea ha^{-1} were set by the Ministry of Agriculture and Rural Development later (Kenea *et al.*, 2001).

Those blanket recommendations brought generally, an increase in yield of improved cultivars ranging from 1700 to 2200 kg/ha (Seyfu, 1997). Accordingly, the average national yield in the year 2010 reached 1200 kg/ha (CSA, 2010). However, the recommendations do not work for all production aspects of various soil types of different regions. Tef responds to fertilizers especially to N highly in all its yield components. Nitrogen is essential for carbohydrate use within plants and stimulates root growth and development as well as uptake of other nutrients (Tisdale et al., 1993; Brady and Weil, 2002).

Soil test based application of plant nutrient helps to realize higher response ratio and benefit: cost ratio as the nutrients are applied in proportion to the magnitude of the deficiency of a particular nutrient and correction of the nutrients imbalance in soil helps to harness the synergistic effects of balanced fertilization. Location specific fertilizer recommendations are possible for soils of varying fertility, resource conditions of farmers and level of target yield conditions of similar soil classes and environment (Ahmed *et al*., 2002).

Currently there is no site specific fertilizer recommendation for different soil-crop climatic condition. To come up with solution, soil test based crop response phosphorus recommendation and verification trial was conducted in Werra Jarso district and determination of optimum N-fertilizer P-Critical level and P-requirement factor were completed and promising result was obtained. However, the recommended soil test based P fertilizwe rate was not demonstrated on farmers' fields. This pre-extension demonstration trial was therefore conducted to demonstrate soil test crop response based phosphorus recommendation on teff and to create awareness on site specific crop response fertilizer recommendation.

Materials and Methods

Description of the study area

The study area, Werra Jarso district, is found in North Shewa zone of Oromia region at about 185 kms distance to the North West of Finfine (Addis Ababa). It is geographically located between $09^0$29'30" to $09^0$41'30"N and $38^0$30'00" to $38^0$45'00" E. The district has an altitude ranging from 500-2606 masl, and receives an average annual rain fall of 1000mm. The annual average minimum and maximum temperature was about 13 and 25^0C respectively. The soil of the study area is dominantly characterized by vertisol.

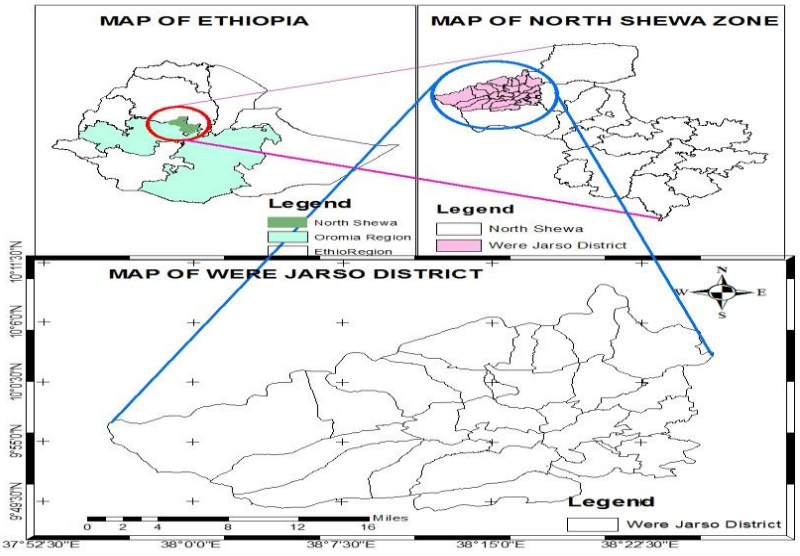

Fig.1 Location map of Were Jarso district.

Experimental design and layout

The trial was conducted on improved (Kora) and local (Bora) teff variety having 4 treatments (improved variety + P recommended rate, Blanket recommendation + improved variety, control (No fertilizer) + improved variety) in Werra Jarso district in 2018 on thirteen(13) farmers' field on 10mx10m ($100m^2$) experimental plot size for each treatment considering farmers as a replication. The seed rate used was 30kg/ha.

Soil sampling and analysis

Prior to planting time, surface soil samples were collected from farmers' field from Werra Jarso district following the standard procedures for available P analysis at a depth of 0-20cm. The collected samples were properly labeled, packed and transported to Fitche soil research center's laboratory for analysis. A total of 33 composite soil samples were collected and 13 farmer's field having initial available phosphorus below critical concentration determined for the district were selected to conduct the experiment. Then Phosphorus fertilizer rate was calculated by using the formula given below.

Phosphorus fertilizer rate (kg/ha) = (Pc-Pi)*Pf;

Where; Pc- Critical phosphorus concentration 10 ppm,

Pi- Initial available Phosphorus

Pf- Phosphorus requirement factor which was derived from the calibration study 16.33.

Economic Analysis

Marginal rate of return **(MRR)** was calculated both for farmer practice and soil test based values by using the formula given blow.

$$\mathbf{MRR} = \frac{\textbf{Net Income From Fertilized Field} - \textbf{Net Income From Unfertilized Field}}{\textbf{Total Variable Cost From Fertilizer Application}}$$

Total variable cost is a cost incurred due to application of P fertilizer (both for Soil test based P calibration result and farmers' fertilizer rate) with the assumption that the rest of the costs incurred are the same for all treatments. Total revenue is obtained by multiplying mean grain yield (kg/ha) of each treatment by the price of one kg of the grain. Net income is calculated by subtracting the total variable cost from the total revenue. To use the marginal rate of return (MRR) as basis for fertilizer recommendation, the minimum acceptable rate of return (MARR) was set to 100%.

FREGs Establishment

One Farmers Research and Extension Group (FREG) comprising of 15 members was established in each different seven kebeles (PAs). The established FREG (two newely established and five strengthened) had a total of 105 members among which 76 are males and 29 are females. The FREG member farmers were selected based on their willingness accessibility for supervision of activities and considering age and gender issues. Training was given on the importance of soil test based fertilizer recommendation as well as related agronomic practices to be followed in teff production.

Field day

Field day was organized to facilitate farmer to farmer learning and to collect feedbacks from participants. The field fay participants included farmers, Development Agents (DAs) and zonal and district Subject Matter Specialists (SMS).

Results and Discussion

Grain yield of teff

The Teff grain yield (kg/ha) was affected by different fertilizer rates as presented in table 1. According to the result of Analysis of Variance, there was significant mean difference ($p < 0.05$) among the treatments (the different fertilizer rates). The result showed that the highest mean grain yield (1603 kg/ha) was recorded in the soil test based calibration result + improved variety (Kora) followed by soil test based calibration result + local variety (1254 kg/ha). The application of 92N Kg/ha and site specific fertilizer recommendation with improved and local variety had 523 kg/ha (32.63%) and 174 kg/ha (13.90 %) yield advantage, respectively over the blanket fertilizer recommendation.

Similar studies conducted by Gidena (2016) has also reported that teff grain yield was highly increased with application of 46 kg/ha N and site specific phosphorus fertilizer recommendation.

Table: 1 Mean grain yield of teff, plant height and panicle length

Treatment	PH(cm)	P.L(cm)	GY(kg/ha)
Control(No fertilizer)	45.38[b]	13.25[b]	562.5[c]
Farmer Practice	82.70[ab]	20.90[b]	1080[b]
STBFR + Improved Variety	94.10[a]	36.25[a]	1603.13[a]
STBFR +Local variety	75.65[ab]	22.45[ab]	1254.38[ab]
LSD	37.40	14.19	489.61
CV (%)	32.28	39.28	27.96

Key: PH=plant height, P.L =Panicle length, GY=Grain yield, CV =coefficient of variation, LSD=least significant difference at five level. Means designed by the same letters are not significantly different at $p<0.05$.

Economical Analysis

To estimate the economic significanve of the different fertilizer rates, partial budget analysis (CIMMYT, 1988) was employed to calculate the Marginal Rate of Return (MRR). Based on actual unit prices during the year 2018, farm gate price of 25ETB per kg of teff for improved variety and 23 ETB for local variety, 12.78 and 10.4 ETB per kg of DAP & Urea, respectively, were used to calculate variable cost.

The marginal rate of return were found to be 614.09% for soil test based fertilizer rate with improved variety and 458.13 % for farmers practice (blanket recommended) .The economic analysis showed that the highest net income (36,435.04 ETB) were obtained from soil test based fertilizer recommended rate with improved variety of teff (Kora).

Table 2 Partial Budget Analyses

Treatments	Total variable cost (Cost of DAP and Urea)	Total revenue (TR)	Net income	MRR (%)
Control (No fertilizer)	0	14,062.50	14,062.50	
Farmers' practice (blanket recommendation)	2318	27,000	24,682	458.13
Soil test based fertilizer recommendation with improved variety	3643.21	40,078.25	36,435.04	614.09
Soil test based fertilizer recommendation with local variety	3643.21	28,850.74	25,207.53	305.91

Conclusion and Recommendation

From the experiment, the highest mean grain yield (1603 kg/ha) was recorded in the soil test based calibration result with improved variety with 32.63 % yield advantage over the blanket fertilizer recommendation. The economic analysis also showed that the highest net income (36,435.04 ETB) and marginal rate of return of 614.09 % was obtained from soil test based recommended fertilizer rate with improved variety. Based on this result, the soil test based fertilizer recommendation is recommended for further scaling up to reach more farmers with the technology.

References

BekabilFufa, BefekaduBehute, Rupert Simons and TarekeBerhe, (20011).Strengthening the tef Value Chain in Ethiopia (Unpublished Report).Agricultural Transformation Agency. 12p

Benson T, 1999. Area-specific fertilizer recommendation for hybrid maize grown by Malawian small holders. Manual for Field Assistants by Action Group I. Maize commodity Team-chitedze Agricultural Research station and Member of Action Group I, Maize Productivity Task Force.

Bungard, R. A., A.Wingler, J. D. Morton and M. Andrews, 1999. Ammonium can stimulate nitrate and nitrite reductase in the absence of nitrate. Plant Cell and Environment, 22: 859-866.

BushaAbabu, 2006. Effect of N and P application and seedbed types on growth, yield and nutrient content of sweet potato (Ipomoea batatas L.) grown: In West Wellega. M. Sc. Thesis, Haramaya University. 4p.

California Fertilizer Association, 1995. Western Fertilizer Hand Book (8thed.). Inter State Publishers, Inc. USA

CIMMYT, 1988.From Agronomic data to farmer Recommendation: An Economic Training Manual. Completely revised edition, Mexico, DF.

CSA (Central Statistical Authority), 2015.Agricultural Sample Survey 2014/2015 vol. 1. Report On area and production for major crops (private peasant holding meher season) statistical Bulletin 278, Addis Ababa, Ethiopia.

Deckers, J. A., F. O. Spaargaren and O. C. Nachtergaele, 2001. Vertisols: Genesis, properties and soil-scape management for sustainable development. pp. 3-20. In: Syers, J. K., F. W. T. Penning de Veris & P. Nyamudeza (eds.). The sustainable management of Vertisols. Proceedings of the 20th International Board for Soil Research & Management (IBSRAM). CABI Publishing, Wallingford, UK

Doris Piccinin (2002), "More about Ethiopian Food: Teff", University of Washington, USA.

FandufeEY,Eneji AE, Agboola AA, Yamamota S, and T.Honna, 2001.An Assessment of some Fertilizer Recommendations Under Different Cropping System in a Humid Tropical Environment.TROPICULTURE,19,1:21-27.

Gidena (2016). Verification and Demonstration of Soil Test Based Phosphorus Fertilizer Recommendation Rate on Yield of Teff (Eragrostis tef), in vertiso lof Northern Ethiopia.

Gilbert, F. Stallknecht (1997), "New Crop Factsheet: Teff", Montana State University, USA.

HailuTefera and W.E. Peat, 1996. Evaluation of selection methods for grain yield in the F2 and F3 generations of tef (Eragrastistef). Ethiopian Journal of Agricultural Science, 15: 20-32.

KebebewAssefa,Yu JK, Zeid M, Getachew Belay, HailuTefera and Sorrells MF.2011.Breeding tef [Eragrotistef (Zucc.)Trotter]. Conventional and Molecular approaches (review). Plant Breeding 130:1-9

KebebewAssefa, Solomon Chanyalew and ZerihunTadele (eds.) 2013.Achievements and Prospects of Tef Improvement; Proceedings of the Second International Workshop, November 7-9, 2011, DebreZeit, Ethiopia.Ethiopian Institute of Agricultural Research, Addis Ababa, Ethiopia; Institute of Plant Sciences, University of Bern, Switzerland.Printed at Stämpfli AG, 3001 Bern, Switzerland. ISBN: 978-3-033-03818-9.

Lory, J. A., G. W. Randall, and M. P. Russelle, 1995. A classification system for factors affecting crop response to nitrogen fertilization. Agron. J., 87: 869-76.

Mengle K. and E. A. Kirkby, 1996.Principle of Plant Nutrition.Panimo Publishing Corporation. New Delhi, India.

Miller, R. W. and R. L. Danahue, 1995. Soils in Our Environment (7th ed.). Prentice-Hall of India Private limited, New Delhi.

Miller, P. W. and R. L. Donahue, 1997.Soils in Our Environment. (7th ed.). Prentice-HallInc, USA. 649p.

National Soil Service (1994), "Training Materials on Soils for Use by Development Personnel.Watershed Development and Land Use Department MONRDEP, Addis Ababa, Ethiopia.

Panhwar, P.2004.The Role of Nitrogen Fertilizer in Agriculture.

Penning De Veris and P. Nyamudeza (eds.). The sustainable management of Vertisols.Proceedings of the 20th International Board for Soil Research and Management (IBSRAM).

Prasad, R and J.Power.1997.Soil fertility Management for sustainable Agriculture.Lewis publishers, Bocan Raton, New Work.

Purcell Mountain Farms (2008), "INGREDIENTS: Whole Grain Teff. Nutrition Facts", Moyie Springs -Idaho, USA.

Sanchez, P. A., A. M. Izac, I. Valencia and C. Pieri, 1996. Soil fertility replenishment in Africa: A Concept Note. In: Proceeding of the workshop on developing African agriculture: Achieving Greater Impact from Research Investments. September 26-30, 1995. Addis Ababa, Ethiopia. pp. 200-207

Santhi R, Natesan R, and G.Seh'akumari, 2002. Soil test based fertilizer recommendation under IPNS for aggregatum onion in Inceptisols of Tamil Nadu. Department of Soil Science and Agricultural Chemistry.Tamil jadu Agricultural University.Coimhatore Ml 003. India. Agrupedolo R.V, 12:141-147.

AS (statistical analysis system), 2004.SAS for windows, version 9.1. SAS Institute, Inc., Cary, NC, USA

Schulthess, Urs. Boy Feil and S. C. Jutzi, 1997. Yield independent variation in grain nitrogen and phosphorus concentration among Ethiopian wheats. Agronomy, 89 (3): 497-506.

Scoones,I and Toulmin,C.eds (1999).Polices for Soil fertility Management in Africa.IIED/DFID, London.

SeyfuKetema (1993), "Breeding, Genetic resources, Agronomy, Utilization and role of tef in Ethiopian Agriculture", Ethiopian Institute of Geological Surveys, Ministry of Mines and Energy, Addis Ababa, Ethiopia.

SeyfuKetema, 1997. Tef (Eragrostistef). Promoting the conservation and use of underutilized and systems. Fert.Res. Rome, Italy. 42: 89-92.

Tisdale, S. L., W. L. Nelson, J. D. Beaton and J. L. Havlin, 1995. Soil fertility and Fertilizer, (5th ed.). Prentice-Hall of India, New Delhi. 684p.

Tisdale, S. L., W. L. Nelson, J. D. Beaton, and J. L. Havlin, 1993. Soil Fertility and Fertilizers

Treoh, F. R. and L. M. Thompson, 1993. Soils and Soil Fertility (5th ed.). Oxford University Press, New York.

Pre-extension Demonstration of Phosphorus Critical and Phosphorus Requirement Factor for Teff Crop at Lume District, East Shewa Zone, Oromia, Ethiopia

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Abstract

Participatory on farm demonstration of phosphorus critical and phosphorus requirement factor for teff crop were carried out in Lume District in 2017 and 2018 with the objective of demonstrating and popularizing soil test based phosphorus fertilizer recommendation through Farmers' Research and Extension Group (FREG) approach. Accordingly, six sites were selected from three Kebeles purposively and six FREGs; each consisting 10-15 members were organized in each selected sites. Composite soil samples were collected and initial soil phosphorus was analyzed for all sites. The demonstration treatments were established on adjacent plots each with an area of 25 m x 25 m (650 m^2), replicated over six farmers' fields. The highest mean grain yield of 1975Kg ha^{-1} was obtained from the application of Soil Test Based Fertilizer Recommendatiion (STBFR) with an extra 28% yield advantage over the farmers' practice(blanket recommendation) whereas the lowest mean grain yield of 1545 Kg ha^{-1} was obtained from farmers' practice. Financial evaluation of the demonstration revealed that maximum net benefit of (37,270ETB ha^{-1}) was obtained from STBFR while minimum net benefit of 28,361ETB ha^{-1} was obtained from farmers' practice.Thus large scale popularization of Soil test based phosphorus fertilizer recommendation for teff crop is recommended in the study area.

