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CROP RESEARCH

Pre-extension Demonstration of Improved Bread Wheat Technologies in Bale and West Arsi Zones

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Abstract

Pre-extension demonstration of recently released bread wheat varieties were carried out in Adaba and Dodola districts from West Arsi zone, and Sinana, Agarfa, Gassara and Ginnir districts from Bale zone during 2017/18 main cropping season. The demonstration was conducted on 11 representative farmers' fields with the main objective of demonstrating and selecting best performing bread wheat variety/ies with its full packages. An improved variety (Dambal) was demonstrated and compared with one standard check (Sannate) and one farmers' variety (Hidase) on a plot size of 20m x 20m. About 160 farmers and 23 experts were participated on evaluation and selection of the best performing variety. Farmers were encouraged to select the variety/ies of their interest by their own evaluation criteria. Combined analysis of variance revealed significant variation among the varieties in terms of number of fertile tillers per plant; and high significant variation was observed in terms of numbers of seed per spike. Moreover, Dambal and Sannate varieties had 9.3% and 20.1 yield advantage over Hidase variety respectively. Pair wise ranking result indicated disease tolerance, high yielding and high numbers of fertile tillers were the top three important criteria considered by farmers in variety selection. Sannate variety was selected first due to its disease tolerance, high yielding capacity, high number of tillers (>10), seeds/spike (>60), good crop stand. Dambal variety was selected second for its attractive uniformity in the plot, attractive seed color, good crop stand, resistance to lodging. Therefore, Dambal variety should be further promoted in the study areas and in similar agro-ecologies as an alternative bread wheat variety.

Key words: *Bread Wheat, Dambal, PVS, Varietal Traits, Yield Advantage,*

Introduction

Bread wheat (Triticum aestivum L.) is one of the most staple food crops in the world and is one of the most important cereal crop cultivated in Ethiopia. Ethiopia is the largest wheat producer country in sub Saharan Africa (FAOSTAT, 2014). In Ethiopia wheat is cultivated on over 1.6 million hectares of land, accounting for 13.33% of the total grain crop area, with an annual production of 4.2 million tons, contributing about 15.81% of the total grain production (CSA, 2015). Wheat is largely grown in the mid and highland areas of Ethiopia spanning at altitudes of 1500 to 3000 m above sea level (m.a.s.l). However, it is mainly grown between1800 to 2500 m.a.s.l in the country (Winch, 2007). Arsi, Bale and Shewa administrative zones of the Oromia Regional State of Ethiopia are among the major wheat areas with 53.4% of the wheat produced in Ethiopia coming from these zones (CSA, 2015).

The Arsi and Bale zones are included among the highest potential agro ecologies in Eastern Africa for wheat production (Jobie, 2007).In 2015/16 cropping season, the area covered with wheat production in Bale and West Arsi zones were about 143,972 and 120,067.93 hectares respectively with average yield of 28.97 and 32.97 quintals respectively (CSA, 2016). In Ethiopia wheat is predominantly grown by small scale farmers at a subsistence level, and these farmers experience a wide range of biotic, abiotic and socioeconomic constraints. Wheat rusts stem rust, leaf rust and stripe or yellow rust are the major biotic constraints in all wheat growing regions of the country (DRRW, 2010).Different reports are available on the low adoption rate of improved wheat varieties by resource poor farmers in Ethiopia. The major reasons are lack of effective seed production and delivery mechanism, weak integration of variety requirements between breeders and farmers and less adaptation of the breeders developed varieties to the local environments (Nelson, 2013).

Consequently, the research system have been making continuous and unreserved endeavors in varietal development and variety replacement to ensure the sustainability of early generation seed source for both formal and informal seed multipliers and distributors. In line with this, Dambal variety of bread wheat was recently released by Sinana Agricultural research center in 2015 with full recommended packages. Dambal has 56-64 qt/ha yield potential, 20.6% yield advantage over standard check (Madda-Walabu) and 41.3% over local check. However, this technology was not evaluated still by farmers in recommendation areas to ensure the social feasibility of the technology.

Studies show that participatory technology evaluation on farmers’ management condition may have several advantages, such as increased and stable crop productivity, faster release and adoption of varieties, better understanding farmers’ criteria for variety selection, enhanced biodiversity, increment in cost effectiveness, facilitated farmers learning and empowerment (Sperling, 2001).Thus, participatory demonstration and evaluation of improved bread wheat technologies with the participation of farmers and other stakeholders for sustainable production and productivity was conducted to creat awareness on the importance of improved bread wheat technologies, build famers` knowledge and skill on wheat production and management packages and recommend the best performing bread wheat variety for further scaling up.

Methodology

Description of the study area

Pre-extension demonstration of recently released bread wheat varieties was carried out in Adaba and Dodola districts of West Arsi zone and Sinana, Agarfa, Gassara and Ginnir districts of Bale zone, Oromia National Regional State (ONRS), Ethiopia. West Arsi and Bale zones are among the 20 Administrative zones located in south eastern parts of Oromia, Ethiopia.

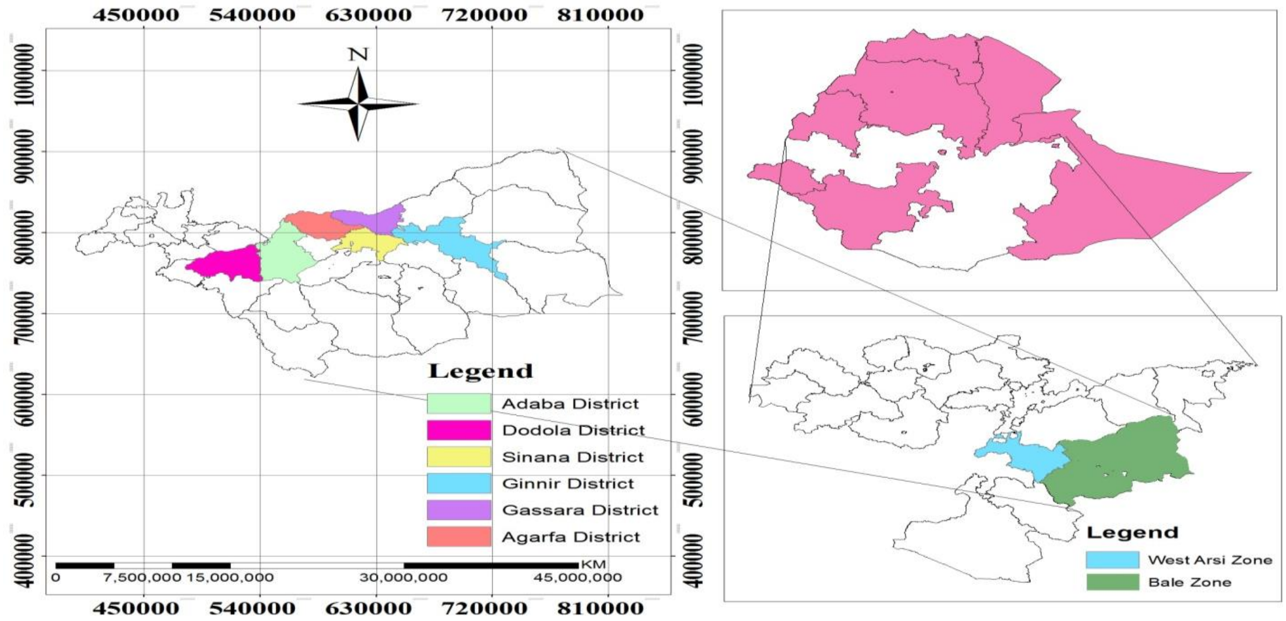
Bale Zone

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 63,555km2 (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 3.5oc and 35oc, 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).

West Arsi Zone

West Arsi zone has twelve (12) rural and two (2) town districts and having the total area of 12,556km2 (1,255,600 hectares). About 95% of the population is engaged in agriculture. Geological Survey shown that about 76.19% of the zone are flat plain, while about 23.81% are ragged or unutilized terrain that including valley, gorges, hills and dissected plateaus (MOFED, 2010). Most parts of the zone have elevations of ranging from 1500m to 2300m.a.s.l. The mean annual temperature of the zone is found between 10oc -25oc. For most of the areas, the rainy season starts in March and extends to November with the increasing concentration in June, July and August. On average, the zone gets annual mean rainfall of 1300mm. The zone is bounded by East Shewa zone in the North, South Nations, Nationalities and People National Regional State in the West, Arsi zone in the northeast, Guji zone in the South and Bale Zone in the East. Shashemenne town is the capital town and administrative center of the zone (WAZADO, 2014).



Source: Own sketch

Site and farmers’ selection

Site selection

The research was conducted in four districts (Agarfa, Gassara and Sinana) potential bread wheat producing districts of Bale zone. Whereas two Districts (Adaba and Dodola) were selected from West Arsi zone. Purposive sampling methods were employed to select five representative districts from the two zones based on their potential for bread wheat production and being AGP-

II target districts given for Sinana Agricultural Research Center. From each district two representative Kebeles were also selected purposefully based on their accessibility and production potential of the crop.

Farmers' selection

Participatory approach by strengthening the formerly established Farmers Research Extension Group (FREGs/FREGs) was the main strategy during demonstration of the technology. Strengthening the previously established FREGs was aimed to bring significant change on the farmers' knowledge, altitude and skill of the members on introduced technology. During the establishment of FREGs/FREGs different criteria were taken in to consideration in order to sustain the group work; of which were farmers' willingness to be held as member, accessibility for supervision of activities (vicinity), good history of compatibility with groups and motivation and experience to share innovations to other farmers. Consequently, one FREG/FREG with 20 members by taking in to account farmers' resource categories (i.e. rich, medium and poor) was established at each Kebele with involvement of gender disaggregation. Moreover, two representative trial farmers from each FREG/FREG were selected at each kebele (with the help of group members and DAs).Willingness to contribute suitable the land for the trial, 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.

Materials and Field design

An improved bread wheat variety (Dambal) was demonstrated and evaluated against one standard check (Sannate) and one farmer's variety (Hidassie) in which a simple plot size of 20m x 20m was assigned for each variety in the main cropping season. Row planting with the spacing of 20cm between rows was applied in which sowing was done by drilling in the prepared rows. The recommended seed rate of 150 kg/ha and inorganic fertilizer rate 100/100 kg/ha UREA/DAP was applied with split application of *Nitrogen:* 1/3 at planting time and 2/3 at tillering stage of the crop. Farm operations (land preparation-ploughing four times oxen plough) were carried out by hosting farmers, whereas activities such as land leveling, planting, first and second weeding, harvesting, threshing were handled by Sinana Agricultural Research Center.

Technology demonstration and evaluation approaches

Mini-Field day: 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.

Participatory selection of demonstrated varieties

FREGs/FREGs members and other follower farmers were encouraged to participate on different extension events organized at each site. These were mechanisms used to enhance farmer-to-farmer learning and information exchange such as trainings and field visits. The target beneficiaries of improved agricultural technologies are strongly inclined to their preferences. These preferences will cause them to give up less favored good crops/varieties for more favored ones. So, consulting the intended end users to assess which quality/ies of a particular variety they desire (to be considered in plant breeding program) is highly important. Because, it will not only be resource saving in terms of preferred variety promotion/dissemination, but also time saving and fast adoption (Dan, 2012). At each trial site, brief orientation was given to the evaluators on how to integrate researchers' criteria to their own criteria to select the demonstrated varieties in order of their importance, 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 group leader at the end.

Data type and method of data collection

Both qualitative and quantitative data were collected using appropriate data collection methods such as direct field observation and focused group discussion (FGD). Yield data per plot in all locations were recorded. Total number of trial farmers and mini field days were recorded by gender disaggregation. 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

SPSS was used as statistical package (descriptive statistics was used to analyze the data). Farmers' perception on the performance of improved bread wheat varieties were tested at each district and analyzed using Pair Wise Ranking. Pair Wise Ranking was used as a tool to summarize farmers' preference towards important variety traits (Boef and Thijssen, 2007).

Results and Discussions

Yield and agronomic performance of the Varieties

The yield and agronomic performance of demonstrated varieties (Dambal, Sannate and Hidassie) is shown in table 1 below. Results from ANOVA table revealed that there was significant difference among demonstrated varieties in terms of number of fertile tillers per plant and numbers of seed per spike. However, there was no significant yield difference among the demonstrated varieties.