Key words: *Blanket recommendation, P- Critical; Pre- extension demonstration, P-requirement factor; Teff.*

Introduction

Teff (Eragrostis tef (Zucc.) Trotter] is a cereal crop extensively cultivated in Ethiopia with annual coverage of about 2.8 million hectares (Kebebew Assefa *et al*., 2013). The crop harbors several useful traits both for farmers and consumers. Some of these beneficial traits are: The plant is tolerant to extreme environmental conditions; seeds are not attacked by storage pests and gluten-free and hence considered as a healthy food.

Teff is grown under diverse agro-climatic zones. It grows at altitudes ranging from sea level 900to 2800masl with varying annual rainfall of 750-850 mm and temperatures between 10 and 27 ^oC (Seyfu, 1993). Interestingly, teff can thrive well in both waterlogged and drought conditions. But, teff production and productivity have been far below the potential, which can give yields of 4 t ha^{-1} at the on-station fields and 2.5 t ha^{-1} on farmers' fields (Kebebew Assefa *et al*., 2013). Currently the national average yield is about 1.7 t ha^{-1}, as compared to 3.9 tha^{-1} for maize and 2.7 t ha^{-1} for wheat (CSA,2018). This low productivity could be because of

many yield-limiting factors of which poor soil fertility is typical in the teff growing areas. Soil testing is the most reliable tool for making good economic and environmental decisions about applying fertilizers; hence it is helpful for efficient and effective use of P fertilizer (Vitosh, 1998). To this end, to improve the productivity of teff to its existing genetic potential Batu Soil Research Center under taken site specific soil test based crop response fertilizer calibration trail at Lume district, Oromia, Ethiopia and determined optimum nitrogen to be applied for this specific area, P critical and P-requirement factors.

These determined P- critical and P-requirement factors were also farther evaluated and verified across the district on farmers' fields and gave good results. But to move the recommendations out of shelf and to make use of it, it needs further effort for awareness creation of end users. Therefore, this activity was initiated with objectives of demonstrating and popularizing soil test based teff crop response phosphorus fertilizer recommendation through FREGs and to create awareness for farming communities in order to break traditional fertilization.

Materials and Methods

Description of the study area

The Demonstration was conducted in Lume district on Farmers field. The district it is 78km Far from the capital City of Ethiopia. It is located between 8^0 24'300" to 8^0 49'30" North and 39^0 01'00" to 39^0 17'00" East. Elevation Ranges from 1590 to 2512 masl. It is characterized by semi-arid and sub-humid climate (Lemma Gonfa, 1996). Maximum mean monthly temperature of 6.86 ^oC - 32.13 ^oC .

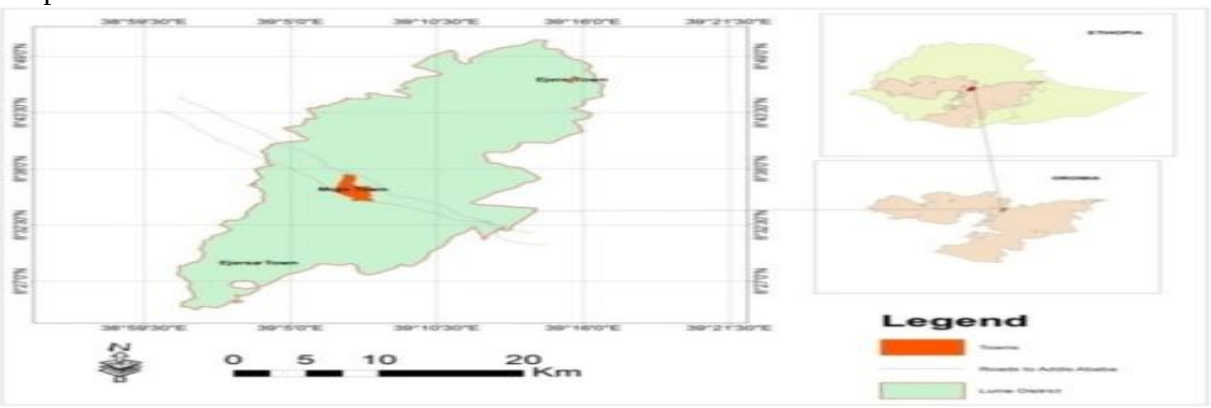

Figure 1. location map of Lume district.

The soil types of the district include Eutric Vertisol (44.84%), Mollic Andosols (21.69%) and Luvic Phaeozems (14.76%). Crops grown in the district are mainly Teff, wheat and Chickpea.

Materials

Boset teff Variety and Chemical fertilizer in the form of NPS (19% N, 38% P_2O_5 and 7% S) were used as planting material and a source of N, P and S fertilizers. GPS was used during composite soil sampling for taking coordinates of the sampling points.

Site selection and FREGs formation

FREG groups were formed to enhance farmers' participation in demonstration process and use of the technology. Accordingly, two sites were selected purposively from each three teff potential Kebeles. Six FREGs consisting of 10-15 members each were organized in selected sites (Table1).

Table1: FREGs organized and strengthen for Pre-extension demonstration of P-critical and P-requirement factor for Teff at Lume district.

Year	Number of FREGs	FREG members		
		M	**F**	**Total**
2017	5	53	14	67
2018	1	13	2	15
Total	**6**	**66**	**16**	**82**

Soil sampling and analysis

Composite soil samples were collected following the zigzag soil sampling pattern using auger. The importance of composite sampling in a zigzag pattern is relatively inexpensive, easily tracked and reproducible result might be obtained (Hardy *et al*., 2008). Available soil phosphorus was determined by Olsen method in which samples were extracted by $NaHCO_3$ Solution at pH of 8.5(Olsen *et al*., 1954). Accordingly, available phosphorus of the respective sites were categoried as Low(4.60ppm), medium(6.42ppm,8ppm,8.04ppm and 9.40ppm) and high (11.16ppm) rate according to Landon(1991).

Demonstration procedures and Management

The demonstration treatments were established on two adjacent plots each with an area of 25 m x 25 m (625 m^2) replicated over six farmers. Phosphorus addition was based on initial Phosphorus content of the soil. Available Phosphorus in the soil was tested and P recommendation rate was calculated using the formula; *Applied P* = (Critical P - Po)* Pf. Whereas *Pc= 13 ppm and Pf = 3.65 ppm* (Kefyalew *et al*., 2017).

Phosphorus fertilizer was applied at planting while, Urea fertilizer was top dressed as supplemental after planting with the rate of 46N $Kgha^{-1}$(Kefyalew *et al*., 2017). The fields were prepared following the conventional tillage practice which includes four times plowing before sowing of the crop. Moreover, agronomic management practices were carried out uniformly for all demonstration plots.

Data Collection

Biomass yield was determined by harvesting the plants from net plot area and sun drying to aconstant weight and expressed in kg ha-1. Grain yield: was taken by harvesting and threshing the grain yield from net plot area. The yield was adjusted to 12.5% moisture content and expressed as yield in kg ha.-1.

Yield advantage was also calculated using the following formula.

$$\text{Yield advantage of STBPFR} = \frac{\text{STBPFR - FP}}{\text{FP}} \times 100$$

Where, STBPFR= soil test based phosphorus Fertilizer recommendation; FP= Farmers' practice

Data Analysis

SAS statistical software version 9 was used to analyze the data. One way ANOVA was used to compare mean grain and biomass yield data. Descriptive statistical analysis was used for opinion test with **Yes** and **No** questions.

Partial Budget analysis

Partial Budget analysis was done for both farmer practice and soil test based values by using the approach explained on CIMMYT (1988).

Results and Discussion

Yield performance

The present study indicated that, grain yield, biomass and harvest index were not significantly ($p \leq 0.05$) affected by treatments. However, soil test based phosphorus fertilizer application enhanced Teff grain yield by 28% over blanket method of fertilizer application (Table 2).

Table 2. Grain yield, Biomass and harvest index of Teff as influenced by soil test based and blanket method of phosphorus fertilizer application.

Treatments	GY(kg ha^{-1})	BM (kg ha^{-1})	HI (%)
STBPFR	1979 [a]	7167 [a]	27.73 [a]
Blanket recommendation	1545 [a]	5892 [a]	26.21 [a]
LSD (0.05)	NS	NS	NS
CV (%)	24.4	15.4	12.7

Means within a column followed by the same letter are not significantly different at 5% level of significance according to Fisher protected LSD test; BM= Biomass yield; GY = Grain yield HI= Harvest Index. Pr = phosphorus required, Blanket (100/100 NPS/Urea kg ha^{-1}): STBFR = Soil test based fertilizer recommendation.

Yield advantage

The soil test based phosphorus fertilizer recommendation had 28% yield advantage over farmer's practice.

Training

Training is one of the approaches to create awareness and interest on the technology. Training was given for Farmers, DA's and Subject matter specialist at Woreda and respective sites (Table3).

Table 3: Trainings given on soil fertility improvement and soil test based fertilizer recommendation

Year	Participants					
	Farmers		DA's		SMS	
	M	F	M	F	M	F
2017	179	69	7	3	3	1
2018	13	2	8	2	5	1
Total	192	71	15	5	8	2

Field visit and mini field day

Field visit was conducted at vegetative and grain filling stage of the crop**.** Mini Field day on which 76 farmers (62M and 14F), 13 DA's (11M& 2F) and 6 SMS (5M and 1F) were participated was organized (Table 4). During field day, FREG members were exchanged their experience and discussed on soil test based fertilizer recommendation and compared it with the conventional practice based yield performance and cost of production.

Table 4. Number of Field day Participants in 2017 and 2018**.**

Year	Participants					
	Farmers		DA's		SMS	
	M	F	M	F	M	F
2017 & 2018	62	14	11	2	5	1

Partial Budget Analysis

Economic Valuation of the treatments was estimated using current market price of products and inputs. Accordingly, field price of 23 Birr Kg^{-1} 1.14.75 Kg $^{-1}$ and 13.50 Birr Kg $^{-1}$ was used for Teff grain, NPS fertilizer and Urea respectively. Transport cost, Harvesting and bagging Cost was 5Birr Kg^{-1}. According to the result of partial budget analysis, maximum net benefit (37270 ETB ha^{-1}) was obtained on Soil test based Phosphorus fertilizer recommendation while minimum net benefit(28361.25ETB ha^{-1}) was obtained from Farmers' practicesTable 6).

Table 6: Partial Budget analysis for Teff crop at Lume district in 2017 and 2018.

Treatments	GYL $Kgha^{-1}$	AGYL $Kgha^{-1}$	GFB ha^{-1}	FC ha^{-1}	TAC ha^{-1}	HBC ha^{-1}	TVC ha^{-1}	NB ha^{-1}
FP	1545	1390.5	31981.5	2825	100	695.25	3620.25	28361.25
STBPFR	1979	1781.1	40965.3	2708.8	96.06	890.55	3695.38	37269.92

Key: GYL=Grain Yield**;** AGYL= Adjusted Grain Yield; GFB= Gross field benefit ; FC= Fertilizer Cost; TAC= Transport Cost; HBC= Harvesting and bagging cost ; TVC= Total variable cost ;NB= Net benefit; EB= Ethiopian Birr; FP= Farmers' practice; STBPFR= Soil test based phosphorus Fertilizer recommendation

Conclusion and Recommendation

Pre extension demonstration activity was conducted at Lume district for demonstration of soil test and Teff response based phosphorus fertilizer recommendation through FREGs. The result of soil test based based phosphorus fertilizer indicated the highest mean teff grain yield of 1979 kg ha^{-1} was obtained from test based based phosphorus fertilizer recommendation with an extra yield advantage of 28% over faemers practice. Moreover, net benefit (37270ETB ha^{-1}) was obtained from test based based phosphorus fertilizer recommendation while a net benefit of 28361ETB ha^{-1}) was obtained from blanket recommendation. Therefore, further popularization of the recommended soil test based crop response fertilizer rate is of paramount importance.

References

Central Statistics Authority (CSA), 2018. Agricultural sample survey. Report on area and production of major crops Meher (main rainy) season for private peasant holdings in Ethiopia. Statistical bulletin 578. Addis Ababa, Ethiopia.

CIMMYT ,1988. From Agronomic Data to Farmer Recommendation: An Economics

Gonfa, L., 1996. Climate classification of Ethiopia. NMSA, Addis Ababa, Ethiopia

Hardy, D., J. Myers, and C. Stokes. 2008. "Soil Sampling Large Areas: Agricultural Crops, Pastures, Parks, or Athletic Turf." North Carolina Department of Agriculture and Consumer Services. http://www.ncagr.gov/agronomi

JR Landon, 1991. Booker tropical soil manual, Hand book for soil survey and agricultural land evaluation in the tropics and sub tropics. Longman, New York, USA.

Kebebew Assefa, Solomon Chanyalew & Zerihun Tadele (eds.), 2013. Achievements & Prospects of Teff Improvement; Proceedings of the Second International Workshop, November 7-9, 2011, Debre Zeit, Ethiopia. Ethiopian Institute of Agricultural Research, Addis Ababa Ethiopia; Institute of Plant Sciences, University of Bern, Switzerland. Printed at Stampfli AG,3001 Bern, Switzerland. ISBN: 978-3-0303818-9.

Kefyalew Assefa, Tilahun Firomsa and Tadesse Hunduma. 2017. Phosphorus Critical Level and Optimum Nitrogen Rate Determination on Teff for Sustainable Soil Fertility Management and Economical Teff Production at Lume Area of Oromia Region, Ethiopia. Journal of Biology, Agriculture and Healthcare Vol.7, No.19, ISSN 2224-3208 (Paper) ISSN 2225-093X (Online) WWW.iiste.org

Olsen SR, Cole CW, Watanabe FS, Dean LA (1954). Estimation of available phosphorus in soils by extraction with sodium bicarbonate. Circular, Vol 939 (p. 19). Washington, DC: US Department of Agriculture.

SAS. *2002* . *Statistical* Analysis System (SAS), user guide, statistics SASA. Northern Carolina, USA.

Seyfu, K., 1993. Tef (Eragrostis tef). Breeding, genetic resources, utilization and role in Ethiopia agriculture. lAR, Addis Ababa, Ethiopia.

Pre-extension Demonstration of Phosphorus Critical and Phosphorus Requirement Factor for Bread Wheat Crop at Lume District, East Shewa Zone, Oromia, Ethiopia

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Abstract

Participatory on farm demonstration of phosphorus critical and phosphorus requirement factor for bread wheat crop were carried out at Lume District in the 2017 and 2018 with the objective of demonstrating and popularizing soil test and bread wheat response based phosphorus fertilizer recommendation through FREGs. Accordingly, six sites were selected from five Kebeles purposively and six FREGs; each consisting 10-15 members were organized in each selected sites. Composite soil samples were collected, analyzed and six initial soil phosphorus (13ppm, 15.84ppm, 10ppm, 16ppm, 13.5ppm and 8.74) were identified for the sites. The demonstration treatments were established on adjacent plots each having an area of 25 m x 25 m (625 m^2) replicated over six sites. The analysis of variance indicated that, the highest mean grain yield (3780.5Kg ha^{-1}) was obtained from the application of Soil Test Based Phosphorus Fertilizer Recommendation (STBFR) whereas the lowest mean grain yield (3046.3 Kg ha^{-1}) was obtained from Farmers' practice. The economic analysis also revealed that the maximum net benefit (25809.33ETB $ha^{-1)}$ was obtained from STBFR while the minimum net benefit (20378.19ETB ha^{-1}) was obtained from farmers' practice. Thus, the Soil Test Based Phosphorus Fertilizer Recommendation is recommended for further scaling up in the district.

Key words: *Blanket recommendation; Bread wheat, P-Critical; P- requirement;* Pre-extension *demonstration*

Introduction

Healthy crops have access to soil that has an active supply of balanced nutrients. Crops are living indicators of the status of the overall soil physical, chemical, and biological environment. Hence reduced soil productivity is an indication of soil fertility decline. Currently, declining soil fertility is a major constraint on crop production in Ethiopia.Farmers are either entirely abandoning the traditional practice of using natural fallow to restore soil fertility, or are unable to leave land fallow for long enough for it to be effective (Corbeels *et al.*, 2000). Due to this, farmers are intending to find other options for mitigating continuous decline of soil fertility status for crop production. This is why the popularization of urea and DAP/NPS fertilizers are increasing from time to time through the extension programs. However, fertilizer use majorly is not recommended based on soil fertility status and crop nutrient requirements. There is also a major challenge concerning recommendations on the amount and type of fertilizers to be applied for most crops and soil types. As a result, farmers

are using blanket type fertilizer recommendations; that forced them either to use excess or low amount of these inputs.

Hence, excessive nutrient applications are economically wasteful and can also damage the environment (Bumb and Baanate, 1996). On the other hand, insufficient nutrient application can retard crop growth and results in lower yield. To alleviate this problem Batu Soil Research Center was determined optimum Nitrogen rate for bread wheat production in the first year and site specific soil test based bread wheat response phosphorus calibration study in the second two consecutive years, to identify soil P-critical and P-requirement factor at Lume district. Such soil testing is the most reliable tool for making good economic and environmental decisions about applying fertilizers and helpful tool for efficient and effective use of P fertilizer (Vitosh, 1998).