Table1. Yield and agronomic performance of demonstrated varieties

Yield components	Varieties	Number of trial farmers	Mean	Std. Deviation	Significance (at α=5%)
Number of fertile tillers	Dambal	6	5.95	1.84	*
	Sannate	6	7.05	0.97	
	Hidase	6	4.95	1.08	
Number of seed per spike	Dambal	6	47.88	4.71	**
	Sannate	6	56.92	7.29	
	Hidase	6	46.65	4.34	
Yield obtained per hectare	Dambal	11	47.25	10.22	Ns
	Sannate	11	55.95	11.31	
	Hidase	11	43.19	14.97	

Comparison of yield advantage of improved varieties

Calculating yield advantage of the improved varieties over the farmers' variety shows the extra benefit obtained in percentage as result of producing the improved variety rather than growing the variety at farmers' hand. As shown in table 2 below, Dembal and Senate varieties had 9.3% and 20.1% yield advantage over the commercial variety (Hidase) which is under production respectively.

Table 2. Yield advantage of demonstrated varieties over the commercial variety

Demonstrated Varieties	Yield obtained (Qtha^{-1})	Yield Advantage over farmers' variety (Hidase)
Dambal	47.2	9.3%
Sannate	55.9	20.1%
Hidase	43.2	-

Participatory Varietal Evaluation and Selection

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. Then 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. Accordingly, results of pair wise ranking of variety traits revealed that disease resistence, yield and number of ferile tillers were the most important traits ranked as first, second and third (Table 3).

Table 3. Pairwise rankings of variety traits

code	variety traits	Disease tolerance	Lodging resistance	No of fertile tillers	No of seed/ spike	Plant height	Plump seed	Seed color	Thresh ability	Yield	Frequency	Rank
1	Disease tolerance										8	1st
2	Lodging resistance	1									1	8th
3	No of fertile tillers	1	3								6	3rd
4	No of seed/spike	1	4	3							5	4th
5	Plant height	1	2	3	4						0	9th
6	Plump seed	1	6	3	4	6					4	5th
7	Seed color	1	7	3	4	7	6				3	6th
8	Thresh ability	1	8	3	4	8	6	7			2	7th
9	Yield	**1**	9	9	9	9	9	9	9		7	2nd

Based on the above ranked traits, Senate variety was ranked 1st for its High number of tillers (≥10), seeds/spike (≥60), disease tolerance, good plant height, good crop stand, strong stem, it is adaptable to the environment, but late maturing (needs early planting) and lacks attractive seed color follows by Dembal variety and Hidase for the reasons indicated in table 4 below.

Table 4. Rank of the varieties based on farmers' selection criteria

No	Varieties	Rank	Reasons
1	Dambal	**2nd**	Medium tillering capacity, attractive uniformity, less disease tolerant, attacked by frost, good crop stand, resistant lodging and attractive seed color.
2	Sannate	**1st**	High number of tillers (≥10), seeds/spike (≥60), disease tolerant, good plant height, good crop stand, strong stem, it is adaptable to the environment, but late maturing (needs early planting) and lacks attractive seed color.
3	Hidase	**3rd**	Susceptible to disease and frost, low number of tillers and spike, small head, soft seed for market, medium crop stand, it has the problem of shattering.

Conclusions and Recommendations

In this pre-extension demonstration improved bread wheat varieties viz. *Dambal and Sannate* were demonstrated, evaluated and compared against the farmers' variety (*Hidase*). Accordingly, Sannate variety gave highest yield followed by Dambal with additional yield advantages of 9.3% and 20.1%, respectively over commercial variety (*Hidase*). Moreover, participant farmers were encouraged to select the variety/ies of their interest by setting their own selection criteria. To this end, suitable and widely accepted bread wheat variety/ies for the study areas were identified and ranked based on farmers' preferences. Disease tolerance, grain yield and high numbers of fertile tillers were the top three priority concern of the farmers for sustainable production of bread wheat in the study areas. Finally, participant farmers in all districts selected Sannate at first stage due to it is disease tolerance with high number of tillers (>10), seeds/spike (>60), good crop stand and strong stem. Dambal was selected in the second place due to its attractive uniformity, good crop stand, resistant lodging and attractive seed color. Basing the results, even though, Sannate was selected first by participant farmers, the variety have been under different scaling up works. On the other hand, Dambal variety has special merits of attractive seed color and attractive uniformity. Participant farmers have also selected it at second stage. Therefore, the succeeding pre-scaling up/out of Dambal variety of bread wheat should be carried out in the coming main production season in the study areas and in similar agro-ecologies.

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Pre-extension Demonstration of Improved Food Barley Technologies in Bale and West Arsi Zones

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Abstract

This study was initiated with the objective to demonstrate and popularize recently released food barley technologies in Dodola and Adaba (West Arsi zone), and Sinana and Agarfa (Bale zone) during 2017/18 cropping season. An improved variety Robera was demonstrated and compared with Abdanne (standard check) and local variety through FREG approach. The plot size was 20m x 20m replicated on different farmers' fields. Analysis of variance showed significant difference among the demonstrated varieties for number of seeds per spike with the highest value (54.76) recorded for Robera variety followed by 44.8 and 36.6 for Abdanne and Aruso varieties, respectively. However, there was no significant difference among the varieties in terms of average yield. Results of variety trait ranking revealed that yield, number of fertile tillers and seeds per spike and head length were the varietal traits given priority attention by farmers to be taken into account in the variety selection. Accordingly, Robera variety was selected in Sinana and Agarfa districts due to its high yield, high number of tillers (>8), seeds/spike (>54), attractive seed color and it has good uniformity. Based on the farmers' variety selection criteria and yielding ability, Robera variety with its recommended production packages is recommended in areas where it was selected and similar agro-ecologies.

Key Words: *Farmers' criteria, Food barley, FREG Approach, Robera*

Introduction

Barley (Hordeum vulgare L.) is a major cereal crop, which is predominantly produced in high land parts of Ethiopia, accounts for 8% of the total cereal production (Wosene et al, 2015). Ethiopia is the second largest barley producer in Africa, next to Morocco, accounting for about 25 percent of the total barley production in the continent. Unlike in industrialized countries where barley is mainly used for animal feed and malting, it is one of the staple food crops in Ethiopia, accounting for 6 percent of the per capita calorie consumption (FAO, 2014).

However, Ethiopia produces mostly food barley, with its share estimated to be 90 percent and remains significantly deficient in malt barley. Food barley is commonly cultivated in stressed areas where soil erosion, occasional drought or frost limits the ability to grow other crops (Alemu et al, 2014), Suitable barley growing regions in the country are the highlands ranging from 2300 to 3000masl (Bayeh and Birhane, 2011). In Ethiopia, barely is a dependable source of food in the highlands as it is produced during the main and short rainy seasons as well as under residual moisture; it is also a principal Belg season crop second to maize in area coverage and production (Melle, 2015).

From 9,974,316.28 hectares of land allocated for cereal 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 average productivity of 19.66 qt/ha (CSA, 2016), while most model farmers obtain 3500 - 4000 kg ha-1 on average. In Bale, 42,368.67 ha of land was covered by barley and 839,875.10 quintals of grain was produced with the productivity of 19.82 qt/ha (CSA, 2016).

However, grain yields and its quality are still not at 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. Moreover, low use of recommended full packages is also another yield limiting factor.

Developing high yielding, disease tolerant and stable varieties that can meet increasing food demand of the growing human population, improve the income and livelihood of farmers are very important. Consequently, an improved food barley variety (Robera) was recently released by Sinana Agricultural Research Center in 2015/16 with full recommended production packages. Robera has 24-42qt/ha yield potential, 10% yield advantage over standard check (Abdanne) and 17.5% over local check (Aruso) under research management. Thus, the study was aimed to undertake participatory demonstration and evaluation of improved food barley technologies with the active participation of farmers and other stakeholders in order to hasten the future dissemination of the food barley technologies in the study areas.

Methodology

Description of the study areas

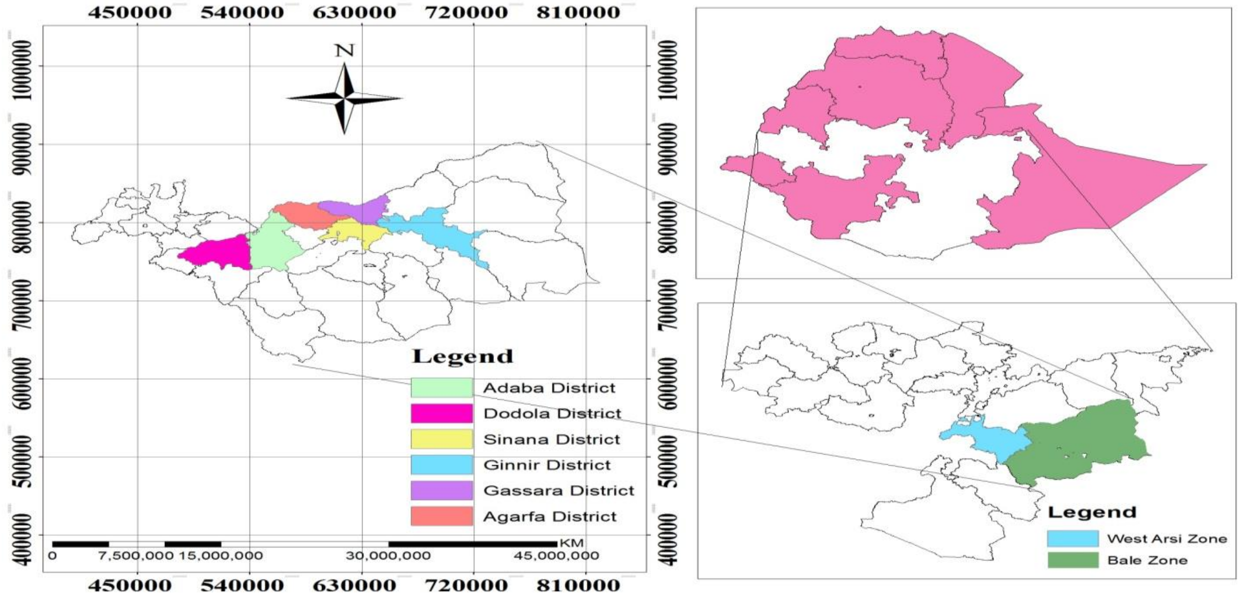
The trial was conducted in selected districts of West Arsi and Bale zones of Oromia National Regional State. These districts were Dodola and Adaba from West Arsi whereas Sinana and Agarfa were included from the parts of Bale zone.

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 63,555km2 (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 3.5oc and 35oc, 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).

West Arsi Zone

West Arsi zone has twelve (12) rural and two (2) town districts and having the total area of 12,556km2 (1,255,600 hectares). About 95% of the population is engaged in agriculture. Geological Survey shown that about 76.19% of the zone are flat plain, while about 23.81% are ragged or unutilized terrain that including valley, gorges, hills and dissected plateaus (MOFED, 2010). Most parts of the zone have elevations of ranging from 1500m to 2300m.a.s.l. The mean annual temperature of the zone is found between 10oc -25oc. For most of the areas, the rainy season starts in March and extends to November with the increasing concentration in June, July and August. On average, the zone gets annual mean rainfall of 1300mm. The zone is bounded by East Shewa zone in the North, South Nations, Nationalities and People National Regional State in the West, Arsi zone in the northeast, Guji zone in the South and Bale Zone in the East. Shashemenne town is the capital town and administrative center of the zone (WAZADO, 2014).



Source: own sketch

Site selection

Agarfa and Sinana districts of Bale zone as well as Adaba district of West Arsi Zone were selected purposively as demonstration sites based on being AGP-II Beneficiary districts and the potential for barley production. Moreover, based on the accessibility of road, two representative kebeles were selected from each district.

Farmer selection

FREG/FREG approach was employed by strengthening the formerly established FREGs in order to enhance the participation of other farmers and the concerned stakeholders. Accordingly, in each kebele one FREG/FREG was strengthened which consists of 15-20 members by taking into account all categories of farmers and the concept of gender disaggregation. The task of FREG members selection was carried out by giving due attention for farmers’ interest to be a member, good history of compatibility with groups, initiatives and commitment to share innovations to other farmers. Furthermore, from each district, two representative hosting farmers were selected in collaboration with SMS, DAs and the members themselves.