Furthermore, to ensure confidence in the recommendations the determined values of STBFR were also verified for grain yield and economic feasibility as compared to blanket recommendation and control across the district on farmers' land that gave good correlations. Because, according to (Singh *et al*., 2010), optimum return from the investment on input and minimum environmental pollution are the two major issues to be addressed while prescribing soil test based nutrient recommendations. Therefore, the objectives of this study was to demonstrate and popularize soil test based bread wheat response phosphorus fertilizer recommendation through FREGs, create awareness and enhance technology transfer to farmers of Lume district.

Materials and Methods

Description of the study area

The Demonstration was conducted at Lume district on Farmers field. The district it is 78km Far from the capital city of Ethiopia. It is located between 8^0 24'300" to 8^0 49'30" North and 39^0 01'00" to 39^0 17'00" East. Elevation Ranges from 1590 to 2512 masl. It is characterized by semi-arid and sub-humid climate (Lemma Gonfa, 1996) with Maximum means of monthly temperature 6.86 ^{o}C - 32.13 ^{o}C.

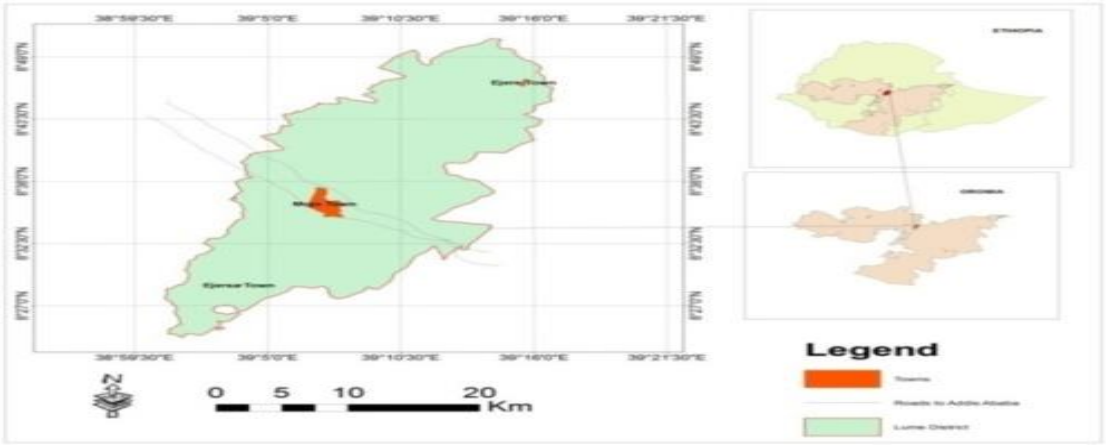

Figure 1. Location map of Lume district.

The soil types of the district include Eutric Vertisol (44.84%) Mollic Andosols (21.69%) and Luvic Phaeozems (14.76%). Crops grown in the district are mainly Teff, wheat and Chicke pea.

Materials

Bread wheat Variety (Kekeba) and Blended fertilizer in the form of NPS (19% N, 38% P_2O_5 and 7% S) were used as planting material and as a source of N, P and S fertilizer. GPS material was used during composite soil sampling for taking coordinates of the sampling points.

Sites and Farmer Selection

Sites and Farmers were selected following the potential, accessibility and willingness to provide land for demonstration. Accordingly, five sites were selected purposively from five wheat producing potential Kebeles in the year 2017 and one additional site and FREG was included 2018 (Table 1).

Table 1. FREGs organized and strengthen in Lume District.

Year	Number of FREGs	FREG members		
		M	F	Total
2017	5	49	19	68
2018	1	12	3	15
Total	6	61	22	83

Farmers research extension group (FREG) Organization.

Six FREGs each consisting 10-15 members were organized in each selected sites. During FREGs organization emphasis was given for participation of women.

Soil sampling and analysis

Composite soil samples were collected following the zigzag soil sampling pattern using auger. The importance of composite sampling in a zigzag pattern is relatively inexpensive, easily tracked and reproducible result might be obtained (Hardy *et al*., 2008). Available soil phosphorus was determined by Olsen method in which samples were extracted by $NaHCO_3$ Solution at PH of 8.5(Olsen *et al*.,1954). Accordingly, available phosphorus of one site was categorized under medium (8.74ppm) rate while all other sites were categorized under high (13ppm, 15.84ppm, 10ppm, 16ppm, and 13.5ppm) rate.following Landon (1991).

Demonstration procedures and Management

The demonstration treatments were established adjacent plots of 25 m x 25 m (625 m^2) each replicated over six farmers. Phosphorus addition was based on initial Phosphorus content of the soil. Available Phosphorus in the soil was tested and P recommendation rate was given according to the formula. P in kg/ha = (P critical – P initial)*P requirement factor. Where 19 ppm and 4.92 were P critical and P requirement factor, respectively (Kefyalew *et al*., 2018).
Phosphorus was applied at planting while, urea was top dressed as supplemental after planting with the rate of 46N Kg/ha. The fields were prepared following the conventional tillage practice which includes four times plowing before sowing of the crop. Moreover, all the

necessary agronomic management practices were carried out uniformly for all demonstration plots.

Data Collection

Grain yield was taken by harvesting and threshing the grain yield from net plot area (4*4m sample plots). The yield was adjusted to 12.5% moisture content and expressed as yield in kg ha^{-1}. Biomass yield: was determined from plants harvested from net plot area after sun drying to a constant weight and expressed in kg ha^{-1}. Yield advantage was also calculated using the following formula.

$$\text{Yield advantage\%} = \frac{\text{Yield of STBPFR (kg/ha)} - \text{Yield of FP (kg/ha)}}{\text{Yield of FP (kg/ha)}} \times 100$$

Where, STBPFR= Soil Test Based Phosphorus Fertilizer Recommendation, FP= Farmer practice

Data Analysis

SAS statistical software version 9 was used to analyze the data. ANOVA was used to compare mean grain and biomass yield data. Descriptive data analysis method was used for opinion test with **Yes** and **No** questions.

Economic analysis

Economic analysis was done for both farmer practice and soil test based values according to CIMMYT (1988).

Results and Discussion

Yield and Yield Components of bread wheat

The Analysis of Variance indicates that except harvest index, there was significan mean difference ($P \leq 0.05$) in wheat grain and biomass yield between soil test based P fertilizer recommendation rate and farmers' practice. As indicated in Table 2, the highest (3780 kg ha^{-1}) grain yield, and (11283 kg ha^{-1}) Biomass yield were recorded in soil test based fertilizer recommendation. The soil test based fertilizer application had 24.1% grain yield advantage over blanket recommendation. The result signifies that application of the required amount of phosphorus fertilizer based on soil test and crop response can give promising yield response. This result is in agreement with (Kefyalew *et al*., 2016) verification trial undertaken on bread wheat in 2014 at Lume.

Table 2. Grain yield and Biomass yield as influenced by soil test based and blanket method of phosphorus fertilizer application.

Treatments	GY(kg ha^{-1})	BM (kg ha^{-1})	HI (%)
STBPFR	3780 [a]	11283 [a]	33.8 [a]
Blanket recommendation(FP)	3046 [b]	9967 [b]	30.6 [a]
LSD (0.05)	329.2	532.7	7.99
CV (%)	6.5	3.4	19.3

Key: Means within a column followed by the same letter are not significantly different; BM= Biomass yield; GY = Grain yield, HI= Harvest Index, STBPFR = Soil test based phosphorus fertilizer recommendation.

Yield advantage

The yield advantage of the soil test based phosphorus fertilizer recommendation with that of Farmer's practice is 24.1%.

Partial Budget analysis

Partial budget analyses of the treatments were estimated using current market price for wheat grain and fertilizers. Accordingly, the price of wheat grain, NPS and Urea fertilizers were 9 Birr $Kg^{-}1$, 14.75 Kg^{-1} and 13.50 Birr Kg^{-1}, respectively in June, 2019. Transport, harvesting and bagging costs was 5Birr Kg^{-1}. The partial budget analysis result showed that the maximum net benefit (25809.33 ETB) was obtained from Soil test based Phosphorus fertilizer recommendation (Table 3).

Table 3: Partial Budget analysis for Pre-Extension Demonstration of PC and Pf for Bread wheat crop at Lume district 2017 and 2018

Treatments	GYL $Kgha^{-1}$	AGYL $Kgha^{-1}$	GFB $EBha^{-1}$	FC EB ha^{-1}	TACEB ha^{-1}	HBC $EBha^{-1}$	TVC $EBha^{-1}$	NB EB ha^{-1}
FP	3046.3	2741.67	24675.03	2825	100	1370.85	4295.84	20379.19
STBPFR	3780.5	3402.45	30622.05	3008.5	103	1701.25	4812.73	25809.33

Key: GYL=Grain Yield**;** AGYL= Adjusted Grain Yield; GFB= Gross field benefit ; FC= Fertilizer Cost; TAC= Transport Cost; HBC= Harvesting and bagging cost ; TVC= Total variable cost ;NB= Net benefit; EB= Ethiopian Birr; FP= Farmers' practice; STBPFR= Soil test based phosphorus Fertilizer recommendation

Training

Awareness creation training was given for woreda experts, DA's and farmers on soil fertility management & importance of soil test fertilizer recommendation in respective sites(Table 4).

Table 4: Training farmers, DAs and SMS on soil fertility management and soil test based fertilizer recommendation

Year	Participants					
	Farmers		DA's		SMS	
	M	F	M	F	M	F
2017	102	33	33	8	9	1
2018	12	3	18	3	9	1
Total	114	36	51	11	18	2

Key: *SFM= Soil fertility management; STFR= Soil test fertilizer recommendation

Mini Field Day

Field visit was arranged for farmers at vegetative and grain filling stage of the crop at six sites**.** Mini Field day on which 170 farmers (150M and 20F); 18 DAs (16M& 2F) and 6 SMS (4M and 2F) were participated was organized (Table 5).

Table 5. Number of farmers, DA's and SMS participate on the field Visiting and Field day at Lume district 2017 and 2018**.**

Years	Participants					
	Farmers		**DA's**		**SMS**	
	M	F	M	F	M	F
2017	75	10	10	1	2	1
2018	75	10	6	1	2	1
Total	150	20	16	2	4	2

Conclusion and Recommendation

A pre-extension demonstration activity was conducted at Lume district; Oromia, Ethiopia for demonstrating soil test based wheat response phosphorus fertilizer recommendation through FREGs. The study found out that the STBFR had higher yield when compared with farmers' practices. Furthermore, farmers who participated in Soil test based Phosphorus fertilizer recommendation demonstration obtained better net benefit than farmers who used the conventional blanket fertilizer recommendations. Therefore, to enhance production and productivity of bread wheat at Lume district, the soil test based crop response fertilizer recommendation should be further popularized through scaling up approach with full participation of all stakeholders.

References

Bumb, B. and C. Baanate, 1999. The role of fertilizer in sustaining food security and protecting the environment to 2020. Vision paper 17. IFPRI, Washington, DC,1996.

CIMMYT Economics Program, International Maize and Wheat Improvement Center, 1988. From agronomic data to farmer recommendations: an economics training manual (No. 27).

Corbeels Marc, Abebe Shiferaw and Mitiku Haile, 2000. Farmers' knowledge of soil fertility and local management strategies in Tigray, Ethiopia; Managing Africa's Soils No. 10.

Gonfa, L., 1996. Climate classification of Ethiopia. NMSA, Addis Ababa, Ethiopia

Hardy, D., J. Myers, and C. Stokes. 2008. "Soil Sampling Large Areas: Agricultural Crops, Pastures, Parks, or Athletic Turf." North Carolina Department of Agriculture and Consumer Services. http://www.ncagr.gov/agronomi

JR Landon, 1991. Booker tropical soil manual, Hand book for soil survey and agricultural land evaluation in the tropics and sub tropics. Longman, New York, USA.

Kefyalew Assefa Gejea and Tilahun Firomsa Erenso, 2018. Phosphorus Critical Level and Optimum Nitrogen Rate Determination on Bread Wheat for Sustainable Soil Fertility Management and Economical Production at Lume Area of Oromia Region, Ethiopia. Journal of Biology, Agriculture and Healthcare. Volume 8, No.1, ISSN 2224-3208 (paper): ISSN 2225-093X (Online).

Kefyalew Assefa, Tilahun Firomsa and Tadesse Hunduma. 2016. Verification and Demonstration Pc and Pf Determined Through Soil Test Based Crop Response Study for P on Bread Wheat at Lume Area of Oromia Region, Ethiopia. International Journal

of Research and Innovations in Earth Science Volume 3, Issue 6, ISSN (Online): 2394-1375.

Olsen, S.R., C.V. Cole, F.S. Watanabe and L.A. Dean, 1954. Estimation of available phosphorus in soils by extraction with sodium carbonate. USDA Circular 939: 1-19.

SAS. *2002* . *Statistical* Analysis System (SAS), user guide, statistics SASA nc. cary. Northern Carolina, USA.

Singh.K.N.Abhishek Rathore,A.K.Tripathi,A.Subba Rao and Salman Khan,2010. Soil Fertility Mapping and its Validation using spatial prediction techniques. Indian Institute of Soil science, Bhopal.

Vitosh M.L.. 1998. Wheat fertility & fertilization, Department of crop and soil sciences, Michigan University state university.

Pre-extension Demonstration of In-Situ Moisture Conservation and Management Practices for Sustainable Maize Production in Mid Land Areas of Bale Zone

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Abstract

Pre-extension demonstration of in-situ moisture conservation technology was carried out in Ginnir District of *Bale Zone, Southeast Oromia, Ethiopia using in-situ moisture conservation technology (furrow) with farmers practice in 2018 cropping season. The main objective of the study was to demonstrate and evaluate in-situ moisture conservation technologies under farmers' condition. The demonstration was undertaken on sized 10m x 10m for each practice with recommended seed and fertilizer rates. The result showed that, furrow practice performed better (80.8qt/ha) than farmers' practice (70.3qt/ha). Furrow practice gave higher yield than the famers' practice. Moreover, all participant farmers selected the furrow practice. Thus, it is important to proceed to scaling up/out of the technology in all demonstration sites and similar agro-ecologies.*

Key words: Demonstration, Farmers' preference, In-situ, Furrow, Maize, Selection criteria

Introduction

Investments in soil and water conservation (SWC) practices enhance crop production, food security and house hold income (Akalu, *et.al*, 2014). Recognizing these connections, the government of Ethiopia is promoting SWC technologies for improving agricultural productivity and production for household food security and rural livelihoods.

In situ water and soil conservation practices are a promising intervention to improve rain water management particularly, in the semi-arid to dry sub humid tropics (Emmanuel et al, 2014). To increase the moisture availability to the agricultural crops, it is necessary to adopt in-situ moisture conservation techniques in addition to the large-scale soil and moisture conservation and water harvesting structures in the watershed (Manjeet et al, 2017). To increase the moisture availability to the agricultural crops in the individual farmer's field and to increase the infiltration and percolation of rain water in to the root profile, the *in-situ* moisture conservation is recommended (M. Muthamilselvan et al, 2006).

Accordingly, some successes of *in-situ* moisture conservation have been recorded for moisture conservation and management, improving yield of Maize variety (Malkassa 2 or Malkassa 4) have been conducting at Ginnir and Goro district of Bale zone for the last three years. This experiment was conducted on small plot for evaluation. The technologies brought yield advantage at Goro Tied rigde 24.94 % and at Ginnir 23.2 % yield advantage under furrow and ridge at both locations while lower yield recorded under farm practice. Therefore,

in order to increase the subsequent Maize crop yield by using the conserved moisture of SWC technologies, it is necessary to popularize the technology in mid and lowlands of Bale zone.

Methodology

Description of the study area

The trial was carried out in Ginnir District of Bale Zone, Southeast, Oromia, Ethiopia (Figure 1). Bale Zone is among the 20 Administrative zones of Oromia. The district was selected purposively based on the potential of maize production.

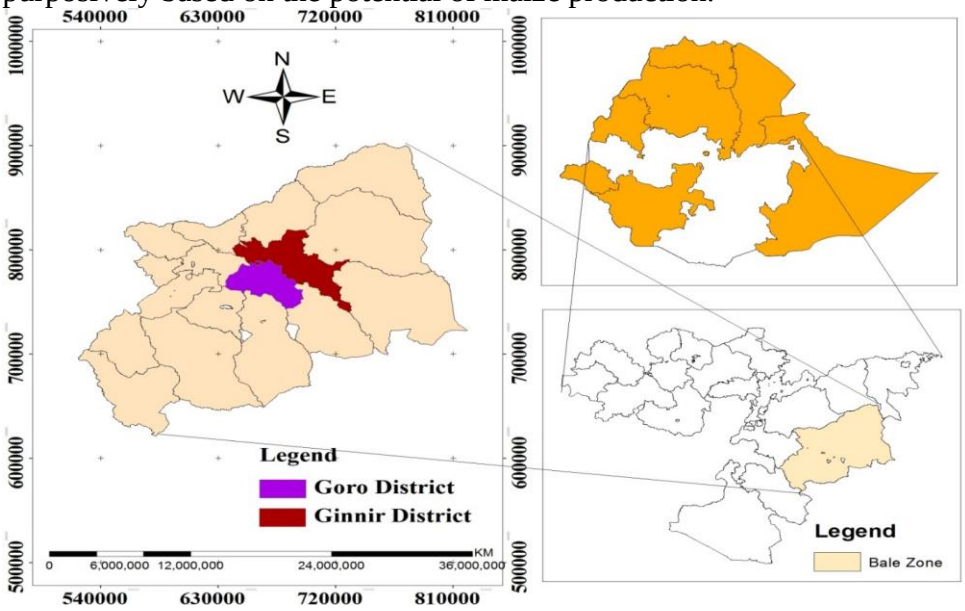

Figure 1. Location map of maize pre-extension demonstration area

Site selection

Pre-extension demonstration of *in-situ* moisture conservation technology was carried out at Ginnir district of Bale zone. Purposive sampling methods were employed to select two representative kebeles based on their potential for maize production and accessibility to road. A total of five farmers were also selected purposefully based on accessibility and willingness.

Materials used and field design

Improved maize variety (Malkasa-2) and *in-situ* moisture conservation and management technology (furrow) was demonstrated and compared with farmers' practice. All the recommended agronomic management practices were carried out for all treatments. The first weeding was done one month after planting and the second weeding carried out one month later after of the first weeding.Hosting farmers provided their land. Farm land preparations were carried out by trial/hosting farmers, whereas land leveling, planting, first and second weeding, follow up visit, harvesting, threshing were handled and managed by the center.

Data collection

Data were collected using direct field observation/measurements, key informant interview and focused group discussion (FGD). Demonstration plots in all locations were harvested and yield data was recorded. Farmers' preference to the demonstrated technologies was identified.

Data analysis
Descriptive statistics was used to analyze the yield data. Simple matrix ranking was used to compare traits of demonstrated technologies. Independent sample t test was used to compare the mean difference among the demonstration treatments.

Results and Discussions

Yield performance of the demonstrated technology
The yield obtained from the demonstration sites revealed that the mean yield of *in-situ* moisture conservation technology (furrow) and farmers' practice was 80qt/ha and 70.3qt/ha respectively. The furrow practice had yield advantage of 14.94% over the farmers' practice.

Table 1: Mean grain yield of furrow and farmers' practices

Treatments	Mean grain yield (Qt/ha) across districts		Overall mean	Yield advantage (%)
	Ebisa	Harawa		
Furrow	73.2	88.4	80.8	14.94
Farmers' practice	70	70.6	70.3	

The independent sample t test result showed that, there was no statistically mean difference between *in situ* moisture conservation and farmers' practice.

Economic evaluation
The cost-benefit estimation result showed that furrow practice had higher benefit to cost ratio (1.57) than the farmers' practice (1.36).

Table 2: Cost Benefit Ratio Analysis

Variables	Furrow	Farmers' practice
Yield obtained (qt/ha)	80.8	70.3
Sale price (ETB/qt)	800	800
Gross Returns (Price X Qt) TR	64640	56240
Land preparation	4500	3500
Seed purchase	400	400
Fertilizers purchase (NPS)	1400	1400
Fertilizers purchase (UREA)	1300	1300
Weeding cost	3500	3500
Insecticide purchase	600	600
Labor for spray	200	200
Harvesting & thresh	4200	4000
Packing, Loading and store	250	200
Store (bag purchase)	810	710
Total Variable Costs TVC (ETB/ha)	17160	15810
Fixed cost	8000	8000
Total cost (TC)	25160	23810
Net Return (GR-TC)	39480	32430
Benefit cost ratio (NR/TVC)	1.57	1.36

Farmers' participatory evaluation and selection

As shown in table 3 below, participant farmers preferred furrow to the traditional practice due to higher number of cob/plant, height of cob, bigger size of seed, better stem strength, unavailability of unproductive plants and good plant height.

Table 5: Rank of the technologies based on farmers' selection criteria

No	Practice	Rank	Reasons
1	Furrow	1st	Higher number of cob/plant, height of cob, bigger size of seed, better stem strength, root has got soil, unavailability of unproductive plants, good plant height.
2	Farmer practice	2nd	Lower number of cob/plant, smaller height of cob, smaller size of seed, stem strength is not good, root hasn't got soil, availability of unproductive plant, plant height is not good

Conclusions and Recommendations

Pre extension demonstration and evaluation of *in-situ* moisture conservation and management practices for sustainable maize production was carried out on representative trial farmers' fields. Furrow was demonstrated, evaluated and compared against the farmers' practice. According to demonstration trial results, furrow was high yielder than farmers' practice. Furrow was selected due to its higher number of cobs/plant, height of cob, bigger size of seed, better stem strength, and root has got soil, unavailability of unproductive plants and good plant height. Therefore, the succeeding pre-scaling up/out of *in-situ* moisture conservation should be carried out in areas where it was demonstrated and selected and similar agro ecology.

References

Akalu Teshome, Jan de Graaff and Leo Stroosnijder, 2014. Evaluation of soil and water conservation practices in the north-western Ethiopian high lands using multi criteria analysis. Soil Physics and Land Management Group, Environmental Science Department, university of Wageningen, Wageningen, the Netherlands.

Emmanuel Opolot, Tesfay Araya, Jan Nyssen, Bashar Al-Barri, Koen Verbist and Wim M. Cornelis, 2014. Evaluating *in-situ* water and soil conservation practices with a Fully coupled, Surface/Subsurface Process-Based Hydrological Model in Tigray, Ethiopia.

Muthamilselvan M, R. Manian and K. Kathirvel, 2006. *In-situ* moisture conservation techniques in Dry farming- A review. Department of Farm Machinery, Agricultural Engineering collegeand Research Institute, Tamil NaduAgricultural University, Coimbatore- 641 003, India.

Manjeet Prem, R. Swarnkar, PremRanjan and A. V. Baria. 2017. *In-Situ* Moisture Conservation Through Tillage Practices. Department of Farm Machinery and Power Engineering, College of Agricultural Engineering &Technology, Anand Agricultural University, Godhra, Gujarat, India.

Pre-extension Demonstration of Moringa Preparation and Utilization Methods in East Shoa Zone, Oromia, Ethiopia

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Abstract

Moringa plants are among high value a tree belongs to the Moringaceae family which consists of 13 species and they are highly distributed in Africa and southern Asia. Eastern Shoa zones of Oromia regional state in central part of Ethiopia have favorable agro climatic conditions for cultivation of moringa tree species. However, there is a few numbers of local communities experiencing Moringa trees production and consumption in the area. Thus, the objective of this training and demonstration was to promote, popularize and improve public awareness on moringa on procedures of moringa preparation for effective consumption and utilization in the areas. Household interview followed by theoretical training with practical demonstration were used for the demonstration. Random sampling methods were used to select 60 farmer households, 4 experts and 7 DA's. Descriptive statistics was used for data analysis. The results indicated that the interviewed farmers about 76% have no Moringa on their farm and as a result most of them cannot identify Moringa visually. Similarly, many local farmers have no trees on their garden, and almost all of them (84%) have no information about Moringa unless few farmers with a piece of information on its medicinal uses alone. Many of the farmers only use Moringa leaves when they sick, especially for blood pressure. However the farmers have a desire to plant Moringa trees where as 40% of have a worry to get Moringa seedlings availability to plant and they claimed that this causes absence of Moringa trees on our farm. About 40% of the respondents were stated that, they only use Moringa for medicinal purpose, and in the same way about 40% of them are not previously used Moringa at all, while the rest 20% of them used as both for its medicinal and food source for some food type supplementation. However, many locals have interested in planting Moringa trees to plant. Hence, Popularization of Moringa should have to get attention by concerned stakeholders, especially on organizing continuous seeds and /or seedlings sources for local communities.

Keywords: *Miracle tree, Nutrient content, Farmers Research Group, Leave powder, Drying process, Healthy leave*

Introduction

Moringa plants are among the high value trees, belongs to Moringaceae family which consists of 13 species and they are highly distributed in Africa and southern Asia. It is multi-purpose tree with medicinal, nutritional, industrial and socio-economic values (Hamza and Azmach, 2017). These species of Moringa are widely distributed in the tropical regions especially M. Oleifera and M. stenopetala have wide geographic ranges. Considering their ecological

nativities, M. stenopetala and M. oleifera often referred to as the African and Indian Moringa tree respectively. These two species have extraordinary nutritional and medicinal properties in various part of the world (Morton *et al*., 2012). Moringa is one of the most useful tropical trees. The relative ease with which it propagates through both sexual and asexual means and its low demand for soil nutrients and water after being planted makes its production and management easy. Introduction of this plant into a farm which has a biodiverse environment can be beneficial for both the owner of the farm and the surrounding eco-system (Azharia, 2016).

Most people in the world lack adequate access to vegetables even though they are essential for good health. Insufficient vegetable and fruit consumption causes 2.7 million deaths annually worldwide and belongs to the top 10 risk factors contributing to mortality. Therefore it is necessary to increase the utilization of Moringa leaves consumption by the different communities The micro-nutrient content in Moringa is even more in dried leaves; (ten times the vitamin A of carrots), (17 times the calcium of milk), (15 times the potassium of bananas), (25 times the iron of spinach) and (nine times the protein of yogurt) (Manzoor *et al*., 2007 and Mahatab *et al*., 1987). It should be consumed either fresh or dry. Dried leaves can be stored for a long time and can be used regularly. So it is necessary to hygienically drying and processing of Moringa leaves for further uses.

Furthermore, Moringa plants have scavenging activities against oxidative radicals; this all implies its potential applications of bioactive principle in the pharmaceutical industries for drugs developments (Kassaw *et al*., 2016). *Moringa* trees have been used to combat malnutrition, especially among infants and nursing Mothers. One rounded tablespoon (8 g) of leaf powder will satisfy about 14% of the protein, 40% of the calcium, and 23% of the iron and nearly all the vitamin A needs for a child aged 1-3. Six-rounded spoonful of leaf powder will satisfy nearly all of a woman's daily iron and calcium needs during pregnancy and breast-feeding. Three non-governmental organizations in particular trees for life, Church World Service and Educational Concerns for Hunger Organization have advocated *Moringa* as "natural nutrition for the tropics." Leaves can be eaten fresh, cooked, or stored as dried powder for many months without refrigeration, and reportedly without loss of nutritional value. *Moringa* is especially promising as a food source in the tropics because the tree is in full leaf at the end of the dry season when other foods are typically scarce. Leaves were also used for food Fortification (Singhal *et al.*, 2001).

Eastern Shoa zones of Oromia regional state in central part of the country have favorable agro climatic conditions for cultivation of different medicinal plant varieties like moringa tree species. However, there is a few numbers of local communities experiencing Moringa trees production and consumption in the area, there is a lot of awareness gap regarding with preparation and utilization of this precious tree. Threrefore, the objective of the present study is to explore knowledge and perception of local farmers' on Moringa uses and preparation processes and promote, popularize and improve public awareness on Moringa on procedures of Moringa preparation for effective consumption, thereby to increase its production and utilization in the areas

Materials and Methods

Description of the Study Area

Dugda District is located in East Shewa Zone of Oromia Regional State. Geographically the District is located between 80 01'N to 80 10'North latitude and 380 31'E to 380 57'E longitude. The total area of the District is 959.45 km^2. The altitude of the District varies from 1600 meters to 2020 meters above sea level. The highest part of the District lies towards the West along the border of Gurage zone. Mount Bora is the highest peak of the District which is about 2020 meters above sea level. The average annual rainfall in the District was 671.8 mm in the past twenty years. In the past two decades the average maximum temperature of the District was 24.8^0C and the average minimum temperature was 11.4^0C. On average, this trend in temperature could be taken as suitable for crop production, animal husbandry and human habitation. Meki, the main capital of the District, is located 134km to the South East of Addis Ababa on the main asphalt road to Ziway town. The boundaries of the District are Bora District in the North and North West, Arsi zone in the East, Adami Tulu Jido Kombolcha District in the South and Gurage zone of (southern nations, nationalities and peoples regional state) SNNPRS in the West (Ammakiw and Odiem, 2014). According to the National Housing and Population Census, population projection of the year 2015, the population of the District was 185, 534 of whom 95,095 (51.3%) are men and 90,439 (48.7%) are women. Moreover, 53,314 (29%) of its population are urban dweller and the remaining 71% of its population are rural inhabitants (CSA, 2015). The two major types of soil in the District are Sandy Loam (59%) and Clay Loam (41%). These soil types have light texture making them vulnerable to both wind and soil erosions. In addition, these soil types are saline and alkaline contents, though the degree of salinity is very low. Lume District is located in East Shewa zone of the Oromia region, on a cross-road running from Addis Ababa to Djibouti, and Addis Ababa to southern part of Ethiopia. An old Ethiopia-Djibouti railway also crosses the District, which is located 70 km to the east of the national capital, Addis Ababa, and about 25km to the west of Adama. It is located between 80 12'-80 50' latitude north east and between 390 01'-390 17' longitude east and has an altitude of 1500-2300 m asl. Ranges of rainfall and temperature are 700-800 mm and $18\text{-}28^0$C respectively (District Bureau of Agriculture and rural development, 2001 EC).

Techniques and Procedures Followed for Moringa Utilization Training

Farmer selection

For this training two Districts, namely Dugda and Lume were selected randomly. Two Kebeles (the smallest administrative units in Ethiopia) with 20 farmers (10 from each Kebele) (Bekele Girissa and Wolda Kalian) and (Joko Gudedo and Ejersa Joro) with 40 farmers (20 from each Kebele) were selected from Dugda and Lume District respectively using random sampling method.

Identification of potential Moringa tree sites

Prior to standard Moringa utilization procedures, purposeful potential Moringa tree sites were identified. Then, young and old Moringa leaves were selected to make dried leaf powder of Moringa for effective Moringa nutrient contents consumption, and Morphology of leaf was identified as they are 20-70 cm long, grayish-downy when young, long petiole with 8-10 pairs of pinnae each bearing two pairs of opposite, elliptic or obovate leaflets and one at the apex, all 1-2cm long; with glands at the bases of the petioles and pinnae following Morton (1991).

Since *Moringa* leaves can easily lose moisture after harvesting; harvests were done in early morning and completed the initial phase of processing in the same day. Generally the following procedures were performed following the above steps.

Selection of healthy leaves
Fungi like Cercospora spp and Septorialycopersic causing brown spot in the leaves and further turning the leaves yellow and killing them. Apart from fungi, the most common pests on the leaves are grasshoppers, crickets and caterpillars (Alawole *et al*., 2011). Therefore diseased and damaged Moringa tree leaves were discarded, manually just after the collection of fresh leaves.

Washing
After we identified the health and potential biomass Moringa trees, we collect the leaf from the tree. Collected leaves were washed in running tap water until the removal of dirt. After this, leaves were soaked in 1% saline solution (NaCl) for 5 minutes to remove microbes. This step plays a substantial role in removal of dust, pathogens as well as microbes present on the leave surface.

Draining
We wash the collected leaf and then we put it in the sun for short period of time until excess water removed by spreading the leaves in sunlight for a brief period till the removal of water present on the leaf surface.

Drying
It is estimated that only 20-40% of vitamin A will be retained if leaves are dried under direct Sunlight, but that 50-70% will be retained if leaves are dried in the shade. High temperature may lead down to the breakage of protein present in the leaves (Martin, 2002).

Data Management
Farmer's perception and feedback on the way of *Moringa* preparations and utilization was assessed. Audio visual (Photo and video) was used during the demonstration. The assessment helps to get farmers feedback on Moringa use initiative as their food source and their interest to promote these trees on their farm. Descriptive analysis through (percentage, frequency, mean, range, and standard deviation) applied using IBM statistical package for social science SPSS version 20.0 for the data collected through household field survey.

Results and Discussion

Training of farmers, DAs and experts
A total of 71 participants (60 farmers, 4 experts and 7 DA's) were trained on Moringa utilization and preparation method.

Demonstration of Moringa Leaves Powder Making
Dry under the shade method was used for the drying process. Spread the leaflets on the sterile clean green net in a well-ventilated room. Mosquito mesh wire was used for this purpose because these materials give a space between the floor and the leaves. This room was checked

as it is free from insect, rodent and dust. It is possible to use a fan, but the air must not be directly oriented towards the leaves, as it can increase contamination with germs in the air. Leaves were completely dried within 4 days under shade (in a room with open space allowing normal air circulation) at normal temperature. The loading density was tinny layer to allow air movement freely. Dried leafs was grinded by mortar and pestles for fine grinding. As it is recommended 0.5 mm-1.0 mm pore size screen was used for the separation of the fine grinded leaf powder.

We use locally available materials for crushing of dried Moringa, because these leaves were simple available for the community and they also familiar with it to use. So the people can make or prepare Moringa powder easily at their home in combination with different food types. In this training, women's are more encouraged to gain practical exercise they involve more frequently in food preparation for children, food preparation for children and the whole family and women use Moringa during pregnancy and feeding too as supplementary food. Therefore this training is good opportunity for the woman and they were also very happy with the given training as they have heard or learned new ideas about Moringa and the way of preparing it. The practical exercise includes: drying, grinding, sieving and making tea from the powder. As it was indicated in the following picture grinded Moringa was sieved by mesh wire prepared by locally available materials and the powder was used for tea making and all participants tested the prepared tea from Moringa (see the following pictures). In addition to using by tea, the powder could also be added to different foods and can be used in daily meals.