Table 1. Number of FREG members strengthened in each demonstration site

District & kebeles	**FREGs (No)**	**Members by Gender**				
		Adult (Male)	**Adult (Female)**	**Youth (Male)**	**Youth (Female)**	**Total**
Sinana (Salka & Gamora)	2	20	15	4	1	40
Agarfa (Ali &Illani)	2	22	14	2	2	40
Adaba (Washa & Ejersa)	2	24	16	0	0	40
Dodola (Katta Baranda & Kachama Chare)	2	23	15	1	1	40
Total	**8**	**89**	**60**	**7**	**4**	**160**

Field design and materials

Simple plot demonstration on 20m x 20m size of land was allotted for each variety by using the recommended spacing (20 cm b/n rows), seed rate (120 kg/ha) and fertilizer rate (100 kg/ha DAP). An improved variety of food barley (Robera) was demonstrated, evaluated and compared against Abdanne (standard check) and the local check (Aruso). Farm operations (land preparation) were carried out by hosting farmers; whereas activities such as land leveling, planting, first and second weeding, harvesting, threshing were handled by FREG members with close supervision from Sinana Agricultural Research Center.

Technology demonstration and evaluation approaches

Mini-Field day: Field day is a method of motivating people to adopt new practices by showing what has already achieved under field conditions. To this end, mini-field days were arranged to create awareness and farmers shared experience and knowledge. Regular joint monitoring and evaluation (follow up actions) and provision of technical advice were also undertaken at different crop stages based on necessary emerging knowledge/skill and technical advice needs..

Participatory selection of demonstrated varieties: FREGs/FREGs members and other follower farmers were encouraged to participate on different extension events organized at each site. These were mechanisms used to enhance farmer-to-farmer learning and information exchange such as trainings and field visits. The target beneficiaries of improved agricultural technologies are strongly inclined to their preferences. These preferences will cause them to give up less favored good crops/varieties for more favored ones. So, consulting the intended end users to assess which quality/ies of a particular variety they desire (to be considered in plant breeding program) is highly important. Because, it will not only be resource saving in terms of preferred variety promotion/dissemination, but also time saving and fast adoption (Dan, 2012).

At each trial site, brief orientation was given to the evaluators on how to integrate researchers' criteria to their own criteria to select the demonstrated varieties in order of their importance. The orientation also included how to carefully assess each variety by considering each criteria and using rating scale, how to organize collected data, how to discuss in groups and reach on consensus, and finally report through their group leader at the end.

Data type and method of data collection

Both qualitative and quantitative data were collected using appropriate data collection methods such as direct field observation and focused group discussion (FGD). Yield data per plot in all locations were recorded. Total number of trial farmers and mini field day participants were recorded by gender disaggregation. 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

SPSS was used as statistical package (descriptive statistics was used to analyze the data). Farmers' perception on the performance of the varieties was tested at each district and analyzed using Pair Wise Ranking. Pair Wise Ranking was used as a tool to summarize farmers' preference towards important variety traits (Boef and Thijssen, 2007).

Results and Discussions

Yield performance of the Varieties

Analysis of variance among demonstrated varieties for number of seeds per spike, number of tillers and yield was shown in table 2 below. Accordingly, the highest number of seeds per pike 54.76, 44.8 and 36.6 were observed for Robera, Abdanne and Aruso varieties, respectively and the result was significant at 5% level of significance. Similarly, the highest value was obtained for the same variety in terms of number of fertile tillers per plant and an average yield per hectare. However, there is no statistically significant variation among the varieties for number of fertile tillers per plant and average yield per hectare.

Table 2. Yield and yield components demonstrated food barley varieties

Yield components	Varieties	Descriptive		
		Mean	Std. Deviation	Sig (p-value)
Number of fertile tillers	Abdanne	8.30	5.04	Ns
	Robera	9.20	3.42	
	Aruso	5.02	1.2	
Number of seed per spike	Abdanne	44.80	7.63	**
	Robera	54.76	8.98	
	Aruso	36.60	6.96	
Yield obtained per hectare	Abdanne	31.46	6.07	Ns
	Robera	33.94	4.04	
	Aruso	26.06	7.22	

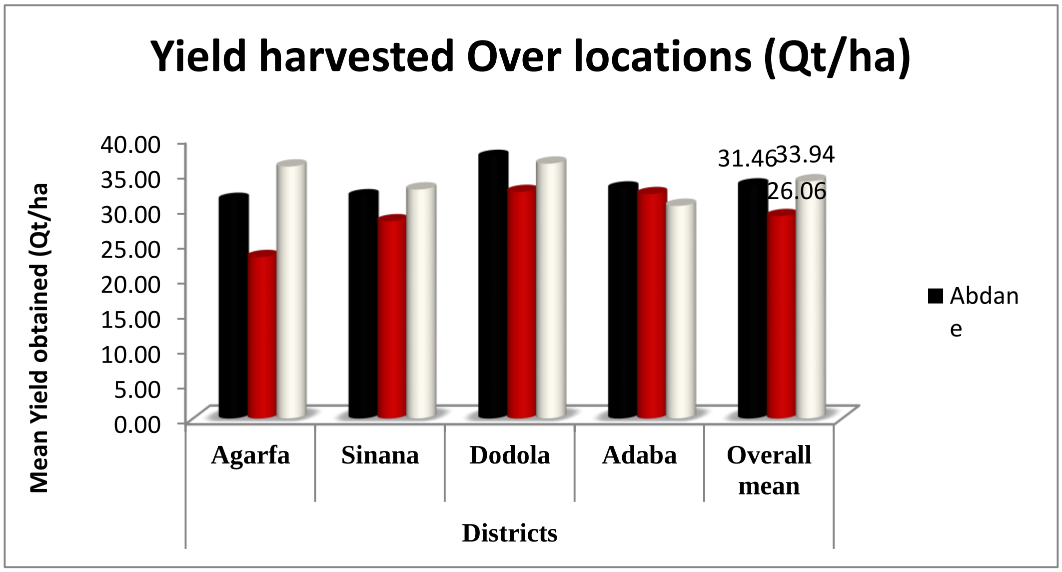


Fig.1. The mean yield obtained over locations

Comparison of yield advantage of improved varieties

Calculating yield advantage of the improved varieties over the farmers' variety shows the extra benefit obtained as result of producing the improved variety. It also helps the researcher to recommend the improved variety based on the relative yield advantage. As shown in table 3 below, Robera and Abdane varieties had 30.2% and 20.7% yield advantage over the local variety Aruso respectively.

Table 3. Yield advantage of the newly released variety over the checks

Demonstrated Varieties	Yield obtained (Qtha^{-1})	Yield Advantage over Aruso variety
Abdanne	31.46	20.7%
Robera	33.94	30.2%
Aruso	26.06	-

Participatory Varietal Evaluation and Selection

According to the pairwise ranking result, yield is the first important characteristics farmers look in barley varieties followed by number of fertile tillers, number of seed per spike and head length respectively (Table 4).

As shown in table 5 and 6 below, Abdane variety was ranked first, followed by Robera in Adaba and Dodola districts while Robera was ranked first for the reasons specified in the table.

Table 4. Pair wise ranking result to rank variety traits in order of importance

variety traits	Disease tolerance	Head length	Lodging resistance	No of fertile tillers	No of seed/ spike	None shattering	Plump seed	Seed color	Yield	Frequency	Rank
Disease tolerance										3	5th
Head length	2									5	**3rd**
Lodging resistance	3	2								4	4th
No of fertile tillers	4	4	4							7	**2nd**
No of seed/spike	5	5	5	4						5	**3rd**
None shattering	1	2	3	4	5					0	8th
Plump seed	1	2	3	4	5	7				2	6th
Seed color	1	2	3	4	5	8	7			1	7th
Yield	9	9	9	9	9	9	9	9		8	**1st**

Table 5. Rank of the varieties based on farmers' selection criteria in **Adaba and Dodola** districts

No	**Varieties**	**Rank**	**Reasons**
1	Abdanne	**1st**	High number of tillers (≥8), seeds/spike (≥55), disease tolerant, good head length, plumps seed, it is adaptable to the environment, good in black soil.
2	Robera	**2nd**	Medium tillering capacity, attractive uniformity, less disease tolerant, good crop stand, resistant lodging and attractive seed color.
3	Aruso	**3rd**	Susceptible to disease and lodging, few numbers of tillers and spike, small head, it has the problem of shattering and low yielder.

Table 6. . Rank of the varieties based on farmers' selection criteria in **Sinana and Agarfa** districts

No	**Varieties**	**Rank**	**Reasons**
1	Robera	**1st**	High yielder, high number of tillers (≥8), seeds/spike (≥54), disease tolerant, good crop stand, good plant height, resistant to lodging, adaptable to the environment, attractive seed color and it has good uniformity
2	Abdanne	**2nd**	Medium yielder, medium tillering capacity, disease tolerant, less resistant to lodging, lacks good seed color.
3	Aruso	**3rd**	Susceptible to disease and lodging, few numbers of tillers and spike, poor crop stand, small head, it has the problem of shattering and low yielder.

Conclusions and Recommendations

Pre-extension demonstration of improved food barley technologies was carried out in the main cropping season in Sinana, and Agarfa districts of Bale and Adaba, and Dodola districts of West Arsi zone. One recently released food barley variety (Robera) was demonstrated and evaluated with Abdanne (standard check) and Aruso (farmers' variety). From the compared varieties Robera variety gave the highest yield followed by the standard check (Abdanne) and local check (Aruso) respectively. On this event participant farmers were enhanced to select the varieties of their interest by setting their own variety traits evaluation criteria. Accordingly they selected Robera at Sinana and Agarfa and Abdanne was selected at Adaba and Dodola districts. Based on the farmers' variety selection result, it is recommended to carry out pre-scaling up of Robera variety with its recommended production packages in the coming cropping season in areas where it was selected and similar agro-ecologies of Bale zone. On the other hand Abdanne variety is also another option given the farmers selection criteria at Adaba and Dodola districts of West Arsi zone.

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

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Abstract

Pre-extension demonstration of faba bean technologies were conducted in Adaba and Dodola districts of West Arsi zone and Sinana and Agarfa districts of Bale zone in 2017/18. The major objective of the study was to demonstrate and evaluate improved faba bean varieties and select best performing variety (ies) for further popularization and scaling-up. Recently released variety Mosisa was demonstrated and compared with standard check (Moti) and farmers' variety (Shallo) on a simple plot size of 20m x 20m replicated on different farmers' fields. The trail was carried out on nine farmers' fields and two Farmer Training Centers (FTCs).The result of descriptive statistics shows that a mean yield of 38.57, 34.9 and 31.81 qt ha^{-1} was recorded for Moti, Mosisa and Shallo varieties, respectively. Moti variety was selected for its high yield, high number of tillers, high pods/plant, high seed/pod, disease tolerant, good plant height, good crop stand, strong stem, big seed size and good taste quality. Therefore, Moti variety should be scaled up/out in the study areas and in similar agro-ecologies.

Key Words: *Faba bean, Farmers' criteria, Mosisa, Participatory variety selection, Yield.*

Introduction

Faba bean, which is the third most important cool-season food legume in the world, is originated in the near East and is one of the earliest domesticated legumes after chick pea and pea (Torres et al, 2006).Faba bean is mostly grown in the mid and highland areas of Ethiopia covering at altitudes of 1800 to 3000 m above sea level (Asfaw, 1985). The crop has a multipurpose use and is consumed as dry seeds, green vegetable, or as processed food. Its products are a rich source of high-quality protein in the human diet, while its dry seeds, green haulm and dry straw are used as animal feeds (Sainte, 2011).In Ethiopia, faba bean is the most important protein source for the rural people and used to make various traditional dishes. Moreover, it can improve soil fertility through fixing atmospheric nitrogen and provides large cash for producers and foreign exchange for the country (Beyene, 1988).

From 1,652,844.19 hectares of land allocated for pulse in 2015/2016 production season, faba bean covered 443,966.09 hectares of land from which 8,486,545.69 quintals of grain was produced with the national average productivity of 19.12 qt/ha (CSA, 2016). Similarly, in Bale, 16,471.36 ha of land was covered by faba bean and 388,302.53 quintals of grain was produced with the average productivity of 23.57 qt/ha (CSA, 2016).

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).Nevertheless, the productivity of faba bean is far below its potential in Ethiopia due to a number of factors, the biological limitations include inherently low grain yielding potential of the indigenous cultivars and susceptibility to biotic and abiotic stresses (Mussa et al, 2008).

To overcome prevailing problems, efforts have been made through the regional and federal research centers in the nation by releasing different improved faba bean varieties. In line with this, Sinana Agricultural Research Center had released different faba bean varieties among which Mosisa variety is the recent one. Mosisa has 32-48qt/ha yield potential, 12.57% yield advantage over standard check (Shallo) and 24.25% over local check. However, farmers have little information about the variety in particular and the agronomic practices to follow and the economic importance of the variety in general. Hence, the study aimed to carry out participatory pre-extension demonstration of these recently released faba bean variety along with its packages in the study areas with following objectives.

Methodology

Description of the study area

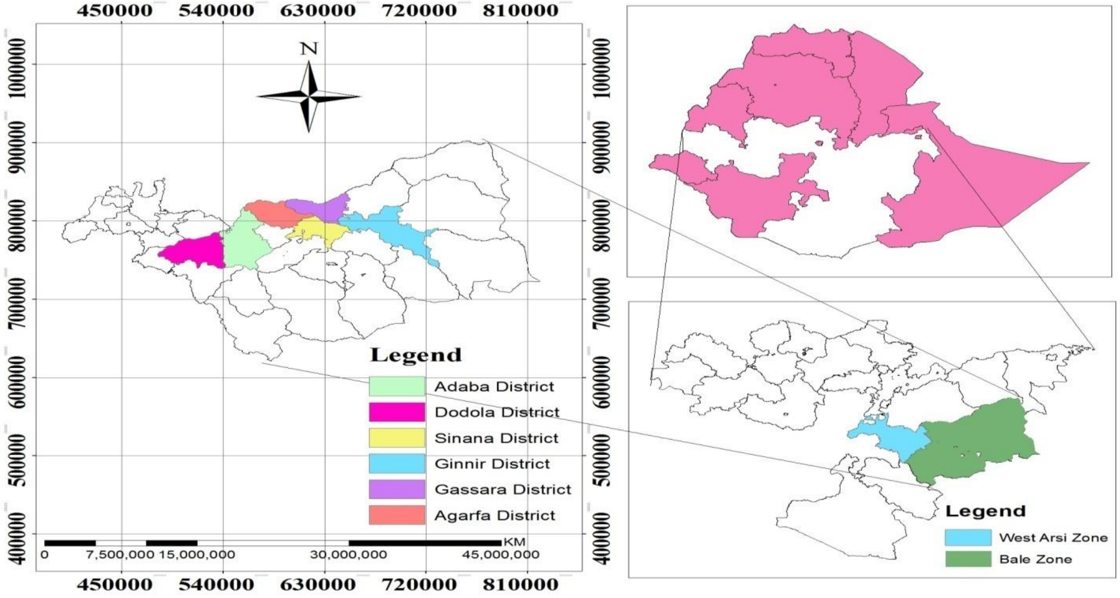
The study was carried out in Adaba and Dodola districts of West Arsi zone and Sinana, Agarfa and Gassara districts of Bale zone, Oromia National Regional State (ONRS), Ethiopia. West Arsi and Bale zones are among the 20 Administrative zones located in south eastern parts of Oromia, Ethiopia.

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 63,555km2 (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 3.5oc and 35oc, 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).

West Arsi Zone

West Arsi zone has twelve (12) rural and two (2) town districts and having the total area of 12,556km2 (1,255,600 hectares). About 95% of the population is engaged in agriculture. Geological Survey shown that about 76.19% of the zone are flat plain, while about 23.81% are ragged or unutilized terrain that including valley, gorges, hills and dissected plateaus (MOFED, 2010). Most parts of the zone have elevations of ranging from 1500m to 2300m.a.s.l. The mean annual temperature of the zone is found between 10oc -25oc. For most of the areas, the rainy season starts in March and extends to November with the increasing concentration in June, July and August. On average, the zone gets annual mean rainfall of 1300mm. The zone is bounded by East Shewa zone in the North, South Nations, Nationalities and People National Regional State in the West, Arsi zone in the northeast, Guji zone in the South and Bale Zone in the East. Shashemenne town is the capital town and administrative center of the zone (WAZADO, 2014).



Source: Own sketch

Site and farmers' selection

Site selection

The research was conducted in Agarfa, Gassara and Sinana districts of Bale zone; whereas Adaba and Dodola were selected from West Arsi zone. Purposive sampling method was employed to select five representative districts from the two zones based on their potential for Faba bean production and being AGP-II target districts mandated for Sinana Agricultural Research Center. From each district two representative Kebeles were also selected purposefully based on their accessibility and production potential of the crop.

Farmers' selection

Participatory approach by strengthening the formerly established Farmers Research Group (FREGs/FREGs) was the main strategy during demonstration of the technology. Strengthening the previously established FREGs was aimed to bring significant change on the farmers' knowledge, altitude and skill of the members on introduced technologies. During the establishment of FREGs/FREGs different criteria were taken in to consideration in order to sustain the group work. These criteria includes farmers' willingness to be held as member, accessibility for supervision of activities (vicinity), good history of compatibility with groups and motivation and experience to share innovations to other farmers. Consequently, one FREG/FREG with 20 members by taking in to account farmers' resource categories (i.e. rich, medium and poor) was established at each Kebele with the consideration of gender disaggregation. Moreover, two representative trial farmers from each FREG/FREG were selected at each kebele (with the help of group members and DAs).Willingness to contribute suitable the land for the trial, 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.

Table1: Number of FREG members strengthened in each demonstration site

District & kebeles	FREG(No)	Members by Gender				
		Adult (Male)	Adult (Female)	Youth (Male)	Youth (Female)	Total
Sinana (Salka & Gamora)	2	20	15	4	1	40
Agarfa (Ali &Illani)	2	22	14	2	2	40
Adaba (Washa & Ejersa)	2	24	16	0	0	40
Dodola (Katta Baranda & Kachama Chare)	2	23	15	1	1	40
Total	8	89	60	7	4	160

Materials and Field design

One recently released Faba bean variety (Mosisa) was demonstrated and evaluated against one standard check (Moti) and one farmer's variety (Shallo) in which a simple plot size of 20m x 20m was allocated for each variety in the main cropping season. Row planting with the spacing of 40cm between rows was applied in which sowing was done by drilling in the prepared rows with the recommended seed rate of 180 kg/ha. Similarly, inorganic fertilizer (DAP) was applied with the recommended rate of 100 kg/ha during planting time. Farm operations (land preparation-ploughing four times oxen plough) were carried out by hosting farmers, whereas activities such as land leveling, planting, first and second weeding, harvesting, threshing were executed by FREG members with close orientation from Sinana Agricultural Research Center.

Technology demonstration and evaluation approaches

Mini-Field day: 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. Thus 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.

Participatory selection of demonstrated varieties

The target beneficiaries of improved agricultural technologies are strongly inclined to their preferences. These preferences will cause them to give up less favored good crops/varieties for more favored ones. So, consulting the intended end users to assess which quality/ies of a particular variety they desire (to be considered in plant breeding program) is highly important. Because, it will not only be resource saving in terms of preferred variety promotion/dissemination, but also time saving and fast adoption (Dan, 2012). In line with this, FREGs/FREGs members and other follower farmers were encouraged to participate on different extension events organized at each site. The learning events will let them understand the objectives of the activity more and helps in evaluating the varieties demonstrated according to their own selection criteria apart from orientations. Yet, before commencing on the selection, at each trial site, brief orientation was given to the evaluators on how to integrate researchers' criteria to their own criteria to select the demonstrated varieties in order of their importance. The orientation also incorporated 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 group leader at the end.

Data type and method of data collection

Both qualitative and quantitative data were collected using field observation, scoring and focused group discussion (FGD) of data collection techniques. Yield data per plot in all locations were recorded.Total number of trial farmers and mini field day participants were recorded by gender disaggregation. 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) were identified.

Data analysis

SPSS was used as statistical package (descriptive statistics was used to analyze the data). Farmers' perception on the performance of improved bread wheat varieties were tested at each district and analyzed using Pair Wise Ranking. Pair Wise Ranking was used as a tool to summarize farmers' preference towards important variety traits (Boef and Thijssen, 2007).

Results and Discussions

Agronomic performance of the Varieties

The yield and yield components harvested from all replicated trial farmers in each kebele was recorded and analysed using descriptive statistics. Result of combined analysis of variance revealed that there was significant difference among the demonstrated faba bean varieties in terms of number of seeds per plant. However, there was no significant difference among faba bean varieties in terms of number of fertile tillers per plant, number of pods per plant and yield obtained per hectare (Table 2).

Table2: Combined analysis of yield and yield components of demonstrated Fab bean varieties

Parameters	Varieties	Mean	Std. Deviation	Sig (α=5%)
Number of Fertile Tillers	Moti	3.03	0.84	Ns
	Mosisa	3.23	0.40	
	Shallo	3.00	0.00	
Pod Per Plant	Moti	25.17	7.01	Ns
	Mosisa	21.67	5.51	
	Shallo	20.23	10.60	
Seed Per Pod	Moti	3.67	1.15	Ns
	Mosisa	2.57	0.51	
	Shallo	3.43	0.51	
Yield Per Hectare	Moti	38.57	4.43	* Ns
	Mosisa	34.90	4.81	
	Shallo	31.81	4.13	

The average yield harvested across trial locations is shown in the following graph.

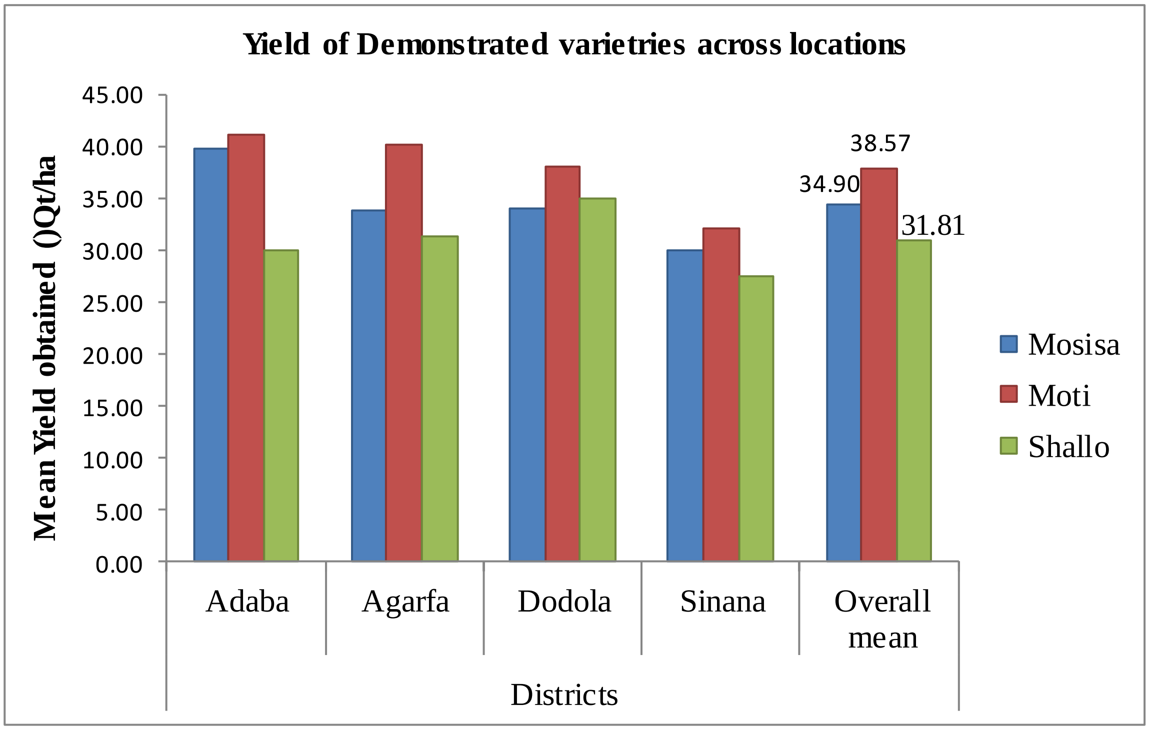


Fig. 1. Average yield of demonstrated varieties

Comparison of yield advantage of improved varieties

Calculating yield advantage of the improved varieties over the farmers' variety shows the extra benefit obtained in percentage as result of producing the improved variety. It also helps the researcher to recommend the improved variety based on the relative yield advantage. To this end, Moti variety had 21.25% yield advantage over farmers' variety (Table 3).

$$\textbf{Yield advantage (\%)} = \frac{\text{Yield of new variety (qt/ha)-Yield of commercial variety (qt/ha)}}{\text{Yield of commercial variety (qt/ha)}} \text{X100}$$

Table 3. Yield advantage of the newly released variety over the checks

Demonstrated Varieties	Yield obtained (Qtha^{-1})	Yield Advantage over farmers' variety (Shallo)
Moti	38.57	21.25%
Mosisa	34.9	9.75%
Shallo	31.81	-

Farmers' Variety evaluation and selection

The task of variety evaluation and selection was carried out in Adaba, Dodola, Sinana and Agarfa districts. During variety evaluation and selection process, participant farmers were encouraged to reflect their preference to varietal attributes by setting their own varietal selection criteria. On this event 108 farmers and 20 experts were actively participated and selected the variety of their preference.