Community Perception on Moringa before the Demonstration

Prior to the theoretical and practical training, there was an assessment on community perception on Moringa utilization and preparation methods. The assessments on local farmers' familiarity to the Moringa use indicate that about 68% of the farmer respondents have different trees planted on their backyard, where as the rests have no any plants on their land. This could be probably because of the lack of access to seedlings and shortage of the land they have. Among the interviewed farmers about 76% have no Moringa on their farm consequently most of them cannot identify Moringa visually. There are also some farmers having Moringa on their land and consider themselves as they have no Moringa as a result of lack of knowledge about Moringa. Lack of visually identifying Moringa from other trees and lack of ability to identify Moringa tree by the end users enforced to provide training and demonstration for local farmers to improve their understanding on Moringa preparation and utilization because of the importance of the trees for nutrition as food supplementation and the medicinal uses for the health benefits. Similarly, many local farmers have no trees on their garden, and amazingly almost all of them (84%) of the respondents have no information about Moringa at all unless few farmers with a piece of information on its medicinal uses alone. Regarding the frequency of their Moringa uses many of the farmers only use it when they sick, especially for blood pressure. Through the given training they were surprised with importance of Moringa and the way of preparation, how to use, with what food type could be added. However the farmers have interested to plant Moringa trees, about 40% of them said that, Moringa seedling is not available to them to plant and this factor causes absence of Moringa trees on our farm. Regarding with its advantage, about 40 % of the respondents were stated that, they only use Moringa for medicinal purpose, and about 40% of them are not

previously used Moringa totally, while the rest 20% of them used for both medicine and as food source for some food type supplementation.

Table 2 : Response of farmers about Moringa

Variable	Frequency %		
	Yes	No	Not sure
Have you planted trees on your garden/on farm	68	32	-
Have you Moringa on your farm	24	76	-
Have you information about Moringa	84	16	-
Can you identify Moringa from other trees visually	40	60	-
Have you used Moringa before	36	64	-
Do you believe in healing power of Moringa	52	16	32
Have you interest to plant Moringa	80	4	16
Have you access of Moringa seedling	8	52	40

Conclusions and Recommendation

Moringa tree contains remarkable nutrient contents that are really important for human kind with a great potential to heal many diseases. However, less attention was given to encourage communities to Moringa production, preparation and utilization by concerned stakeholders and concurrently lack of information exists on Moringa uses and its preparation ways for utilization in society. As a result few numbers of local communities have culture of consuming Moringa trees and little Moringa potential benefits exploited is in the Districts of East Shoa zone. Thus, improving local people awareness should have to be enhanced through effective training and demonstration. Based on the training and demonstration, the following recommendations are suggested: Attention should be given to make popularize the local peoples on moringa production and utilization. Popularization of Moringa should get attention by concerned stakeholders, especially for continuous seeds and /or seedlings sources for local communities. Further study is needed on identification of Moringa utilization side effects.

References

Alawole O Obembe, *Jacob O Popoola*, Sadhu Leelavathi, Siva V Reddy 2011. Advances in plant molecular farming. Biotechnology Advances 29, 210–222. , 2(1).

Ammakiw and Odiem, 2014. Availability, preparation and uses of herbal PLANTS IN KALINGA, PHILIPPINES. European Scientific Journal,. , p.9(10).

AMV Kakengi, JT Kaijage, SV Sarwatt, SK Mutayoba, MN Shem, T Fujihara 2003. Moringa oleifera be used as protein supplement to ruminant diet". Asian – Australian Journal of Animal Science 18 (1): *U. of K. J. Vet. Med. A nim. Prod*, 5(2), pp.42 – 47.

Hamza and Azmach 2017. Seed yield components, oil content, and fatty acid composition of two cultivars of

Azharia, 2016. Moringa Seeds. Available at: https://www.ahealthyleaf.com/product/moringa-seeds-pkm1/

Charles WindepagnagdeYameogo, Marcel Daba Bengaly. Aly Savadago, Phillippe Augustin Nikiema, Sabadenedyo Alfred Traore 2011. Determination of Chemical Composition and Nutritional Values of Moringa oleifera leaves. Pakistan J Nutrition 10: , 1(1), pp.264–268.

Elena Sanchez- Zapata, Juana Fernandez-*Lopez, Jose Angel Perez-Alvarez* 2012. Tiger nut (Cyperus esculentus) commercialization: health aspects, composition, properties and food applications. Compr Rev Food Sci Food Saf 11: 366-377. *Preventive Nutrition and Food Science*, p.8.

Morton, 1991. Amplified fragment length polymorphism (AFLP) analysis of genetic variation in Moringa oleifera Lam. *Molecular ecology*, p.7. Available at: http://www.ncbi.nlm.nih.gov/pubmed/10199008.

Mahatab, S.N., Ali, A and Asaduzzaman, A.H.M. (1987). Nutritional potential of sajna leaves in goats. Live stock Advisor, 12 (12): 9-12

Manzoor, M., Anwar,F., Iqba,T. l and Bhnager, M.I.(2007). Physico-chemical characterization of Moringa concanensis seeds and seed oil. J. Am. Oil Chem. Soc., 84: 413-419

Martin, 2002. THE MORINGA TREE. Echo Technical Note. USA. , (December), p.4. moringa (Moringa oleifera Lam.) growing in the Arid Chaco of Argentina. Ind Crop Prod. *Advances in Research*, (6), p.8.

Ray-Yu Yang, Lien-Chung Chang, Jenn-Chung Hsu, Brain BC Weng, Manuel C palada, ML Chadha, Virginie Levasseur 2006. Nutritional and Functional Properties of Moringa Leaves − From Germplasm, to Plant, to Food, to Health. , p.5.

Reyes, N., 2006. Potential Fodder Species for Ruminants in Nicaragua Nadir Reyes Sánchez,

Sangam L Dwivedi, Edith T Lammerts van Bueren, Salvatore Ceccarelli, Stefania Grando, Hari D Upadhyaya, Rodomiro Ortiz 2017. Diversifying food systems in the pursuit of sustainable food production and healthy diets." Trends in plant science 22.10 84 2-856.Development : A Review. , p.3.

Shalini Singhal, R Gupta, Anuradha, Goyle 2001. Comparison of antioxidant efficacy of vitamin E, vitamin C, vitamin A and fruits in coronary heart disease: a controlled trial. Journal of the Association of Physicians of India 49: 327-31. *Trees for Life Journal*, , p.2.

Stevens, G.C., Baiyeri, K.P. and Akinnagbe, O.(2013):Ethno-medicinal and culinary uses of Moringa oleifera Lam. in Nigeria. Journal of Medicinal Plants Research. 7(13):799-804

Pre-extension Demonstration of In-Situ Moisture Conservation Techniques on Maize yield and yield components in Moisture Deficit area of Dugda Woreda, East Shewa Zone, Ethiopia

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Abstract

The study was conducted during 2018 cropping season at Dugda Woreda to investigate the effect of in situ moisture conservation techniques on grain yield and yield components of maize. Treatments comprised of tied ridge, furrow closed at both end and farmer practice as control. The experiment was laid out in a randomized complete block design with three replications. The grain yield and thousand seed weight were highly significantly ($p<0.001$) difference on tied ridge and furrow closed at both end as compared to farmer practices. But stand count and number of cobs at harvest per hectare and plant height were not significantly ($p>0.05$) difference on tied ridge, furrow closed at both end and farmer practice, respectively.Tied ridge practices increased maize grain yield and thousand seed weight (gm)by up to 45.52% (27.913Qtha^{-1}) *and 41.43% over farmer practice(control), respectively. Also furrow closed at both end increased the grain yield and thousand seed weight (gm) by up 30.68%* (18.82Qtha^{-1}) *and 27.63% as compared to farmers' practice, respectively. These results claim the potential use of tied ridge and furrow closed at both end improved grain yield and thousand seed weight in study areas by enhancing moisture in the soil. Farmers should be more advisable to use in situ moisture conservation structures widely in moisture deficit area for improving crop production. Therefore, in situ moisture conservation (tied ridge and furrow closed at both end) structure is promising moisture conservation structures to mitigate dry spell period and improve maize production in the study area and similar agro ecology.*

***Key words**: Tied ridge, Furrow closed at both end, yield and moisture deficit*

Introduction

Agriculture in Ethiopia is dominated by rain fed farming with low productivity. The average annual grain production as 7 million tons is too low to support national food demands (Eyasu, 2005). Since rainfall is seasonal and erratic in dry lands of Ethiopia, there is moisture stress limiting the productivity of rain fed agriculture in the moisture stress areas (Haregeweyn et al., 2005). Food deficit in the whole country, in general, and in the dry land areas in particular, is increasing mainly due to drought and moisture deficit (Kidane and Abuhay, 2000).

Maize crop was ranked as a third place cereal consumed in the world after wheat and rice (Olaniyan, 2015), and first yield and productive cereal (FAOSTAT, 2015). Maize is an important food crop in sub-Saharan Africa, 300 million people in sub-Saharan Africa are

considering maize as primary source of food crop and livelihood (Macauley, 2015). It occupied 17% of cultivated land (FAOSTAT, 2015) and 21% in East Africa (Ndlovu, 2013). While most of sub Saharan Africa maize production is based on rain fed systems (Gebrehiwot and Gebrewahid, 2016), there is a need to find out alternative soil moisture conservation strategies to mitigate moisture deficit effects.

Moisture stress is a prolonged period of short precipitation resulting water deficiencies and lack of soil moisture to support crop production (Solh and van Ginkel, 2014), in the World is the most hazard from climate change which frustrates the productivity of agricultural crops (Muhammad, Muhammad and Cengiz, 2015). Every year there is a loss of 25% crop yield globally caused by severe drought (Bankole et al., 2017) and 36 million people in sub Saharan Africa are experiencing severe food shortage because of the drought and shortage of moisture in soil profile (Nazareth, 2016;WaterAid, 2017).

Low agricultural productivity in semi-arid region is not only due to land degradation, but also due to moisture deficit (Gebreegziabher et al., 2009). A study by Mekuria, M. and Waddington, S. (2004) noted the moisture stress being the major limitation to crops yield in cereal based cropping systems in Eastern and Southern Africa. Similarly, due to soil and crop moisture stresses are dramatically expending in the country moisture retention structures plays a vital role for successful and sustainable crop production. Therefore, planting crops using in situ moisture conservation reduces problems of soil moisture stress. By so reducing runoff through increased infiltration and storage of water in the soil profile, the onset and occurrence of severe water stress is delayed thereby buffering the crop against damage caused by water deficits during dry periods (Nyamadzawo et al., 2013). In these regards using tied ridge and furrow closed at both end are some of the methods that contribute to mitigate soil moisture content deficit and enhance maize productivity in semi arid and arid area.

In East Shewa zone, high moisture deficit is the primary problem which highly constrains the productivity of small holders' farmers of the Woreda (priority problems raised by farmers). In moisture scarce environments like Central Rift valley in general, particularly like Dugda Woreda crop plants would face shortage of moisture available in the soil throughout the growing season. The major problem in this study area is unavailability of in situ moisture conservation techniques in the study area (APCA in East and North Shewa Zone, Oromia, Ethiopia, unpublished, 2017). And also the distribution of rainfall is not sufficient to sustain crop growth and development in the study area.

As a result, the crop frequently suffers from moisture stress at some stage during its growth period, with the ultimate result of reduced yields from their farmland; because of shortage or uneven distribution of rainfall and absence conserving surface runoff within the catchment. The significance of the problems of study area is soil moisture stress, which is leading to low crop productivity. There are no sufficient research works on evaluating the effectiveness of moisture conservation techniques on improving maize yield and yield components in the study area. To increase crop yields and improve food security, using in situ moisture conservation structure in study area is critically important. Therefore, this study designed to

investigate the effects of in situ moisture conserving techniques on maize yield and recommended relevant treatments in improving production in the study area.

Materials and Methods

Description of Study Area

The field experiment was conducted at Dugda Woreda which is found in East Shewa zone of Oromia regional state. It is located at a distance of 140 and 95 km from Addis Ababa and Adama, respectively. Geographically, it is situated in the central rift valley between 8º02‘59" North latitude and 38º43'59" East longitude, respectively. Its elevation is 1600 meters above sea level (masl). According to the climatic data collected in 2018 from Adami Tulu Agricultural Researcher Center, the total annual rainfall of the area is 795.4mm and minimum and maximum temperature is 13.6ºc and 29.2ºc, respectively. The dominant soil type of the study area is sandy loam soil.

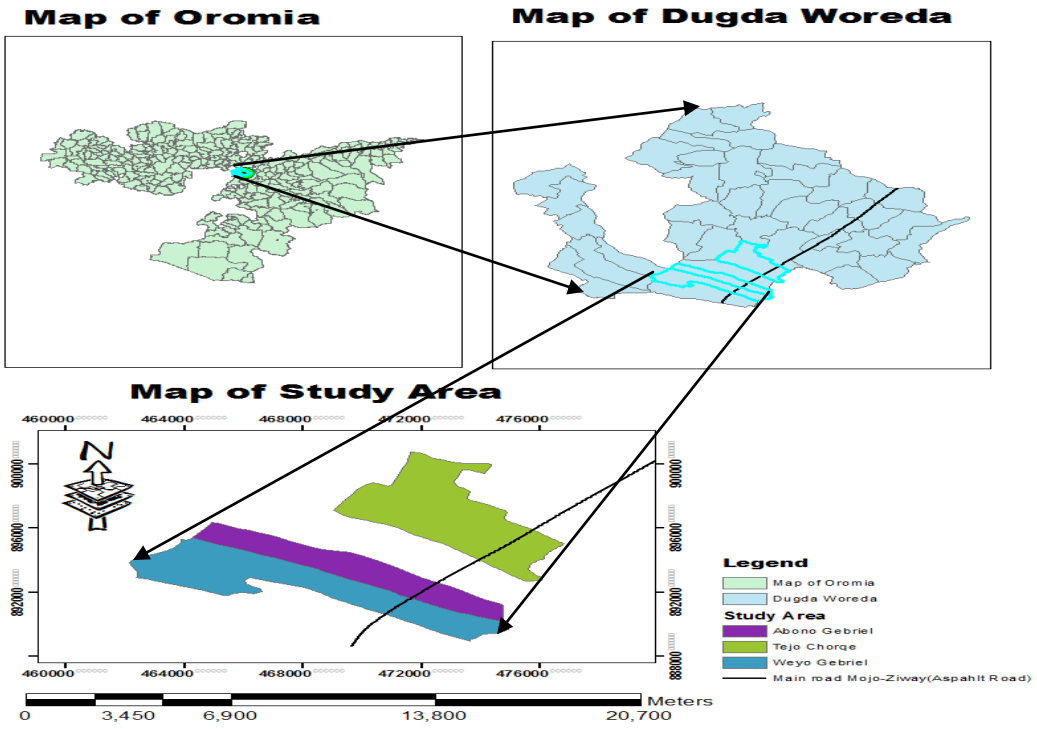

Figure 1: Map of Study area

Experimental design and Treatments

The experiment was conducted for a period of one year (2018) at the three selected kebeles (Tepo choroke 140, Woyo Gebriel and Abuno Gebriel) of Duda Woreda under rain fed condition on farmers’ farmland. The three kebeles of study area were selected purposively on the basis of its maize production and moisture deficit. Two farmers for each kebele were selected purposively based on their willingness and recommendation by woreda agricultural expert and Development agent (DA) for conducting experiment. The experiment was laid out

in a Randomized Complete Block Design (RCBD) with three replications on six farmers. Three levels of treatments (Farmer practice (control), Furrow Closed at both End(FCE) and Tied ridge(TR)) were used and conducted on similar slope.

Each treatment was applied on a plot size of 10mx10m ($100m^2$) separated by a distance of 1.5m between blocks and 1 m within plots. The height of tied ridge and ties was 30cm and 20cm .respectively. Maize was planted at spacing of 25cm between plant and 75cm between plots. The BH-540 maize variety was used as testing crop. Recommended fertilizers were applied.

Preparation of in situ Moisture conservation structures

All experimental plots were ploughed three times by oxen plow using the local maresha before imposing any of the treatments. In tied ridging, ridge furrows are blocked with earth ties at 3.3m distance apart from one another to form a series of micro catchment basins in the field. The furrow was closed at both ends at spacing of 10m. The tied ridge was prepared by hand hoe. The tied ridge was prepared after planting maize crop.

Farmer Research Extension Group (FREG) Establishment and Min field day

The selected farmers were organized under Farmers Research Extension Group (FREG) to increase farmers awareness on in situ moisture conservation structures in view of improve maize yield in moisture deficit area.Three Farmers Research Extension Group (FREG) were established one at each kebele's. Each FREG members hold 15 farmers and a totally 45 farmers participated in the project, from this 40% of them were women and 60% of them were men household heads. Farmers participated on mini field day and became aware on the importances of in situ moisture conservation structure. Also two (2) subject matter specialist (SMS) from Woreda Agriculture and Natural Resource Bureau and six (6) Development Agents (DAs) participated on mini field day (Figure 3). The directly benefited farmers played the role of information sharing to other farmers, recording and provided information and took an active participation in all the way from site selection, in situ moisture conservation construction to harvesting.