Table 4. Participants of Variety evaluation and selection

Location	Number of participants				
	Farmers		Experts (DAs & SMS)		Subtotal
	Male	Female	**Male**	Female	
Adaba	23	9	**4**	2	38
Dodola	20	10	**4**	1	35
Agarfa	20	8	**3**	2	33
Sinana	14	4	**4**	-	22
Total	**77**	31	**15**	5	128

Farmers' preference to demonstrated varieties

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). 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).

Thus, in this study, the task of variety evaluation and selection was made by enhancing the participation of farmers and experts in which farmers were encouraged to reflect their preference to varietal attributes by setting their own varietal selection criteria. Accordingly farmers have settled their criteria and pair wise ranking was used to select which criteria are more important to farmers. Consequently, yield, number of pods per plant and number of fertile tillers were the three most important characteristic farmers look in faba bean varieties. Thus filling these criteria Moti variety was found as the first choice of the participants. The following tables describe the results.

Table 4. Pair wise ranking result to rank variety traits in order of importance

variety traits	Disease tolerance	Lodging resistance	No of fertile tillers	No of pods/plant	No of seed/pod	Seed size	Taste	Yield	Frequency	Rank
Disease tolerance									2	4th
Lodging resistance	1								1	5th
No of fertile tillers	**3**	3							3	**3rd**
No of pods/plant	4	4	4						6	**2nd**
No of seed/pod	5	4	5	4					3	3rd
Seed size	6	6	6	6	6				6	**2nd**
Taste	1	2	3	4	5	6			0	6th
Yield	**8**	8	8	8	8	8	8		7	**1st**

Table 5. Rank of the varieties based on farmers' selection criteria

No	**Varieties**	**Rank**	**Reasons**
1	Moti	**1st**	High yielder, high number of tillers, high pods/plant, high seed/pod, disease tolerant, good plant height, good crop stand, strong stem, big seed size, good taste (especially during green pod stage), resistant to lodging, it is adaptable to the environment.
2	Mosisa	**2nd**	Medium yielder, medium number of tillers, medium pods/plant, medium seed/pod, disease tolerant, adaptable to the environment, it has more infertile pods than Moti.
3	Shallo	**3rd**	Low yielder, Susceptible to disease and lodging, few number of tillers, few number of pods/plant and seed/pod.

Conclusions and Recommendations

In the study, Moti variety was found to be best performing and accepted faba bean variety for the study area. It was ranked first based on participant farmers' varietal attributes evaluation criteria and also the technical evaluations. According to pair wise ranking result, yield and yield components are the priority concern of the farmers for sustainable production system in the study districts. The result of descriptive statistics also showed that among the demonstrated varieties, Moti has performed better than Mosisa and Shallo in overall mean yield obtained across locations. Thus, Moti variety is recommended for pre-scaling up activity in the districts where the study took place and in similar agro-ecologies.

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Pre-extension Demonstration of Potato late blight (*Phytophthora infestans* L.) Management options in western Oromia

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Abstract

This study was conducted in Jimma Geneti, Horo and Jimma Rare districts of Western Oromia with the objective of demonstrating the recommended fungicide with its frequency and time of application for controlling potato late blight. The study districts were purposively selected based on potentiality for potato production. From each district one Kebele was selected based on production potential and accessibility to the road. One FREG was established at each kebele and training was given for the members on potato production, management and postharvest handling technologies. The recommended late blight management practice (Matico 1.5 kg ha^{-1}) and farmers practice (without fungicide) were applied on six farmers' fields in 2016/17 and four farmers' fields in 2017/18. Accordingly, the on-farm demonstration result revealed that application of Matico for late blight management reduced late blight severity and increases potato tuber yield. The maximum tuber yield of 340 and 280 qt ha^{-1} was recorded in fungicide applied plots in 2016/17 and 2017/18, respectively. The severity of diseases was also found to be low for fungicide applied plots. The increased yield of potato is expected to substantially increase the income as well as livelihood of the farming community. Therefore, research organizations should further scale up/out the recommended technology in the study districts and other similar areas to reach more number of farmers.

Key words: *FREG, Matico, participatory evaluation, Potato late blight*

Introduction

Potato *(Solanum tuberosum* L., *Solanaceae*), 'The king of vegetables' has about 200 wild species in the world. Potato has become a staple food in many parts of the world. It is the world's fourth largest food crop, following maize, wheat, and rice (Saidul et al, 2018). It is an important source of food and employment in developing countries. Potato provides high energy and quality protein as well as substantial amount of vitamins and minerals (Kuarabachew et al., 2007 and FAO, 2008). Potato was first introduced to Ethiopia in 1858. However, its adoption was limited until nineteenth century due to genetically very limited availability of potato varieties and their susceptibility to diseases and pests (Kidane-Mariam, 1980). Potatoes play an important role in improving food security and cash income of smallholder potato growers in Ethiopia.

It is most widely grown vegetable crop in the country with a share of 21.9 per cent area. The area under potato cultivation is 2060 thousand ha with total production of 44893 thousand Metric tones (MT) with 21.8 MT/ha productivity. Currently, the national average of potato production in Ethiopia reached 13.45 tone/ha (CSA, 2016). However, the national average potato yield is yet very low as compared to the potential yield (40 tone ha-1) obtained under research conditions. This is due to narrow genetic basis of potato varieties, poor seed quality, susceptibility to diseases and poor farmers' management (Haverkort *et al*., 2012; Tewodros, 2014). The main problem of potato production worldwide are economic losses due to late blight, caused by

Phytophthora infestans L. which can destroy all parts of potato plants (*Solanum tuberosum* L.) within two weeks in wet conditions (Hooker, 1981; Fry *et al*., 1993). *Phytophthora infestans* can survive under adverse conditions and over winter in the form of oospores. The pathogen, however, invades and infects potato plants in the field via zoosporangia, which disperse via soil, water, rain splash and wind (Van der Zaag, 1996).

Infection occurs when leaves are moist for at least 5 hours at 15-20ºC. Spore germination results in colonization and infection causing symptoms on leaves, stem or tubers and production of new spores within four to five days (Rich, 1983). Late blight disease has been controlled using chemical fungicides at seed dressing and repeated spraying of systemic fungicide like Metalaxyl (Milgroom and Fry, 1988) and protective fungicide such as Mancozeb (Samoucha and Cohen, 1986). Control of the pathogen population below economic damage levels is then still not possible and has led to low yields or even no yield where inappropriate chemicals and techniques where applied (Rotem and Bashi, 1983).

Although several tolerant potato varieties were developed nationwide, the pathogen is still causing significant loss particularly in western Oromia where the climate favors the disease development. Potato growers of western Oromia and researchers reported that there is serious damage of the crop due to potato late blight resulting in significant yield and quality losses. To tackle the problem, an alternative and effective fungicide was recommended with its application techniques by Bako Agricultural Research Center (BARC). Combination of systemic fungicide Matico and contact fungicide Mancozeb and Matico sole at three times application every 21 day from the onset of the disease were the best management option of potato late blight recommended by the center. However, farmers in the area were using unknown fungicide and applied only one times in the production periods due to lack of awareness and knowledge of the availability and importance of the technology and its application. Therefore, the objective of this project is to familiarize the farmers with time of fungicide application, application frequencies and type of fungicides to be used to manage potato late blight and thereby increasing productivity of the crop.

Materials and Methods

Site and farmers selection

This activity was conducted in purposively selected districts of Horo Guduru Wellega zone namely Horro, Jimma Rare and Jima Geneti in 2016/17 and 2017/18 main production season based on potato production potential, compatibility with AGP II criteria and accessibility for supervision. From each districts one PA was selected purposively based on potentiality for potato production and accessibility. In each PA one FREG (Farmer's Research-Extension Group) having 12-18 members was established. Gender balance was strictly considered according to the AGP II criteria. From the FREG members two experimental farmers were selected as a host farmer the rest being participant farmers. The experimental farmers were selected based on ownership of suitable and sufficient farm land to accommodate the trials, willingness and accessibility to road to increase the chance of being visited by many farmers.

Training of farmers, experts and development agents (DAs)

Theoretical training was given to farmers, district experts and DAs by multidisciplinary teams of researchers composed of breeder, agronomist, pathologist, extensionist and economists on agronomic practices, diseases and pest managements, economic importance and postharvest managements of potato. In addition, practical training was given for farmers during potato planting. .

Field design and management

The demonstration work had two treatments; the recommended fungicide technology and farmers' practice. Accordingly, the recommended fungicide called Matico was applied at rate of 1.5 kg ha^{-1} every three weeks from the onset of the disease to each demonstration plots sized 100 m^{2} while the control plots(farmers practice) was without fungicide application. The improved variety; Belete used for the purpose. The treatments were replicated on different experimental farmers' fields. The demonstration plots were managed jointly by researchers, extension workers and farmers. The recommended spacing of 70 cm and 30 cm between rows and plants respectively were used for planting. Fertilizers were applied at rate of 100 kg DAP and 200kg Urea; Urea were applied at split during planting and two weeks after full emergence of the tuber. All other agronomic practices were applied equally to the demonstration plots as per the recommendation.

Data collection and analysis

Both qualitative and quantitative data were collected using appropriate data collection methods such as focused group discussion (FGD), direct field observation and scoring the disease severity and incidence. Yield data was recorded on plot bases. Total number of farmers, development workers and experts participated on events such as training and field visits were recorded by gender composition. Farmers' perception toward the technology was also identified. The collected data were analyzed using descriptive statistics such as mean, frequencies, distribution, and percentages.

Results and discussions

Training of farmers, experts and DAs

Participatory training `was given by multidisciplinary team of Bako Agricultural Research Center researchers composed of breeder, agronomist, pathologist, extensionist and economist in both years (2016/17 and 2017/18) at Jimma Ganati, Horo and Jimma Rare districts on potato production technologies(Table 1). Accordingly a total of 165 and 117 participants were participated on the training in 2016/17 and 2017/18 cropping season respectively.

Table 1. Training given to participants across three districts in 2016/17 and 2017/18 cropping season.

Participants	2016/17				2017/18			
	Districts							
	Jimma Geneti	Horo	Jima Rare	Total	Jimma Geneti	Horo	Jimma Rare	Total
Experts	3	5	6	14	3	4	3	10
Das	6	5	10	21	3	4	4	11
Farmers	43	55	32	130	38	16	42	96
Total	52	65	48	165	44	24	49	117

Field day organized

Mini field days were organized in collaboration with district agricultural development offices and farmers at Jimma Geneti, Horo and Jimma Rare in 2016/17 and. Horo and Jimma Rare in 2017/2018. The potato planted for demonstration in 2017/18 at Jimma Geneti was totally infected with bacterial wilt and it was not evaluated. During the field days, the demonstration plots in the two districts; Jimma Rare and Horo were evaluated by farmers, DAs and experts in both years. In general, a total of 117 and 73 farmers were participated on the field day in 2016/17 and 2017/18 cropping years respectively (Table 2).

Table 2. Participants of field day organized at demonstration districts

Districts	2016/17									2017/18								
	Farmers		DAs		Experts		Researchers		Total	Farmers		DAs		Experts		Researchers		Total
	M	F	M	F	M	F	M	F		M	F	M	F	M	F	M	F	
J. Geneti	28	6	3	-	2	-	5	-	44	-	-	-	-	-	-	-	-	-
Horo	32	5	4	-	3	-	5	-	49	28	5	4	1	3	-	6	-	47
J. Rare	38	8	4	1	3	-	5	-	59	34	6	4	1	3	-	6	-	53
Total	98	19	11	1	8		15	-	152	62	11	8	2	6	-	12	-	100

Disease severity and yield performance

Disease severity and performance of treated and untreated plots were recorded during the two years. Application of the recommended fungicide; Matico completely controlled late blight in both cropping years. Application of fungicide on demonstration plots resulted in higher yield advantage of 32.09% over the untreated ones (Table 3). The yield and disease variability between locations and years may be due to the difference in soil, weather conditions.