Data Collection

The plant height recorded by taking the random five plants from the central three rows of the net plot area (2.25 m x 10 m) of each plot. This was done by measuring the main stem and the panicle before harvesting at time of maturity. Yield was recorded from the central three rows of the net area of 2.25 m x 10 m by excluding the border rows. Yield per plot was recorded from air-dry weight of seeds of the net plot area (2.25 m x 10 m) and expressed as $Qtha^{-1}$.The plant stand count and number of cobs (heads) per hectare were determined by counting the number of plants in the net area for the three rows (2.25 m x 10 m). Weight of seeds was determined by counting thousands seed dry seeds and their weight recorded in grams.

The yield advantage (%) of using moisture conservation structure is calculated by Eq.1 and analyzed using descriptive statistics (Eshetu,A and Tadele,G, 2016).

$$\text{Yield advantages (\%)} = \frac{\text{Yield with structure} - \text{Yield without structure}}{\text{Yield without structure}} * 100 \ldots\ldots\ldots\ldots \text{Eq. 1}$$

Data Analysis

The R analytical software version 3.5.2 was used to analyze the data. Analysis of Variance (ANOVA) was used to determine effect of the in situ moisture conservation structure method on yield and yield components parameters of the maize. Mean separation least significant difference (LSD) was used to compare and separate treatment means at 0.1% and 5% probability level.

Results and Discussions

Grain Yield

The grain yield was highly significant ($P < 0.001$) in situ moisture conservation (tied ridge and furrow closed at both end) techniques. The mean yield indicated in Table 1, revealed that grain yield was significantly increased by tied ridge practice. Also the mean yield of maize yield significantly increased on furrow closed at both end. The higher grain yield of maize obtained from the structure of tied ridge is attributed to the greater infiltration and storage of water in soil; which gives plants ample time to take up the stored water as compared to the farmer practice. This finding agrees with many researchers Heluf Gebrekidan, 2003, Gebreyesus, 2004, and Taye and Yifru, 2010) had also reported the importance of the practice of tied ridge in increasing crop yields by increasing the time for the water to penetrate into the soil.

Similarly, Solomon (2015) reported that the grain yield of early maturing maize varieties was significantly affected by in situ moisture conservation practices. The recorded maximum yield from the tied ridge might be attributed to the efficiency of tied ridge to conserve and retain moisture when compared to the other moisture conservation practices. This result is also in conformity with the findings of Mudalagiriyappa et al. (2012) reported that the increased yield of maize could be attributed due to the reduced surface runoff and reduced risk of erosion and soil nutrients and also due to increased water holding capacity of the soil in situ moisture conservation structure. But, there was no significant difference ($p > 0.05$) in yield between the tied ridge and furrow closed both end techniques (Table 1).

Thousand Seed Weight

The thousand seed weight were highly significantly ($p < 0.001$) difference on tied ridge and furrow closed at both end as compared to farmer practices (Table 1). This implies that in situ moisture conservation structures improve thousand seed weight by retaining surface runoff and increase infiltration within the catchment. In fact, the seeds which were supplied with adequate moisture did mature well to have heavier seed weight than farmer practice. This could be attributed to the fact that the relatively higher soil moisture accumulated in the furrows and ridges of the tied ridging system permitted late maturity of the crop and as a

result giving enough time for the maize plant to develop their seeds properly with adequate and continued moisture supply. Also result reported by Gebreyesus (2004) on the effects of in situ soil moisture conservation on thousand seed weight was similar with the findings of this study. But, there was no significantly differences ($p > 0.05$) in thousand seed weight between the tied ridge and furrow closed both end techniques (Table 1).

Plant height, stand count and number of cobs per hectare

There were no statistically significant differences ($p > 0.05$) between treatments on plant height (cm) and stand count and number of cobs per hectare (Table 1).

Plant height

The highest and the least plant heights of (214.51 cm) and (211.05 cm) were obtained from tied ridge and farmers' practice respectively (Table 1). The furrow closed at both end better in plant height than farmer practices. But there was no statistically significant difference between the treatments regarding plant height. Even though, the treatment did not show the significant difference. But the mean of plant height on tied ridge and furrow closed at both end were better than farmer practice; this could be probably due to the merits of this structures (tied ridge and furrow closed at both end). In the above findings; tied ridge and furrow closed at both end relatively gave high plant height as compare to farmer practices due to high efficiency in moisture retention capacity.

Yield advantages over farmer practice

The grain yield and thousand seed weight advantage of 45.5% (27.901Qtha^{-1}) and 41.43% were obtained from tied ridge over the farmers' practice, respectively. And also the yield and thousand seed weight advantages of 30.68%(18.82Qtha^{-1}) and 27.63% were obtained from furrow closed at both end respectively Table 1). This implies that two structures have a capacity to retain more surface runoff within catchment and infiltrate in soil than farmer practice. This could be attributed to increase grain yield and thousand seed weight in study area.

The result agrees with the previous findings of Heluf and Yohannes (2002) who reported that tied ridge, has resulted in yield increments of 15 to 50% on maize and they also stated that yield increment of 15 to 38% was recorded for sorghum on different soil types of eastern Ethiopia. Similarly, Jensen et al. (2003) stated that grain maize yield with tied ridging in year with dry to near normal rainfall was improved by 42% even without any nutrient inputs while the seasonal average runoff was between 5-9% in the plots with water conservation and 16-30% in the plots without water conservation. Also Araya and Stroosnijder (2010) and Walker *et al.* (2005) have stated that single interventions through water conservation could improve crop yields by up to 50% in arid and semi- arid regions of sub-Saharan Africa. Thus, practicing in situ moisture conservation structures is imperative, and positively increases significance difference in grain yield and thousand seed weight in moisture deficit area.

Table 3. Mean yield and yield components of maize as affected by tied ridge and furrow closed at both end

Treatments	Plant height(cm)	Stand count at harvest/ha	Number of cobs/ha	Yield (Qtha^{-1})	1000 seed weight(gm)	Yield advantage (%)
TR	214.51^{a}	74,675^{a}	74,675^{a}	89.22^{a}	410.83^{a}	**45.5**
FCE	213.79^{a}	71,500^{a}	71,500^{a}	80.13^{a}	370.73^{a}	**30.68**
FP	211.05^{a}	62,750^{a}	62,500^{a}	61.32^{b}	290.47^{b}	
Mean	213.12	69,641.67	69,558.33	76.89	357.34	
CV(%)	8.4	20	19.99	17.5	13.61	
LSD(P value)	>0.8556^{ns}	>0.0618^{ns}	>0.0565^{ns}	3.211e-08***	1.85e-09***	

Treatment values within a column followed by the same letter are not significantly different at 0.1%. TR: Tied Ridge, FCE: Furrow closed at both End, FP: Farmer Practies, CV: Coefficient of variation, LSD: Least of significance Difference, * and *** level of significance at P<0.05 and P<0.001 respectively and ns = not significant difference

Conclusions and Recommendations

In situ moisture conservation techniques at farm level are essential options for the moisture deficit area of Dugda woreda for improving yield through better soil water storage. Tied ridge and furrow closed at both end were the paramount practice because of its high mean grain yield and thousand weight seed response. From all treatments, tied ridge was gave higher mean yield and thousand seed weight advantages than farmers practices in study area and it is also better to use it. Also furrow closed at both end was gave high mean yield and thousand seed weight advantages than farmers practices in study area. The grain yield and thousand seed weight were highly significantly ($p < 0.001$) difference on tied ridge and furrow closed at both end as compared to farmer practices (Table 1). This implies that the grain yield and thousand seed weight were increased significantly according to the availability of water in the treatments. Thus, practicing in situ moisture conservation structures is imperative, and positively increases significance difference in grain yield and thousand seed weight in the study area. Therefore, it could be concluded that ensured soil moisture availability through the use of in situ moisture conservation structures and increase maize production in the study area and similar agro-ecology.

Based on the findings obtained from one cropping season, the following recommendations are made. The farmers are advised to use tied ridge first recommendation and furrow closed at both end as the second options to increase maize productivity in the study area. Therefore, results of the present study (tied ridge and furrow closed at both end) should scale up on wider areas of similar agro ecology to assure food security of the country, particularly in Dugda woreda. The future study should focus on integration of in situ moisture conservation with mulching on yield and yield components in study area and similar agro ecology.

References

Agricultural Production Constrain Analysis (APCA) in East and North Shewa Zone,Oromia, Ethiopia, unpublished, 2017.

Araya, A., and Stroosnijder, L. (2010). Effects of tied ridges and mulch on barley (Hordeum vulgare) rainwater use efficiency and production in Northern Ethiopia. Agricultural Water Management, 97, 841-847.

Bankole, F., Menkir, A., Olaoye, G., Crossa, J., Hearne, S., Unachukwu, N., & Gedil, M. (2017). Genetic gains in yield and yield related traits under drought stress and favorable environments in a Maize population improved using marker assisted recurrent selection. Frontiers in Plant Science,8(808).

Eshetu,A.Tadele,G.,2016. Evaluation of Level Bund Conservation Structure for Maize and Sorghum Production in Moisture Deficit Areas of Hawi Gudina District, Eastern Ethiopia.

Eyasu, Y., 2005. Development and Management of Irrigated lands in Tigray, Ethiopia. PhD Thesis, Department of Water Engineering, UNESCO-IHE Institute for water Education, Delft, The Netherlands.

FAOSTAT (2015).Food and Agriculture Organization of the United Nations Statistical Database. Rome, Italy: Pocketbook.

Heluf, G. and Yohannes, U. (2002). Soil and water conservation (tied ridgesand planting methods) on cultivated lands: The case of eastern Ethiopian; Soil andWater Management Research Program, Alemaya University (AU); 154p.

Heluf Gebrekidan, 2003. Grain Yield Response of Sorghum (Sorghum bicolor) to Tied Ridges and Planting Methods on Entisols and Vertisols of Alemaya Area, Eastern Ethiopian Highlands Journal of Agriculture and Rural Development in the Tropics and Subtropics Volume 104, No.2, pages 113–128

Gebreegziabher, T., Nyssen, J., Govaerts, B., Fekadu, G., Mintesinot, B., Mitiku, H., and Deckers, J. (2009). Contour furrows for *in situ* soil and water conservation, Tigray, Northern Ethiopia. Soil and Tillage Research, 103, 257-264.

Gebrehiwot, K. A., & Gebrewahid, M. G. (2016). The need for agricultural water management in sub-Saharan Africa. Journal Water Resources and Protection,8(1), 835–843.

Gebreyesus B. T., 2004. Tied Ridging as In-situ Rainwater Harvesting Methods for Improving Sorghum Yield at Abergelle Area, Tigray Regional State. An M.sc. Thesis submitted to Haremaya University.

Jensen, J.R., Berhard, R.H., Hasen, S., MulchingDonagh, J., Moberg, J.P., Nielsen, N.E., and Nordbo, E. (2003). Productivity in maize based cropping systems under various soil water management strategies in a semi-arid, alfisol environment in East Africa. Agricultural Water Management, 59, 217-237.

Kidane Georgis, and Abuhay Takele, 2000. A Manual for Semi-arid Areas of Ethiopia: Resource Base, Constraints and Improved Technologies for Sustainable Agricultural Production, mimeo. EARO, Addis Ababa, Ethiopia

Macauley., H. (2015). Feeding Africa,Cereal Crops: Rice, Maize, Millet, Sorghum, Wheat (pp1-36).

Mekuria, M. and Waddington, S. (2004) Institutional and Policy Support Is Essential to Promote the Adoption of Soil Fertility Technologies on Maize-Based Smallholder

Farms in Southern Africa. Proceedings of the 4th International Crop Science Congress, Brisbane.

Mudalagiriyappa, B. K. Ramachandrappa, H. V. Nanjappa (2012). Moisture conservation practices and nutrient management on growth and yield of rabisorghum (Sorghum bicolor) in the vertisols of peninsular India. Agricultural Sciences Vol.3, No.4, 588-593.

Muhammad, A., Muhammad, A., M., & Cengiz, R. (2015).Drought stress in maize (Zea mays L.) effects, resistance mechanisms, global achievements and biological strategies for improvement(pp.1–79)Netherland:Springer.http://dx.doi.org/10.1007/978-3-319-25442-5.

Nazareth, V. (2016).Evaluating conservation agriculture and its adoption potential in developing countries (Master Dissertation). University of Florida

Ndlovu, E. (2013).Impact of tree species on maize productivity by smallholder farmers in eastern Kenya (Master Dissertation). Kenya: Jomo Kenyatta University.

Nyamadzawo G, Wuta M, Nyamangara J, Gumbo D. 2013. Opportunities for optimizing in field water harvesting to cope with changing climate in semiarid smallholder farming areas of Zimbabwe. Springer plus 2, 1-9

Olaniyan, A. B. (2015). Maize: Panacea for hunger in Nigeria.African Journal of Plant Science, 9(3), 155–174.http://dx.doi.org/10.5897/Ajps2014.1203.

Solh, M., & van Ginkel, M. (2014). Drought preparedness and drought mitigation in the developing world's drylands.Weather and Climate Extremes, 3(1), 62–66.

Solomon, T. (2015). On-farm verification of the effects of selected soil moisture conservation techniques on yield and yield components of early maturing maize varieties at Bako, western Ethiopia. International Journal of Advanced Earth Science & Engineering, 4(1), 254–264.

Taye Belachew and Yifru Abera, 2010. Response of maize (Zea mays L.) to tied ridges and planting methods at Goro, Southeastern Ethiopia. American-Eurasian Journals if Agronomy, 3(1): 21-24.

Walker, S., Tsubo, M., & Hensley, M. (2005). Quantifying risk for water harvesting under semiarid conditions.Part II. Crop yield simulation. *Agric. Water Manage., 76*, 94-107.

WaterAid (2017).Wild water: The state of the world's water(pp. 1–24), 1–24.

AGRECULTURAL ENGINEERING

Pre-extension Demonstration and Evaluation of Animal Drawn Potato Digger in Selected AGP-II Districts of Harari Region, Ethiopia

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Abstract

Pre-extension Demonstration of potato Digger was conducted at Dire Tayara of Harari Regional State. The objectives of the study were to demonstrate improved potato digger technology and to create awareness to the farmers on potato digger technology in the study area. The selected farmers were organized in two FRG groups having 30 members. The evaluation result showed that the potato digger has Working speed 1.57km/hr, Working width 35cm, Working depth 15cm and effective time of 0.39hr. Perception response showed that the potato digger has good Working speed, Good Tuber lifting up, Low tuber damage and Good working width, high time saving. Thus, the potato digger is recommended for further scaling up.

Key words: FREG, Potato, potato digger

Introduction

The potato is the most important food crop in the world after wheat, rice and maize. Potato is a staple food in the colder regions of the world, while it is generally used as vegetable in other parts of the world (Mohamed *et a*l. 2006). Ethiopia has possibly the highest potential for potato production than any country in Africa with 70% of the 13.5 million ha of arable land suitable for potato cultivation (Dagninet *et al.,* 2015). Among the field operation concerned with potato cultivars, harvesting is the most laborious and costly endeavor. The method of harvest employed depends upon the type and the level of technologies available.

According to (Dagninet *et al.,* 2015) post-harvest loss (20 -25%) is one of the major problems in the potato production. Among this is physical damage, due to the digging (lifting) of the tubers by hoe or local plow maresha (Tesfay; 2008; Hakan. 2012). This entails that significant loss is incurred to the small holders that could have helped in nutrition, food security and income generation (BoFED. 2007). Mature potato is dug out from the soil and is the main product. Potato digging is a cumbersome process as soil-potato ratio is 31:1 and requires 600 man-h/ha for manual digging (Anonymous, 2006).The major reasons for the demand for machinery are to reduce drudgery, to reduce timeliness, and to increase productivity and accordingly the Fadis Agricultural Engineering was developed an animal drawn potato digger tested under field condition. The evaluated digger consisted of beam, frame, handle, having

manually depth adjustment mechanism and V-blade. The average working width and depth of digger were 35.5 cm and 15 cm respectively. The effective field capacity and field efficiency were 0.04 ha/hr and 70% - 85% respectively. The draft values of pair oxen and labor requirement ranged as 600-750 N and 40 - 60 man-h/ha, respectively.

Though, the technology was good and could increase production and productivity of the smallholder by reducing the labor and time, improving post-harvest loss, the promotion and demonstration of the digger was not conducted in the area. This demonstration trial was therefore, initiated to demonstrate and evaluate the improved potato digger in the study area.

Material and Methods

Description of the study area

The pre-extension demonstration of animal drawn potato digger was conducted in selected Dire Tayara district of Harari region. Dire Tayara is located at distance of 16 km from Harar city in north direction. The climatic condition of Dire Tayara is almost mid land with the maximum and minimum temperature 24^0 C and 16^0 C respectively. The district has good potential for crop production like; cereals, vegetables and fruits and tuber crop. Major crops grown in the study area include; sorghum, maize, pulse or oil crop, and legumes.