Table 3. Diseases and yield data of 2016/17 and 2017/18 cropping season.

District	2016/17				2017/18			
	Late blight (1-9 scale)		Yield (qt)		Late blight (1-9 scale)		Yield (qt)	
	Treated	Untreated	Treated	Untreated	Treated	Untreated	Treated	Untreated
J.Geneti	1	4	320	270	1	-	-	-
Horo	1	6	340	254	1	4	260	150
J. Rare	1	6	329	268	2	4	280	230

Conclusions and Recommendations

The demonstration activity was conducted in Jimma Geneti, Horo and Jimma Rare districts of Western Oromia with the objective of demonstrating the recommended fungicide with its application techniques for controlling potato late blight. The results of on-farm demonstration indicated that application of Matico at rate of 1.5 kg ha^{-1} was effective in controlling potato late blight disease. In addition, application of the recommended technology (fungicide) has increased potato yield by reducing loss occurred due to diseases and this is expected to substantially increase the income as well as lived hood of the farming community. From the demonstration conducted in the area farmers were familiarized with potato late blight management technology (time of application, application scheme and types of fungicides to be used). Therefore, research should further scale up/out the recommended technology in the study districts and similar areas in collaboration to other stakeholders to reach wider areas and more number of farmers.

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Pre-extension Demonstration and Evaluation of Melkassa Maize Varieties in Selected AGP-II districts of Harari Region and Dire Dawa City Administration

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Abstract

Pre-extension demonstration and evaluation of early maturing maize varieties were conducted in 2017/18 production season with the objectives of promoting and popularizing, creating awareness, improving farmers' knowledge and skills through training and enhancing stakeholders' participation. A total of fifteen (15) trial farmers were selected from two potential Maize growing kebeles of Dire Dawa Administration and one kebele of Harari Region. Three FREG having 45 farmers were established at each kebele. Two improved maize varieties (Melkassa-2 and Melkassa-6) were each planted on a plot sized 40m x40m and replicated on different farmers' fields. Training and field days involving a total of 39 and 107 participants, respectively were organized at Dire Dawa and Harari Region. The demonstrated maize varieties were evaluated in terms of time of maturity, yield and disease tolerance. Accordingly, the field demonstration result indicated that Melkassa-2 variety gave relatively higher (23.6 qt ha^{-1}) yield followed by Melkassa-6 variety which gave 21.6 qt ha^{-1} with 9.3% yield advantage over Melkassa-6 variety. Moreover, participant farmers ranked Melkassa-2 variety first and Melkassa-6 second. Therefore, both varieties were recommended for further pre-scaling up due to their early maturity, better yield and disease tolerance compared with the local varieties.

Key words: Melkassa Maize, improved varieties, Dire Dawa and Harari districts

Introduction

Food security in Ethiopia, and elsewhere in Africa, is a major socio-political issue. Its economic wellbeing is also dependent on the success of its agriculture. Ethiopia has long suffered from food shortages and economic underdevelopment even though it is endowed with a wide range of crop and agro-ecological diversity. Maize, teff (Eragrostistef), sorghum, wheat, and barley among cereals and enset (Enseteventricosum) among roots and tubers provide the main calorie requirements in the Ethiopian diet. Crop productivity and production remained low and variable in the 90s for the most part but there have been clear signs of change over the past decade. Maize has expanded rapidly and transformed production systems in Africa as a popular and widely cultivated food crop since its introduction to the continent around 1500 A.D (McCann, 2005).

Maize production and its status in determining food security in the country received a major focus in the mid-1980s, particularly spurred by the 1984 devastating drought and the famine that followed. The wide adaptability of the crop and the potential to produce more calories and food per area of land cultivated than all major cereals grown in Ethiopia were important factors in considering maize as part of the national food security strategy, including its inclusion under the government-led intensive agricultural extension program (Berhane et al. 2011). With increased production driving market prices down, maize became more affordable (e.g., relative to other staples such as teff and wheat) to rural and urban consumers. It is now increasingly used both separately as well as in mixed flour with other more expensive cereals in traditional Ethiopian diets. Maize is the most important staple in terms of calorie intake in rural Ethiopia. The 2004/5 national survey of consumption expenditure indicated that maize accounted for 16.7 % of the national calorie intake followed by sorghum (14.1 %) and wheat (12.6 %) among the major cereals (Ibid, 2011).

Compared to the 1960s the share of maize consumption among cereals more than doubled to nearly 30% in the 2000s, whereas the share of teff, a cereal that occupies the largest area of all crops in Ethiopia, declined from more than 30% to about 18% during the same period (Demeke, 2012). The popularity of maize in Ethiopia is partly because of its high value as a food crop as well as the growing demand for the Stover as animal fodder and source of fuel for rural families. Approximately 88 % of maize produced in Ethiopia is consumed as food, both as green and dry grain. Maize for industrial use has also supported growing demand. Very little maize is currently used as feed but this too is changing in order to support a rapidly growing urbanization and poultry industry. Unlike its neighbor, Kenya, which imports a significant share for its consumption needs, Ethiopia has increasingly attained self-sufficiency in maize production since early this decade and even exports some quantities to neighboring countries (e.g., Sudan and Djibouti) in years of surplus production. If production can be significantly expanded, the potential for maize export to all the neighboring countries including Kenya is very high although the national demand is expected to continue to grow in the coming years.

The emerging maize green revolution for Africa that Byerlee and Eicher (1997); Byerlee and Heisey (1997); Byerlee and Jewell (1997); and Eicher and Kupfuma (1997) envisioned in the 1990s has remained elusive so far but is showing strong signs of becoming a reality now in Ethiopia and perhaps in other countries of sub-Saharan Africa (SSA). There is evidence that the increased productivity and production of maize is also having a significant positive impact on poverty reduction (Dercon et al. 2009). Melkasa series maize varieties give high yield when compared with local maize varieties .Melkasa maize varieties mature earlier than local maize and somewhat drought tolerant than local. Farmers in the study area use the local variety which needs enough amount of rainfall and obtain low production if rainfall is not enough. Therefore, this project intended to alleviate these problems and ensure the benefits to be obtained from these Melkasa Maize varieties.

Materials and Methods

Description of the study area

The activity was conducted in nationally selected Agricultural growth program-II implementation districts of Harari region and Dire Dawa administration. 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 soil types that exist in the region is different in different ecologies of the region that is clay, loam, sandy and black types. Dire Dawa Administration is located on distance of 515kms from capital city Finfine in direction of county’s Eastern part; it is bordered by Somali, and Oromia regions in all directions. Dire Dawa Administration has both urban and rural set governance system. The climatic condition of Dire Dawa is almost dry land with the maximum and minimum annual temperature 38^{0c} and 25^{0c} respectively (EBC broadcasting on metrology allocated time).

Site and farmers selection

Two districts from Dire Dawa and one districts Harari Region were selected .From Dire dawa three kebeles (Adada,Dujuma and Wahil) and Sofi from Harari region were selected Farmers were also 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 Development Agents. The selected farmers were grouped in the form of Farmers Research and Extension Group (FREG) with the member of 15 farmers per kebele in consideration of gender issues (women, men and youth). A total of 3 FREGs (One FREG/ PA) from one PA 15 farmers and a total of 45 farmers were grouped in 3 FREGs organized. In the FREG, 5 farmers were trial farmers (3 male and 2 female) and 10 farmers were non trial farmers.

Implementation design

Two improved (Malkessa 2 and Malkessa 6) Maize varieties and one local check were used for the study. The varieties were replicated across five trial farmers per kebele .Each variety was planted on a plot size: 40mx40m, at seeding rate of 25-30kg/ha. A spacing of 75cm*25cm (Between row and plant) and fertilizer (NPS) at rate of 100kg/ha were also used.

Training, field visit and Filed-day organized

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 maize production and management, post-harvest handling and marketing information. Field day was also organized for more awareness creation. Adada, Wahil and Dujuma kebeles from Dire Dawa and Kile from Harari region were selected based on their maize production potential. Mini field day on which 43 farmers (33 male and 10 females), 7 DAs and 5 experts participated was organized at Kile Kebele. Mini field day was also organized at Dire Dawa on which 40 farmers (32 male and 8 females), 5 DAs, 4 experts and 3 journalists participated. 12 farmers (3 female and 9 male) selected both Melkassa-2 and Melkassa-6. Twenty eight farmers (6 female and 22 male) selected Melkassa-2 based on cob size and yield. Both varieties are similar according to farmers' preferences by stack and early maturity.

Data collection and analysis method

Both quantitative and qualitative data were collected. The collected quantitative data were subjected to analysis using SPSS software version 20 (frequency, mean, standard deviation and range) while qualitative data collected using group discussion, key informant interviews, field observation and focus group discussion were analyzed using narrative explanation and argument. Finally data from different sources were triangulated to get reliable information.

Results and Discussions

Training of target group (Farmers, DAs and Experts)

The training was organized at both regions. It was given on the topics of agronomic practices (crop weed and disease management), stakeholders' linkage and extension approach and market and information linkage. At Harari region, 34 (28 male and 6 female) farmers, 2 male development agents and 2 experts were participated while at Dire Dawa, 27 (20 male and 7 female) farmers, 5 male development agents and 4 experts were participated.

Yield performance the varieties

The following graph describes the yield performances of the demonstrated varieties across the study site. The grain yield performance of the improved varieties (Melkassa-6 and Melkassa-2) were 17.26 and 18.91qt/ha at Adada, 24.71 and 24.31qt/ha at Kile, 21 and24.73qt/ha at Dujuma and 23.47 and 26.59qt/ha at Wahil respectively. The average grain yield performance of Melkassa-2 was higher (26.59 quintal per hectare) at wahil while that of Melkassa-6 variety was higher (24.71qt/ha) at kile kebeles.The yield performance of Melkassa-2 variety was higher than and Melkassa-6 at Wahil (26.59qt/ha), Dujuma (24.73qt/ha) and Adada (18.91qt/ha). However, the grain yield performance of Melkassa-6 was higher at Kile (24.71qt/ha).

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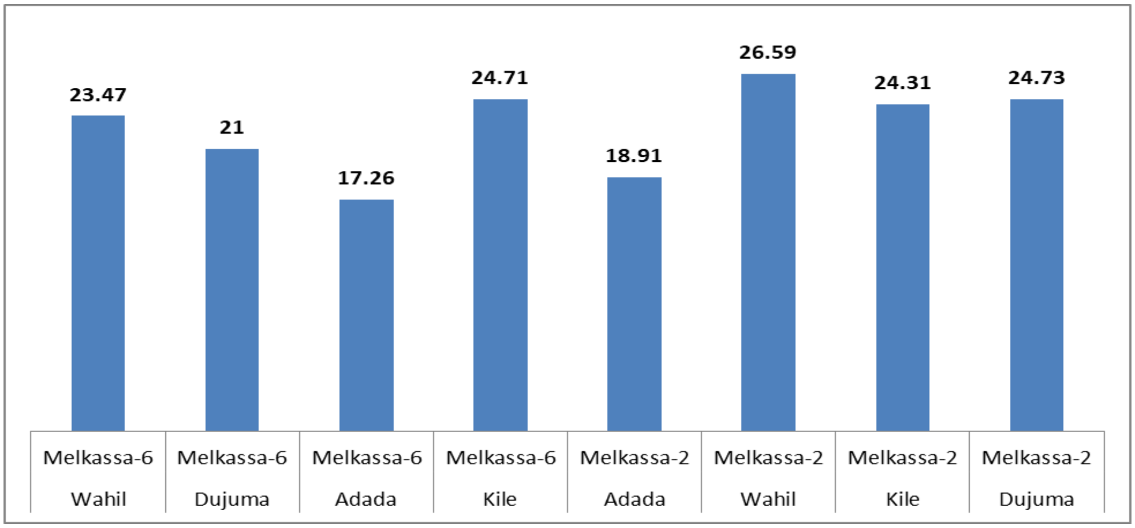

Fig. 1. Yield performance of improved lowland maize varieties across districts on Farmers land

Field day organized and Farmers' perception toward the varieties

Farmers' in the study area also selected the best performing improved lowland maize varieties by using their own criteria. Farmers set these criteria after having know-how about the variety and using those criteria they could select the varieties at harvest time. The opinion of those farmers on varietal preference was collected from participants during variety demonstration. The major criteria used by farmers were grain yielding, diseases tolerance, performance throughout growing stage, Adaptable to the environment, moisture stress tolerance, biomass and labor demand. Based on the above criteria's; farmers evaluated the varieties and ranked first Melkessa-2 followed by Melkassa-6. Generally, farmers selected the varieties (Melkassa-2 and Melkassa-6) based on the current climate and the response of the varieties with regard to their early maturity, disease tolerance and adaptability to the environment. Therefore, the most farmers selected both improved varieties to use on their farm for the future. The following table (Table 1) describes farmers' selection criteria and their perception (feedback) toward the varieties

Table 1. Farmers' feedbacks on the varieties

Variety	Farmers feedback on the varieties of maize	Ranks given to the varieties
Melkessa-2	Relatively good grain yielding Very good diseases tolerance Very goodperformance throughout growing stage Adaptable to the environment Very good in moisture stress tolerance Good feed stalk/biomass/low labor demand Easily manageable/low labor demand	1st
Melkessa-6	Good grain yield Relative diseases tolerance Good performance at the growing stage Relatively adaptable to the environment Good in moisture tolerance Relatively good feed stalk/biomass Easily manageable/low labor demand	2nd
Local	Low grain yield due to moisture stress Low to diseases tolerance Low performance throughout growing stage due to current climate condition Low moisture tolerance Adaptable for the area if and only if there is a sufficient rainfall pattern High feed stalk/biomass Not easily manageable/labor demanded due to long time taken by variety	3rd

Conclusions and Recommendations

In the study area, the rainfall shortage were the most problems that influencing maize production. To address this problem, Fedis Agricultural Research Center (FARC) has undertaken adaptation trials on improved early maturing maize varieties and identified the well adapted varieties to the areas. The result of demonstration showed that the varieties performed well in terms of grain yield and early maturity under moisture stress which has a negative effect on yield and yield components and well appreciated by farmers in the areas. Moreover, farmers said "using these varieties, they are alleviating the existed problems on production and productivity in the areas. Maize not only for grain yield but also they used the stalk for animal feed, fire wood/fuel.

Based on the result, the varieties are suggested to be widely promote and make farmers beneficials through the Office of Agriculture and Natural Resource of the Zone. This can be achieved through appliying appropriate extension approach like giving training to DAs and farmers, experience sharing, field day organizing and collaborative work with stalkeholders, private producers, and NGOs that with close supervision of reseach center.

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Pre-extension Demonstration and Evaluation of Early Maturing Sorghum Varieties in Selected AGP-II Districts of Harari Region and Dire Dawa City Administration

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Abstract

Pre-extension demonstration and evaluation of early maturing sorghum varieties was conducted with the objectives of promoting and popularizing improved lowland sorghum technologies, creating awareness, improving farmers knowledge and skills, improving farmers' livelihood and enhancing stakeholders participation. A total of fifteen (15) trial farmers were selected from two potential sorghum growing kebeles of Dire Dawa city administration council and one kebele of the Harari region. Three FREG having 45 farmers were established at each kebele. Three improved sorghum varieties (Tashale, Misikir and Mako) were planted on the plot sized 40mx40m. Training and field day involving 36 and 101 participants, respectively, were organized at Dire Dawa and Harari region. Lowland Sorghum varieties were evaluated based on their early maturity, yield, Disease tolerance, seed color; seed size and biomass. On average, the demonstrated varieties; Misikir, Tashale and Mako gave 21.4qt ha^{-1}, 23.3 qt ha^{-1} and 23.4 qt ha^{-1} respectively. Mako and Tashale varieties with 9.3% and 8.9% yield advantage over Misikir were ranked first and second, respectively for their relatively higher yield. However, farmers' preferred Mako and Misikir because of their relatively higher feed stalk biomass. Thus, Mako and Misikir were recommended for further pre-scaling up in the study areas and other similar agro-ecologies.

Key words: Sorghum, drought tolerant, improved varieties, Diredawa and Harari districts

Introduction

Sorghum is one of the most important cereal crops grown in arid and semi-arid areas of the world, receiving 400 to 800 mm of rainfall annually. Such areas are characterized by moisture deficit stress that affects the cultivation of the crop (Tadesse et al., 2008; Ouma and Akuja, 2013). It is an indigenous crop to Ethiopia. The origins of its domestication is Ethiopia and the surrounding countries, beginning around 4000-3000 B. C. Numerous varieties of sorghum were created through the practice of disruptive selection, where selection for more than one level of a particular character within a population occurs (Dillion et al., 2007).In Ethiopia, sorghum is a staple food crop widely cultivated in different agro-ecological zones, predominantly in dry areas where other crops can survive least and food insecurity is widespread. These areas cover nearly 66% of the country (Geremew et al., 2004; Adugna, 2007). In 2011/12, Ethiopian main rainy season (*Meher)*, 39512942.36 quintals of sorghum grain is produced on 1923717.49 ha of land (CSA, 2012). This shows that the productivity of the crop is still low, estimated to be 2054 kg ha -1 (CSA, 2013), which is considerably lower than experimental yield that reaches up to 3500 kg ha-1 on farmers' fields in major sorghum growing regions of the country (Geremew et al., 2004).

Moreover, sorghum (sorghum bicolor) is the fifth most important cereal globally and feeds around 500 million people. It is especially important for rural people in arid regions. It provides food for household consumption and produces larger amounts of fodder to support their livestock than other grains (Wortmann 2006). So the contribution of improved varieties of sorghum is almost negligible mainly due to poor participation of farmers in the selection process, poor intervention of improved agricultural technologies (absence of improved varieties), birds damage to early maturing varieties, diseases (grain mold, head smut, anthracnose) and insect pests (shoot fly and stalk borer) (AsARC, 2011).

To solve the problems, Fedis Agricultural Research center (FARC) has conducted adaptation trials and evaluated and promoted a number of early maturing and striga resistance variety in in some districts of East Hararghe Zone. Yet local sorghum variety which is easily affected by drought and striga infestation is under production in Harari and Dire Dawa administration. Local variety needs higher amount of rain fall and it takes 7-8 months to mature. This result in low production in drought areas like Harari and Dire Dawa. Improved early maturing varieties give better yield with minimum possible moisture. These nature of improved early maturing sorghum varieties escapes under the impact of natural factor. Therefore, to address the problems demonstration and evaluation of these improved sorghum varieties under the farmers' condition through different mechanism is important. Thus, this activity aimed on disseminating those technologies at farmers' field there by demonstrating those selected technologies to the end users. These in turn envisioned increasing household income and contributing more to food security so as to alleviate food shortage.

Materials and Methods

Description of the study area

The activity was conducted in the selected Agricultural growth program-II districts of Harari Region and Dire Dawa administration. Harari regional state is located on distance of 526 km from capital city finfinne in the eastern parts of the 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. These selected districts are where the potentiality of the program will be succeeded in consideration of residents' problems, potential succession of the technologies these fit problems and solve; including the outcomes prevailed in AGP-I.

Dire Dawa Administration is located on distance of 515kms from capital city Finfine in direction of county's Eastern part; it is bordered by Somali, and Oromia regions in all directions. Dire Dawa Administration has both urban and rural set governance system. The climatic condition of Dire Dawa is almost dry land with the maximum and minimum temperature 38^{0c} and 25^{0c} respectively (EBC broadcasting on metrology allocated time). These selected districts are where the potentiality of the program will be 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

Adada ,Wahil and Dujuma kebeles from Dire Dawa and Kile from Harari Region were selected based on their sorghum production potential and accessibility to the road for regular field monitoring .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 Development Agents. The selected farmers were grouped in Farmers Research and Extension Group (FREG) with the member of 15 farmers per Kebele in consideration of gender issues (women, men and youth). In the establishment of FREG in the study areas total of 3 FREGs (One FREG/ kebele) from one PA 15 farmers and a total of 45 farmers were grouped in 3 FREG. In the FREG 5 farmers were trial farmers (3 male trial farmers and 2 female trial farmers) and 10 farmers worked with trial farmers.

Implementation design

Misikir, Tashale (standard check) and Meko varieties were used for demonstration in both districts. The input source was Fedis Agricultural research Center (FARC). The varieties were planted on the selected farmers' plot of 40mx40m in rain-fed season. The variety was planted with early maturing sorghum production recommendation or agronomic recommendation practices. Therefore, based on farmers' variety need, those selected varieties were procured to hosting farmers and planted by drilling at seed rate of 10kg/ha. Spacing used between row and plant is 75cm and 25cm respectively. Fertilizers were applied at the rate of 100kg/ha DAP and 50kg/ha Urea while weeding and other management practices were applied as per recommendation required.

Training, field visit and Filed-day organized

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

Data collection and analysis method

Both quantitative and qualitative data were collected. Collected quantitative data were subjected to analysis using SPSS software version 20 (frequency, mean, standard deviation and range) while qualitative data collected using group discussion and key informant interviews, field observation and focus group discussion were analyzed using narrative explanation and argument. Finally data from different sources were triangulated to get reliable information.

Results and Discussions

Training of target group (Farmers, DAs and Experts)

The training was organized at both regions. It was given on the topics of agronomic practices (crop weed and disease management), stakeholders' linkage and extension approach and market and information linkage. At Harari region, 34 (28 male and 6 female) farmers, 2 male development agents and 2 experts were participated while at Diredawa, 27 (20 male and 7 female) farmers, 5 male development agents and 4 experts were participated.

Yield performance across districts

The yield performances for different varieties were different. The grain yield performance of the improved varieties (Misikir,Tashale and Meko) were ranges from18.1, 18.9, and 20.1quintals/ha at Adada,22.3, 22.1 and 24.9quintals/ha at Kile,20.9,25.9 and24.1quintals/ha at Dujuma and 24.4,26.3 and 23.9quintals/ha at Wahil**.**The average grain yield performance of Misikir and Tashale higher (24.4,26.3quintals/ha) at wahil but Mako variety was higher at 24.9 at kile in the production season. The yield performance of Tashale variety was higher than and Misikir and Makoat Dujuma and Wahil. However, the grain yield performance of Meko was highier at Adada(20.1quintals/ha) and Kile(24.9quintals/ha) .These varieties gave 37, 37 and 32 quintal per hectare on station at Fedis Agricultural research Center which is higher than at farmer's condition. The yield difference might be due to farmers land striga infestation, poor land and low crop managements. However, improved sorghum varieties were more advantages than the local one especially in case of severe drought in which farmers remains with some stalks.

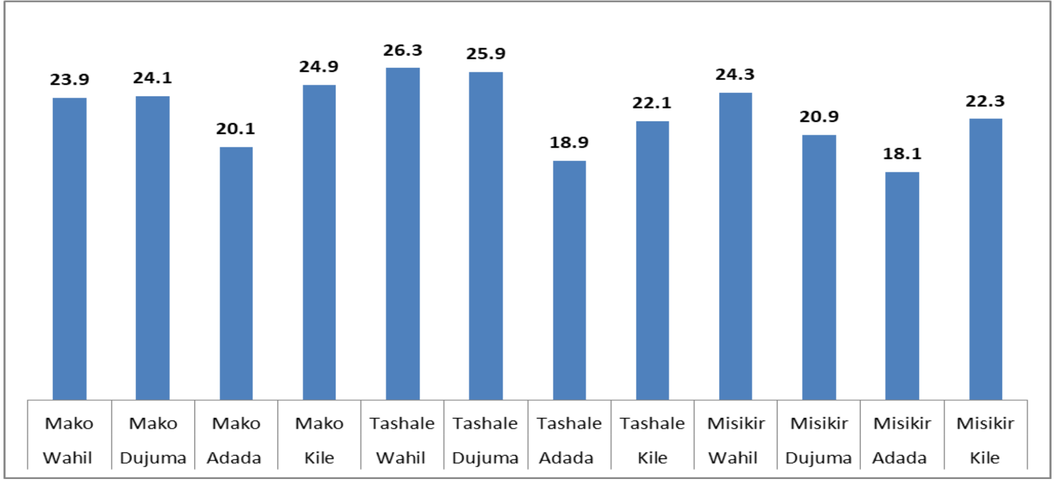

Fig. 3: Yield performance of improved lowland sorghum varieties across districts on Farmers hand

Field day organized and farmers' perception toward the varieties

Fourty farmers (32 male and 8 females), five DAs and four experts participated on mini field day organized at Kile kebele. During the field day participant farmers were let to selecte best performing varieties. Thus 7 farmers (2 female and 5 male) selected both Tashale and Mako. Twenty three farmers (6 female and 17 male) selected Tashale based on early maturing and yield .Both are similar according to farmers' preferences by stack and drought tolerance. More over at Dire Dawa Mini field day and training was organized at Adada on which 27 farmers (20 male and 7 female), 5DAs and 4 Subject matter specialists were participated and at Wahil (Dujuma)

PAs. 40 farmers (32 male and 8females), 5 DAs, 4 experts and 3 journalists participated on mini field day organized at Dujuma PAs.