Site and farmers selection

Two kebeles were selected purposively based on the potentiality, appropriateness of the area, access to road, suittability for frequent monitoring and evaluation. Farmers were selected based on their willingness/interest, accessible of site for monitoring, ability to risk taker and ability to allot land for the intended purpose through studying their profile with the participation of DAs and community leaders. The selected farmers were grouped into two Farmers Research Group (FRG) having 15 members each. Among them five (5) farmers per Kebeles and a total of ten (10) trial farmers were selected to host the trial n their farms.

Technology multiplication

The digger was produced in Fadis Agricultural Research Center Agricultural Engineering Work Shop. After necessary raw materials preparations completed, manufacturing of the required technology production was under taking as follow. The main components of animal drawn potato digger consisted of main frame, digging blade, shank, lifter rods, pulling beam (traditional wood beam (*nuguya*), wood handle and adjusting clamp [Fig-2a, b]. six lifter rods of reinforced round mild steel bar (weight: 1 kg) of 12 cm length and 10 mm diameter were provided which were welded at 50 mm interval in the rear of V shape blade of 1.75 kg weight and overall dimensions of 350 x 330 width and length of the digger respectively. After completion of manufacturing work, the components of the digger were free from pits, burrs, cracks and other visual defects. The digger was symmetrical on both the sides along the longitudinal central axis of the digger bottom. The bearing points were touching the ground and the digger was well balanced when the unit was set at its working position and placed on a plain surface. Pair oxen /animal drawn digger evaluated and demonstrated under field/ farmers conditions on established FREG.

Technology evaluation and demonstration methods/technique

The demonstration was done on selected trials farmers according to technology demonstration approach by involving all FRG members, DAs and woreda experts. The demonstration was conducted during harvesting time. Theoretical and practical trainings were given on the use and operation of the implement to the participants. The activity was jointly monitored by FRGs, researchers, experts and development agents starting from land preparation to harvesting.

Research implementation and field works

A parcel of lands or plots size of 20 m x10 m was selected from on an individual trial farmer for specimen (potato variety) planting during main season. After completion of land preparation furrow was constructed in row following standard planting distance. The selected improved potato variety (Bubu) was planted with 75 cm row and 30 cm plant space. Five trial farmers per PA's and a total of ten farmers were used as replication from two Kebeles for demonstration. All -agronomic practices were applied as recommended by researchers and finally animal drawn potato digger was demonstrated on the farmer's field.

Data Collection

Both quantitative and qualitative data was collected through personal field observation, individual interview, and focus group discussion by using checklist and data sheet tools. The collected data include: total amount of tuber lifted, total amount tuber un-lifted, amount of tuber damaged, digging efficiency, number of farmers participated and benefited directly and indirectly from the project and farmers preference.

Data analysis

Simple descriptive statistics (Mean, Frequency and Percentage) were used to analyze the collected data..

Results and Discussion

Training of farmers and other stakeholders

Training was given on improved potato digger to farmers, DAs and wereda experts. Accordingly, a total of 26 farmers (16 males and 10 female), 3 DAs and 2 experts were participated om the training.

Table 1: Type of profession and number of participants during the training

Participants	Male	Female	Total
Farmers	16	10	26
DAs	3	0	3
District experts	2	0	2
Total	**21**	**10**	**31**

Source: Own computation 2017/18

Working capacity of animal drawn potato digger

The working capacity of the demonstrated potato digger is presentfed in table 2. The evaluation result showed that the potato digger has Working speed 1.57km/hr, Working width 35cm, Working depth 15cm and effective time of 0.39hr. Digging and field efficiency of the digger were 96.55% and 86.7% respectively. Mean draft required for digging was700 N. Effective field capacity was 0.04 ha/h.According different author animal drawn potato digger better than traditional spade digging.

Table 2: On farm working capacity of the digger

Parameter	Unit	Animal drawn potato digger
Plot size completed(area)10 m x 20 m	m^2	200
Soil moisture(dry basis)	%	17.5
Working speed	km/hr	1.57
Working width	cm	35.0
Working depth	cm	15.0
Total time to complete area	hr	0.45
Effective time	hr	0.39
Field efficiency	%	86.7
Effective field capacity	ha/h	0.04
Measured draft	N	700
Total un-lifted potato (digging loss)	%	3.55
Damage potato	%	1.05

Participatory evaluation and farmers' perception

All FRG members and neighboring farmers, development agents, experts and researchers were closely evaluate the performances of the digger evaluated based on their own criteria. The feedback or perception of those farmers on the implements preference was collected from participating during the demonstration. The most important criteria used by farmers were digging efficiency, working speed, tuber lifting, and low tuber loss and working width (Table 4). The technology preferemce ranking result showed that the animal drawn potato digger was preferred by farmers for its high working speed, good tuber lifting up, low tuber damage and good working width and time saving.

Table 3: Ranking of animal drawn potato digger and traditional potato digging

Implements	Rank	Reasons
Animal drawn potato digger	$1^{st\ s}$	High Working speed, Good Tuber lifting up, Low tuber damage and Good working width, high time saving
Traditional implement	$2^{nd\ n}$	Low working speed, Low tuber lifting up, high tuber damage and Low working width, more time or more human per operation

Table 4:- .Pair-wise ranking matrix result of the digger

S. N	Traits	Time of Operation	Working Speed	Tuber lifting	Working width	Tuber loss	Frequency	Rank
1	Time of operation		**1**	**1**	**1**	**1**	4	1st
2	Working Speed			3	2	2	2	3rd
3	Tuber lifting				**3**	4	3	2nd
4	Working width					3	1	4th
5	Tuber loss/damaged						0	5th

Conclusion and Recommendation

Pre-extension demonstration and evaluation of animal drawn potato digger was conducted in Dire Teyara district of Harari region. The result of demonstration showed that the potato digger had high working speed, good tuber lifting up, low tuber damage and good working width and time saving.Moreover, the technology was preferred by farmers for its good working effecincy and use. Thus, it is important to further popularize the technology in the study area and other potato producing areas.

References

Dagninet Amare, Wolelaw Endalew. *Agricultural Mechanization: Assessment of Mechanization Impact Experiences on the Rural Population and the Implications for Ethiopian Smallholders*. Engineering and Applied Science Vol.1,No.2,2016.pp.39-48.doi:10.11648/j.eas.20160102.15

M.Eltawil, D.Samuel and O.Singhal, 2006, "Potato Storage Technology and Store Design Aspects" Agricultural Engineering International: the CIGRE journal. Invited Overview No. 11.Vol. VIII.

Anonymous (2006) Vision (2030) Central Potato Research Institute, Shimla, 7-9

Hakan Kibar, 2012. Design and Management of Postharvest Potato (Solanum Tuberosum L.) Storage Structures. Ordu Univ. J. Sci. Tech., 2(1):23-48

Tesfay, A., 2008. Potato Production Manual. Amharic Version printed in 1999 Ethiopian Calendar.

BoFED (Bureau of Finance and Economic Development), 2007. Annual statistics for Amhara National Regional State. Bahir Dar, Ethiopia

Tiwari R.K., *et al*., (2018) Improved Potato Diggers in Terrace Condition of Sikkim in India. International Journal of Agriculture Sciences, ISSN: 0975-3710 & EISSN: 0975-9107, Volume 10, Issue 11, pp.- 6211-6214

Participatory Evaluation and Demonstration of Overflow Pump through Farmer Research Extension Group under Irrigation in Jimma Zone

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Abstract

This study was conducted in four districts of Jimma zone namely Omo Nada,Dedo,Gomma and Gera with the objectives of Participatory Evaluation and Demonstration of Overflow Pump technology, creating awareness among farmers and raise demand on the use of overflow pump technology. Eight peasants were selected purposely and from each peasant association eight groups of farmers were organized. Data was collected from these groups using simple check list, field observation and participants comment on the demonstration of technology. These data were analyzed using descriptive statistics such as frequency, percentage, mean and standard deviation. The result of this study revealed that almost all participant households perceived that the demonstration of overflow pump could help them for their future irrigation practices. Based on survey conducted, 86.28% of respondents (N= 164) agreed that the overflow pump increased yield. With regard to the possibility of producing vegetable crops at least twice per year using overflow pump, about 76.47% of the sampled respondents were reported that the use of the overflow pump technology enabled crop production more than twice a year while 15.69% disagree with production of crops more than twice a year. Therefore, it is recommended that different concerned stakeholders have to pay attention to multiply and disseminate the technology so as to diversify the income of rural farmers and to attain their dietary balance for their family.

Key word: Overflow pump, irrigation, demonstration, demonstration

Introduction

In Ethiopia, more than 80% of the population lives in rural areas with agriculture representing the primary source of their livelihoods. The majority of agricultural production is based on traditional smallholder farmers, who cultivate over 90% of the total arable land in the country. Thus, agricultural development has the potential to contribute not only to food security but also to poverty reduction and livelihood improvement for the rural population. This is particularly true in light of the high yield gap between the potential and the actual agricultural production in Ethiopia. Almost all smallholders farming in Ethiopia is rain-fed. Erratic rainfall and recurrent drought exposes the majority of the rain-fed farming population to food insecurity and perpetual poverty, and negatively affect the economy of Ethiopia as a whole (Awulachew 2007). Given the rapid population growth and low output of traditional food

production, the country cannot meet its food deficit through rain-fed production alone. Even during relatively good rainfall years, the survival of about 10% of the population depends on external food assistance. Furthermore, climate change is expected to exacerbate extremes in weather patterns and rainfall variability, which is likely to negatively affect rain-fed agriculture. Paradoxically, the highlands of Ethiopia receive very high amounts of rainfall, with annual run off volume of up to 122 billion of water from 12 major river basins. The region also possesses an estimated ground water potential of 27 to 40 billion m^3 (ibid). However, lack of water storage structures, weak water management institutions, and poor implementation of water use and management policies in Ethiopia have limited the realization of the economic potential possible from the abundant water resources

Suitable methods of water lifting and distribution are the most important aspects that determine the efficiency and success of an irrigation system. Also in terms of cost, the water diversion, conveyance and distribution systems are the most expensive parts of modern irrigation network (Abonesh 2006). The distribution of modern irrigation development in Ethiopia is mainly concentrated along the plane of perennial rivers (ibid). Neither the poor smallholders have the capacity to install the expensive modern irrigation system nor can the already implemented and planned large, medium and small scale irrigation schemes benefit the majority of the poor. From farmers perspectives alternative methods such as low-cost smallholder irrigation technologies are vital and attractive. Experiences from other developing countries show that coupling of low-cost irrigation technologies with water conservation and harvesting technologies allows better control and management of limited water resources and results in much higher returns to farmers (MoA, 2011). Small-scale, low-cost irrigation systems that can be easily afforded and managed by poor farmers contribute significantly to the endeavors of ensuring food self-sufficiency at household level.

Water-lifting devices are used to lift water to a height that allows users to easily access water. Water lifting devices can be used to raise ground water, rainwater stored in an underground reservoir and also from river and stream channels. Over the past decade, a small but significant revolution has been taking place in small-scale irrigation in the developing world with the introduction of the different water resources management and use technologies. These simple, human-powered devices can be manufactured and maintained at low cost in rural workshops in developing countries. The costs of buying, running and maintaining pumps for irrigation are unaffordable for most small farmers in the developing world. The majorities rely on traditional human-powered water lifting devices but these too have their drawbacks.

The development of irrigation and agricultural water management holds significant potential to improve productivity and reduce vulnerability to climactic volatility in any country. Although Ethiopia has abundant rainfall and water resources, its agricultural system does not yet fully benefited from the technologies of water management and irrigation. The majority of rural dwellers in Ethiopia are among the poorest in the country, with limited access to agricultural technology, limited possibilities to diversify agricultural production given underdeveloped rural infrastructure, and little to no access to agricultural markets and to technological innovations (Mangisoni, 2006). These issues, combined with increasing degradation of the natural resource base, especially in the highlands, aggravate the incidence of poverty and food insecurity in rural

areas. Improved water management for agriculture has many potential benefits in efforts to reduce vulnerability and improve productivity.

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Many farmers had problems with the unpredictable weather; they were often challenged with lack of rainfall and droughts in unproductive lands. The irrigation pump allows them to have consistent water throughout the year, helping the crops and providing income that is more consistent for the families. The method of lifting water to the field for irrigation in the country and in Oromia too is mostly traditional. The water is transported to the field with the help of bucket; water points and area to be irrigated are far apart; the ground and/or river water is at lower position to convey to the agricultural land to be irrigated. Therefore, this study was aimed at demonstration of over flow pump for micro irrigation and to help farmers increase their income by enabling them to crop more than one cropping seasons.

Description of the study area

The pre-extension demonstration was carried out in Omo Nada, Dedo, Gomma and Gera districts of Jimma zone, Oromia National Regional State, Ethiopia. Jimma zone is among 22 administrative zones of Oromia Region and located in south western Oromia. The zones were characterized by a tropical highland climate with heavy rainfall, warm temperatures and a long wet period. The mean annual rainfall ranges between 1,200mm and 2,500mm, with mean annual temperature of 20 to 25^0c. The crude population density is 175 persons per km^2. About 38.3 percent of the total population is economically active.

Selection of study sites and participating farmers

The participatory evaluation and demonstration of overflow pump was conducted in eight irrigation potential Peasant Associations (PAs) of Jimma zone's AGP districts namely Omo Nada, Gomma, Dedo and Gera which were selected purposively based on their accessibility and potential for irrigation and appropriate for overflow pump technologies. These specific sites (PAs) were selected in collaboration with the respective districts agricultural office (Table 1). Therefore, five farmers were selected from each PAs based on their interest, accessibility of their farm land and capacity to use the proposed technology.

Farmers Research Extension Groups (FREGs) establishment and training

Extension group approach is more effective than dealing with individuals especially in technology demonstration where the majority of the farmers are smallholders and clear socio-economic differences are in place. It enhances the development popularization, dissemination and adoption of improved irrigation technologies intended for our farmers. Thus, establishment of FREGs members was based on farmers' willingness to be held as members' accessibility for supervision of activities, good experience of compatibility with groups and geniuses and transparency to share innovations to other farmers. Consequently, one FREG having five members with the composition of men and women farmers was established at each selected site (Table 1). Gender balanced in each FREG unit was considered.

After establishments of the FREG, a theoretical training session was arranged to farmers, DAs and experts at all select districts. Multidisciplinary team of researchers from Jimma

Agricultural Engineering Research Center (JAERC) delivered the training on different topics (i.e., advantage and disadvantage of irrigation, promotion through FREGs, suitable agro-ecology for irrigation and appropriate technologies for irrigation). The training has also included practical sessions which was very important for awareness creation and bring improvement in filling the knowledge gap, skill and attitude on practical use of overflow pump technology.

Table 1: Number of FREG and its composition at different districts of selected area

Districts	Number of FRGs	Composition		Total
		Male	Female	
Gomma	4	12	9	21
Gera	1	5	0	5
Omo nada	2	7	4	11
Dedo	1	3	2	5
Total	8	27	15	42

Technology Demonstration

Overflow pump technology was provided to FREG members for the purpose of pre-extension demonstration. Accordingly; five farmers from each PAs were selected as our host farmer for the demonstration purpose. Other follow farmers were encouraged to participate on different extension/promotional events organized at each demonstration site. This was the mechanisms used to enhance farmers to farmers learning and information exchange.

Mini field visit was arranged to create awareness and farmers share experience and knowledge. In other words, it is to show the performance and profitability of overflow pump technology and to convince about its applicability. Besides, it is a way of facilitating people to visit overflow pump technology for the purpose of bringing promotion. The mini field days were prepared at each demonstration sites in order to include key stallholders (DAs, Supervisor and Experts) and enhance better linkage among relevant participants.

Data collection methods

Performance of the pump. total number of farmers participated on demonstration events such as training, field visit and mini field days, farmers' attitude on the overflow pump technology and perception towards the performance of overflow pump technology were also collectedusing the following methods.

Focus Group Discussion

FGDs were conducted with farmers from eight different villages in Jimma zone districts where the overflow pumps were demonstrated. The size of each group differed from village to village, ranging from five to seven farmers of mixed gender, as determined by the number of farmers available in the proximity of their farm plots at the time of the site visit. Points of discussions covered wide variables of issues but focused on farmers' perceptions of overflow pump irrigation experience and impacts (both negative and positive) of overflow pump irrigation. Included in the discussion were topics such as cropping patterns, use of inputs (seeds, fertilizers, pesticides), as well as concerns and challenges related to irrigation practices and associations related to water use and management.

Key Informant Interview

Key Informant Interviews (KIIs) were held with government officials, development agents, local elders and technical experts. The KIIs included semi-structured interviews covering a wide variety of topics, depending on the interviewee's. It included topics on aggregate data regarding irrigation practices related to irrigation development, support to farmers and as well as market-related

Field Observation

During farm visits, observations were made on the status of the irrigation practices using overflow pump (i.e., if they were currently functional or not). We also noted major crop types grown on irrigated fields, cropping patterns (strip or intercropping), cropping cycles (from interviewing farmers), irrigation methods used, climatic impacts (frost-damaged plants), plant pests and disease pressures, and use of overflow pump systems.

Result and Discussion

Socio-economic characteristics of the participants

An overall of forty two (42) farmers were participated on demonstration practice and out of them fifteen (15) were females and the rest were males. Average age of the participants was 43.28 years with standard deviation of 10.74 and average family size was 4.34 persons. Average land holding was 1.36 hectare. The educational background of the participants' shows that more than a half of them followed at least primary education and forty four (44%) of them are illiterate and 7% of the respondents completed secondary education (Table 2).

Table 2. Sex composition and educational background of the respondents

Variable	Category	N	%
Sex	Male	27	70
	Female	15	30
Education	Illiterate	17	40
	Primary	20	18
	Secondary	4	10
	Above secondary	1	2

Table 3. Age, rented in land, family size and landholding of the participants

Variable	N	Minimum	Maximum	Mean	Std. Dev.
Age of participant	42	21.00	58.00	43.28	10.74
Rented in land size	42	.00	8.00	.8125	1.41393
Family size of participant	42	2.00	10.00	4.34	2.1416
Participants' land holding	42	.50	4.00	1.36	1.04609

Source: survey (2019)

Training and mini field day

Table 4 and 5 presents training and field day participants. As shown in the table 3, a total of 42 farmers (27M and 15F), 10 DAs (7M and 3F) and 16 experts (8M and 8F) were participated on the training.Similiarly, a total of 164 participants(111M and 53F) drawn from farmers, DAs and experts were participated on the mini field day.

Table 4. Farmers participated on training

Name of woreda	Name of PA	Farmers		DA		SMS		Total	
		M	F	F	M	F	M	F	M
Gomma	Kaso iti	4	2	0	1	1	1	3	6
	Omo bako	3	2	0	1	1	1	3	5
	Bulbulo	0	5	0	1	1	1	6	2
Omo nada	Chedaro suse	5	0	0	1	1	1	1	7
	Wanja kersa	5	0	0	1	1	1	1	7
	Lafteka	4	2	1	1	1	1	4	6
Gera	Waktola	3	2	1	1	1	1	4	5
Dedo	Offolle	3	2	1	0	1	1	4	4
Total		27	15	3	7	8	8	26	42

Table 5. Participants on mini field days

Name of woreda	Name of PA	Farmers		DA		SMS		Total	
		M	F	F	M	F	M	F	M
Gomma	Omo bako	11	4	0	1	1	1	5	13
	Bulbulo	14	12	0	1	1	1	13	16
	Kaso iti	7	4	0	1	1	1	5	9
Omo nada	Chedaro	9	6	0	1	1	1	7	11
	Lafteka	13	7	0	1	1	1	8	15
	Waktola	10	3	1	1	1	1	5	12
Gera	Wanja kersa	17	-	1	1	1	1	2	19
Dedo	Offole	15	6	1	0	1	1	8	16
Total		96	42	3	7	8	8	53	111

Farmers' perception on overflow pump

The majority of farmers in the focus group discussions were excited about access to irrigation technologies like overflow pump. Farmers who have access to irrigation explained the benefits, but also the challenges, of access to spare part of overflow pump. Among the benefits, farmers explained that they were able to cultivate at least two times a year, which would have been often impossible without irrigation. In addition, they stated that irrigation enabled them to produce high-value crops for the market so as to generate income to meet some of their financial needs, such as finances needed to cover their children's education,

health care services and their daily needs. The most important outcome in all focus group discussions was that access to irrigation minimized the impacts of drought. They also indicated that access to irrigation improved the wellbeing of not only the households who have access to irrigation but also communities at large due to the social support system of relatives and friends. Farmers that practiced irrigation for at least two cropping cycles mentioned improved production and increased income. The challenges farmers faced included not realizing the full potential of irrigation agriculture due to limited access to improved seeds and other inputs, price fluctuations for their crops, and plant pests and diseases.

All participants in the technology demonstration process choose this technology over the traditional way of irrigation and show their interest to have this technology individually rather than in group. During practical training, overflow pump users were given a technology in FREG of all farmers and valuation for household comments and suggestion was conducted after two month using checklists. The technology users intensively use overflow pump and ready for comments and valuation conducted against different characteristics of technology like its ease of operation, easy to transport from one irrigation farm to another, it is operated manually/no need of fuel and its simplicity to maintain.

Perception on the advantages of utilization of overflow pump

Based on the survey conducted, the findings revealed that out of the total sample respondents (N=164) 86.28% of them responded that they agree as overflow pump increased yield. With regard to the possibility of producing vegetable crops at least twice per year using overflow pump, about 76.47% of sample respondents were responded that they agree on the possibility of production of crops more than twice per year while 15.69% of them disagree with production of crops more than twice per year (Table 6).

Table 6. Farmers' perception on overflow pump

Variables	Statements	% of respondents
Increased yield	Agree	86.28
	Uncertain	11.76
	Disagree	1.96
Produce twice	Agree	76.47
	Uncertain	7.84
	Disagree	15.69
Increase income	Agree	84.31
	Uncertain	11.76
	Disagree	3.92
Secure /protect crop failure	Agree	84.31
	Uncertain	11.76
	Disagree	3.92
Total		164

Gender analysis

The gender analysis examined the impacts of the overflow pumps on food availability and quality and men's and women's access to control over income. Both men and women stated that the amount of crops available for sale and consumption increased. They also stated that a greater diversity of crops can be grown and that the pumps allow for expanding production on under-utilized lands.
Farmers commented that with increased income and more time, other food items could be purchased to contribute to improved health. They explained that there could be a large increase in the production of their vegetable crops due to the pump and that the family will consume more of what is cultivated from their irrigated land, and be able to purchase more with the income from the increased sale of their crops. One man stated that he sells more and buys preferred consumption items such as egg and meat. Both men and women stated that they believed the food for household consumption is more nutritious because they are growing multi-crops and are able to have a diverse diet. Women said that they had been told that each crop provides different types of diet and that eating different kinds of food items will provide a better diet.

Comparison among irrigation technologies in the study area
During demonstration, one of the interventions included training selected community members on the maintenance of overflow pump and operation systems. The training aimed to build local capacity over an overflow pump systems if the demand would arise. Although the local demand for access to irrigation using overflow pump was high the assumption was that the conventional overflow pump would spread widely. However, the demand was more for the higher capacity system than what the conventional traditional manually irrigated could provide.

The time spent on irrigation activities before the demonstration of the overflow pump was extensive and the activity was laborious, according to the farmers interviewed. It involved many trips to and from a water source with cans, using buckets or dishpans to splash water to splash onto the crops from irrigation channels bordering the plot. Both men and women farmers stated that before the pump, irrigation took many hours and up to a full day, which was described by farmers as slow and challenging.

Income and Assets
Men and women who had the pump for longer than two years described that the amount available for sale and consumption had increased with a noticeable difference in income. Many farmers claimed that plants grew rapidly because of an increase in moisture, and now they would have been found frequently at the market selling. Many of the farmers interviewed had not possessed the overflow pump long enough to record a difference in income. Women expected increased income and mentioned they would use it for expenses such as purchasing agricultural input and paying school fees.

Conclusion and Recommendations

It is concluded that farmers had interest to use overflow pump to irrigate their land. They prefer, if they can get this technology on credit basis even though substantial number of farmers shows their willingness to buy it on cash basis. Training was provided to 42 participant farmers, 8 DAs and 4 SMS at FREGs sites to improve knowledge & skill of farmers in use of overflow Treadle pump. All participants in the technology demonstration process choose this technology over the other and show their interest to have this technology individually rather than in group. Valuation conducted against different characteristics of technology like easy to operate, easy to transport from one irrigation farm to another, it is operated manually/no need of fuel and simplicity to maintain. Based on the survey conducted, the findings shown that 86.28% responded agree as overflow pump increased yield. About 76.47 % were responded that they agree on the possibility of production of crops more than twice per year while 15.69 % disagree with production of crops more than twice per year.

It is recommended that different stakeholders, government organization and non-government organization have to pay attention to multiply the technology. Capacitating micro-enterprise to manufacture the pump is the proposed good intervention. Technical advice and support to farmers is highly required to improve irrigation technology utilization to attain food self-sufficiency and bring the required impact. Consolidating linkages among stakeholders are paramount to achieve the desired goal and improve the income of small scale farmers.

References

Abonesh Tesfaye.2006. The impact of small scale irrigation on household food security and assessment of its management system: The case of Filtino and Godino irrigation scheme in Ada Liben District, East Shoa, Ethiopia. Haramaya University

Awulachew, S.B.; Yilma, A.D.; Loulseged, M.; Loiskandl,W.; Ayana, M.; Alamirew, T. Water Resources and Irrigation Development in Ethiopia; Working Paper 123; International Water Management Institute: Colombo, Sri Lanka, 2007

CASH project (n.d.) http://www.asnapp.org.za/programs/zambia/cash (retrieved September 11, 2015). Chancellor, F. and D. O'Neill 1999 Gender Sensitive Irrigation Design Gender considerations relating to treadle pump adoption: Experiences from Zambia. Report OD 143 (Part III). DFID and HR Wallingford, December

Mangisoni, J. 2006. Impact of Treadle Pump Irrigation Technology on Smallholder Poverty and Food Security in Malawi: A Case Study of Blantyre and Mchinji Districts.International Water Management Institute (IWMI), Southern Africa Sub-regional Office Pretoria, South Africa. February

MoA, 2011, Small-Scale Irrigation Situation Analysis and Capacity Needs Assessment (A Tripartite Cooperation between Germany, Israel and Ethiopia) October 2011 Addis Ababa, Ethiopia

Pre-Extension Demonstration of Animal Drawn Cart in Selected AGP-II Districts of Jimma & Buno Bedelle Zones, Oromia, Ethiopia

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Abstract

The study was conducted in Jimma and Buno Bedele Zones of Oromia National Regional State, with the objective of demonstrating the Asella model Animal Drawn Cart to the farmers of the study areas. Three demonstration sites were selected from Nada district and other three sites from Gechi & Bedelle districts for the study purposes. Participants were organized in six FREGs having a total of 60 members. The demonstration result showed that the Asella model Animal Drawn Cart has got good acceptance by participant farmers for having less weight, fitness to topography and durability. The perception response showed that the cart has good performance and can be used appropriately in their locality fitting to the existing topography. Thus, based on the study result, the Asella model Animal Drawn Cart is recommended for further scaling up in the study areas and other areas having similar topography.

Keywords: - Pre-extension, Demonstration, Cart, Animal Drawn, transportation

Introduction

Rural transportation problem is one of the key problems remained unsolved for centuries in Ethiopia (Paul Starkey, 1997). In Ethiopia, for centuries most of the transport operations are carried out by women and children who physically carry the harvested crop either on their head, shoulder or back. . Donkeys, horses, mules and oxen also play a significant role in transporting harvested crops or threshed grains within the farm sites and to/from the rural or urban mills and markets. Some studies show that the losses caused during on-farm/off-site transporting operation is estimated to be 2-3 % due to the extended utilization of old sacks made of goat skin, sisal, plastics or others.

To solve these problems in their own way, long years ago, farmers were trying different transportation materials such as sledges (locally constructed of wood and pulled by a pair of oxen) at different parts of the country to transport crops from fields to threshing areas. Later on, farmers have got chance to use animal drawn cart that have been imported from France during 1970th. However, this was lasted for longer due to supply problem (Alemneh H. 2012).

Until the recent years, the most important parts used for cart production like Axle were used to import from abroad for car technology introduction. But the supply and the price of the Axle has been challenging over time in further demonstration of the cart to the rural farmers of the study area.

The Asella agricultural engineering research center has developed new model animal drawn cart that can substitute the imported one from locally manufactured materials. The newly developed cart has the capacity to carry about 8-15 quintals depending on the animal being used and topography (Tamrat G.,e., 2014). Hence, this study was conducted to demonstrate and popularize the new animal drawn cart in the selected AGP-II districts of Jimma and Buno Badele Zones.

Materials and methods

Materials

Timber, wood, Axle, sheet metal and flat iron were used to construct the cart.

Site and farmers selection

The study was conducted in Nada, districts of Jimma as well as Gechi and Bedele district of Buno Bedele zones. A total of six sites, three sites from the Nada district of Jimma zone and the rest three from Gechi, and Bedele district of Buno Bedele zone were selected purposively based on cart utilization experience and topography. Six FREGs that consist of ten (10) members composed of male, female and youth were formed in each site of the selected Kebeles.

Training Farmers SMS and DAs

Practical and theoretical trainings were given for the participant farmers and other stakeholders. Participant farmers, Subject Matter Specialists (SMS) from selected districts and Development Agents (DAs) that were working at the Kebele level were trained on cart operation and maintenance before actual demonstration was done to create awareness.

Demonstration

Farmer to farmer learning was used to promote the technology by arranging transporting program at the host farmer's farm site. The farmers' feedback after the demonstration of the cart were collected based on evaluation criteria jointly set by researchers and farmers.

Farmers' perception on the technology

Feedback was taken during and after demonstration to analyze farmers' perception about the cart. The attributes used in the analysis were weighty for single horse drawn, fitness to topography and damage and maintenance per week.

Data collection and analysis

The quantitative and qualitative data were collected on the technical performance and perception through interview, observation and group discussion and the collected data were analyzed by using descriptive statistics.

Results and Discussions

Training of the Farmers, SMS and DAs

Both practical (operation & maintenance) and theoretical trainings were given for 60 farmers 12 DAs and 8 Subject Matter Specialists selected from the study districts and kebeles on cart management and maintenance before the actual demonstration.

Table 1 Training Provided on Animal Drawn Cart Technology

No.	Training Site		Farmers		DAs	SMS	Total	
			Adult	Youth				
1	Nada	Doyo Yaya	2	8	2	2	12	2
2	’’	Waktola-1	5	5	2	0	6	6
3	”	Waktola -2	5	5	2	2	10	4
4	Gechi	Gechi	3	7	2	1	11	2
5	Bedele	Bedele-1	4	6	2	1	11	2
6	”	Bedele -2	5	5	2	2	10	4
	Total		**24**	**36**	**12**	**8**	**60**	**20**

Mini field day

A total of 92 farmers (31 Female, 61Male), 11 SMS, 12 DAs, 14 kebele administrators and 4 Researchers have attended the mini field days.

Table 2 Participants on mini field days

No	Location		Participants of field days									
			Farmers				DAs & SMS		Others Stalk-holder		Total	
			Adult		Youth							
	District	Kebele	M	F	M	F	M	F	M	F	M	F
1	Nada	Doyo Yaya	8	4	12	6	9	2	4	1	33	13
2	Bedele	Sidisa	7	5	14	5	6	3	6	-	33	13
3	Gechi	Gechi	5	4	15	7	3	-	5	2	28	13
	Total		20	13	41	18	18	5	15	3	94	39

Farmers’ perception on the technology attributes

Data on farmers’ perception on the technology were collected and analyzed. Among the total respondents, 53.33% of them replied that the weighty of the cart for single horse is good. More than half (56.67%) of the respondents had stated that the cart could be used appropriately in their locality fitting to the existing topography. As far as the average rate of damage and maintenance occurring on the cart per week during the transportation work was concerned, 60% of the respondents replied that the cart was found to be good as its damage and maintenance could be tolerated. The other respondents 36.67, 26.67 and 26.67 have

ranked the cart to the medium status in terms of its weight, suitability to topography, breakage and maintenance rate respectively.

In general, the feedback data indicated that most of the study participant farmers have perceived the Asela Model Animal Drown Cart positively for its less weighty for single horse, fitness to topography, and damage and maintenance rate per working time.

Table 3. Perception of FREG Members on Animal Drawn Cart

The attributes of Animal Drawn Cart & the acceptance degree by farmers	Scale measurement	Participant Respondents (No=30)		
		Frequency	Percentage	Total
Criteria		(Fr)	(%)	%
Weighty for single horse drawn.	Poor	3	10	
	Medium	11	36.67	100
	Good	16	53.33	
Fitness to topography	Poor	5	16.67	
	Medium	8	26.67	
	Good	17	56.67	100
Damage and maintenance per week	Poor	4	13.33	
	Medium	8	26.67	
	Good	18	60.00	100
Average	**Poor**	**4**	**13.33**	
	Medium	**9**	**30.00**	**100**
	Good	**17**	**56.67**	

Conclusion and Recommendation

The study was conducted in Jimma and Buno Bedele Zones of Oromia National Regional State, with the objective of demonstrating the Asella model Animal Drawn Cart to the farmers of the study areas. The demonstration result showed that the Asella model Animal Drawn Cart has got good acceptance by participant farmers for having less weight, fitness to topography and durability. The perception response showed that the cart has good performance and can be used appropriately in their locality fitting to the existing topography. Thus, based on the study result, the Asella model Animal Drawn Cart is recommended for further scaling up in the study areas and other areas having similar topography.

References

Alemneh H. 2012. Designing and Evaluation of light weight animal drawn cart (unpublished). Asella agricultural mechanization research center

Paul Starkey (1997),The history of working animals in Africa. *Centre for Agricultural Strategy, University of Reading* World bank country report http://www4.worldbank.org/afr/ssatp/Resources/HTML/Gender-RG/(accessed on 28/01/2014)

Tamrat G., Ephrem B., Dinka F., (2014) Scaling up/out of Asella Lightweight animal drawn Cart: Lesson from the activity (Asella agricultural engineering research center-unpublished research report