Farmers' in the study area selected the best performing improved lowland sorghum varieties by using their own criteria. Farmers set these criteria after having know-how about the variety and using those criteria they could select the varieties at harvest time. The opinion of those farmers on varietal preference was collected from participating farmers during variety demonstration. The major criteria used by farmers were maturity, yield, Disease tolerance, seed color, seed size, performance throughout growing stage, biomass, palatability of stalk feed, nutritional value and food test.Based on the above criteria; farmers evaluated the varieties and ranked first Misikir followed by Mako. Both varieties were well appreciated by farmers as compare to the Tashale in the areas. Overall the varieties are well accepted and suggested to widely promote and make farmers beneficials through the Office of Agriculture and Natural Resource of the Zone.

Table 1. Ranks of the varieties based on farmers selection criteria

Crop varieties	**Farmers rank**	**Reasons**
Misikir	**1st**	Early mature, Good in yield, Disease tolerance, Good seed color, Good seed size, Very good performance throughout growing stage, Very good biomass yield, Very good palatability of stalk feed, Very good nutritional value and food test
Mako	**2nd**	Relative to early maturity, Good in yield, Relative to disease tolerance, Very good seed color, Very good seed size, Good performance throughout growing stage, Good biomass yield, Relative to good palatability of stalk feed, Relatively good nutritional value and food test
Teshale	**3rd**	Relative to early maturity, Very good in yield, Relative to disease tolerance, Poor seed color, Low seed size, Poor performance throughout growing stage, Good biomass yield, Poor in palatability of stalk feed, poor nutritional value and food test

Table 2. Pair-wise ranking matrix result to rank variety traits

Code no.	Traits	Early maturity	Overall yield	Disease tolerance	Seed color	Seed size	Palatability of stalk for feed	performance	Biomass	Nutritional test
1	Early maturity		1	1	1	1	6	1	8	1
2	Overall yield			2	2	2	6	7	2	2
3	Disease tolerance				3	3	3	3	3	3
4	Seed color					5	6	4	8	9
5	Seed size						6	5	5	9
6	stalk Palatability as feed							6	6	9
7	performance								8	9
8	Biomass									9
9	Nutritional test									

Conclusions and Recommendations

In the study area, rainfall shortage is the most problems that influencing sorghum production. The participatory demonstration created an opportunity for the farmers to observe and judge the best practice with respect to the sorghum production .Suitable and widely accepted improved early maturing sorghum varieties for the study areas were identified and ranked based on farmers set criteria (Early maturity, yield, Disease tolerance, Food test, Palatability and biomass). Furthermore, linkage was strengthened and opportunities were created for experience and knowledge transfer among stakeholder .Awareness on advantage of early maturing sorghum varieties were increased through promotion in this demonstration. The results obtained from demonstration plot were also encouraging.The result indicated that yield performance for Tashale was better than Misikir and Mako but it has poor food test and low feed stalk palatability Therefore, using Misikir and Mako varieties are more advantageous for farmers than using Tashale (Standard check). As a result, both Misikir and Mako varieties are recommended for more promotion in the area and other similar agro-ecological situation to reduce the problem of food insecurity.

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

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Abstract

The activity was conducted in 2017 main cropping season at Dugda and Lume districts of East shoa zone with the objectives 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 following the recommendation of 2016 participatory variety selection activity. Sites were selected in collaboration with respective district agricultural offices based on potential of the area for bread wheat production. Trainings were given for farmers, Development Agents and experts and other stakeholders. The Participating farmers were also capacitated through training, exchange visits and field days. Recommended seed and fertilizer rate were used for the demonstration trial establishment. According to the results, a mean yield of 38.61 ± 2.82 qt ha^{-1} and 39.24 ± 1.54qt ha^{-1} was harvested from ogolcho and kingbird varieties, respectively. The two varieties showed no statistically significant yield difference at $p<0.05$ in their yield and showed better yield performance when compared to the farmers' variety. To this end, farmers preferred ogolcho as their first choice for future productions based on their own criteria. Thus, ogolcho variety 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.

Key Words: Bread wheat, Demonstration, Pre-extension, rift valley

Introduction

Wheat (*Triticumaestivum L.)* is one of the most important staple food crops in the world. Wheat is a major crop contributing importantly to the nutrient supply of the global population and also a very versatile crop; it shows wide adaptation to diverse agro-ecological conditions and cropping. The crop is grown at an altitude ranging from 1500 to 3000 meter above sea level (m.a.s.l); the most suitable agro-ecological zones, however, fall between 1900 and 2700 m.a.s.l (Bekele *et. al*, 2000). The crop is also one of the most important staple crops grown in Ethiopia. It is third in area of cultivation following teff and maize and cultivated in Ethiopia on about 1.69 million hectares and delivering about 4.56 million tons of grain yields (CSA, 2016/17). The crop has been cultivated in the country since the time of immemorial and is the second largest wheat producer in sub-Saharan Africa, after South Africa. The country is also the major producer of wheat in eastern Africa accounting for over 70% of the total wheat area in the region (Bezabeh et al., 2015). Although most of the wheat grown in Ethiopia is bread wheat, both bread and durum wheat are widely grown in the country constituting about 60% and 40% of the total wheat production, respectively (CIMMYT, 2014).

Wheat is used for the manufacture of flour for different purposes such as bread, biscuits and pasta products such as macaroni, spaghetti and noodle are some of the industrial products. Wheat

is known to be a major source of energy and protein. Traditionally, Wheat is used for making "dabo", "dabokolo", "ganfo", "kinche" and other types of food in the Ethiopian context.
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 satisfy its demands. The national average of wheat yield of Ethiopia is around 2.6 t/ha (CSA 2016/17), which is far below from experimental yields of over 5 t/ha. 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 2.4 t/ha indicates the potential for increasing productivity of wheat production through utilization of agricultural inputs, particularly using quality seed of the improved varieties and optimum fertilizers rate.To this end, in crop improvement and others technology development and dissemination process with the involvement of the end-users may hasten the process and increase the adoption and dissemination of the new technology.

In mid rift valley areas wheat is among the major cereals produced relaying on variety released some time ago with low productivity. In addition, the knowledge base of farmers about wheat production and management is limited. To improve this gap as part of its effort ATARC has conducted an on-station trails and participatory variety selections of improved varieties in the past years with support form AGP-II. The trial results conducted showed that the improved varieties activities performed well when compared with farmers' verities. Accordingly, this experiment was conducted to demonstrate and evaluate the performance bread wheat varieties under farmers' conditions, enhance farmers' knowledge and skill on bread wheat production and management and assess farmers' and other stakeholders' feedbacks for further technology development/improvement

Materials and Methods

Description of the study areas

The study was conducted in selected districts of East shoa zone. East shoa zone is one of the administrative zones of Oromia regional state, Ethiopia. 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 Kebeles 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 Kebeles among which two kebele were used for this study. The district's annual rainfall ranges from 500-1200mm and temperature ranging from 18 to 28 degrees. The major crops produced include teff, wheat, chickpea and lentil.

Site and farmers selection:

The demonstration was conducted in selected Kebeles of Lume and Dugda districts of East Shoa zone. Two Kebele's from lume (Bika and Ejersa) district and one kebele from Dugda (Tephochoroke) 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 6 FREG's were organized having 68 male and 37 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 0.125ha. Packaged production technologies (seed rate, seed treatment, spacing, fertilizer management and weed management) recommended for the bread wheat production was used to establish the trials. Seeds were sown at the recommended rate of 85 kgha-1 in rows (20cm between rows). Urea (46 % N) was used as a source of nitrogen fertilizer. 2/3 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. Plots were kept free of weeds. Field days and field visits were also be organized at the maturity and harvesting stage of the crops.

Planting materials

Two adaptable early maturing bread wheat varieties (*Ogolcho and Kingbird*) were used. Planting material (Seed) were prepared in advance from Kulumsa Agricultural Research center and Oromia Seed enterprise.

Table 1: Characteristics of bread wheat varieties used for the pre-extension Demonstration

Characteristics	Kingbird	Ogolcho
Days to maturity	90-120	102
Altitude	1500-2200	1600-2000
Rainfall	500-800	400-500
Yield (Qtha^{-1})	33-52	33-50

Data collected

Agronomic characteristics like plant height, tiller per plant, grain yield, thousand seed weight, spike length, and effective tiller were recorded. Farmers' feedbacks and costs and income gained involved were collected.

Data analysis

The collected agronomic and financial data was analyzed and presented using tables. Farmers' feedbacks and preference were also analyzed qualitatively and presented using table. The technology gap and technology index were calculated using the formulas as given by (Samui et al., 2000).

Technology gap = Potential yield qt/ha – demonstration yield

$$\text{Technology index \%} = \frac{\text{Potential yield – demonstration yield}}{\text{Potential yield}} \times 100$$

Results and Discussions

Yield performance of the varieties demonstrated

The following table shows the combined analysis result on yield performance of the varieties demonstrated in both Dugda and Lume districts. According to the result a mean yield of 38.61 ±

2.82qt ha and 39.24 ± 1.54 was harvested from *ogolcho* and *kingbird* varieties, respectively. There was no significance difference observed among the varieties at ($p<0.05$).

Table 2: Grain Yield per hectare (GY) in quintal of the demonstrated varieties

Variety	N	Mean	Min	Max	SD
Kingbird	8	39.24 ± 1.54	35.00	47.50	4.35400
Ogolcho	8	38.61 ± 2.82	24.75	53.50	7.97581

The demonstration result obtained was higher than what was reported during the participatory variety selection (PVS) stage of the varieties conducted in the rainy season of 2016. The PVS result was reported as 23.8qt/ha for *kingbird* and 23.7qt/ha for *Ogolcho* (Dagnachewet,al 2017) varieties. This increment in yield could be associated with the rainfall availability during the duration of the activity compared with the PVS stage. Furthermore, the average yield gained from the demonstrated varieties has an increment from farmers variety (Hawi) which was 22.6qt/ha in the same production season. These shows that these varieties have 73.6% yield advantage over the farmers' variety (Hawi).

Technology gap and Technology index

The technology gap shows the gap in the demonstration yield over potential yield. The observed technology gap is attributed to dissimilarities in soil fertility, salinity and erratic rainfall and other variability of weather conditions (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. Furthermore, 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 technology index of demonstrated varieties in this study (*Ogolcho* and *Kingbird*) was calculated using the following formulas and presented in the following table.

Technology gap = Potential yield qt/ha – demonstration yield

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

Table 3: Technology gap and index for *ogolcho* and *kingbird* bread wheat varieties at Dugda and Lume districts

Parameter	Bread wheat Varieties	
	Ogolcho	Kingbird
Yield gap (qt/ha)	11.39	12.76
Technology index (%)	22.78	24.53

As it can calculated from the above table the average technology index percentage is 22.78 and 24.53 for *ogolcho* and *kingbird* varieties, respectively. Similarly both varieties show resemblance in their average yield gap yield performance between this demonstration and the potential of the varieties, having 11.39qt/ha and 12.76qt/ha for ogolcho and kingbird, respectively.

Financial analysis

In terms of profitability the financial analysis result show that an average return of 21542.3Birr and 21998.2 birr per hectare can be gained from *Ogolcho* and *Kingbird* varieties, respectively in one production season in the study areas. Yet, this financial analysis considered land as a fixed cost; considering there are farmers who rent in land at a fixed cost. However, for those farmers who own land the additional income of 2500 and 2800 at Dugda and Lume districts could be added to their return.

Table 4: Financial analysis for the two districts

Financial Analysis					
Location : Dugda			**Location:** Lume		
	Variety			**Variety**	
Parameters	Ogolcho	Kingbird	**Parameters**	Ogolcho	Kingbird
Yield qt/ha (Y)	38.8	39.85	Yield qt/ha (Y)	38.29	38.21
Price (P) per quintal	1000	1000	Price (P)	1000	1000
Total Revenue (TR)= TR= YxP	38800	39850	**TR= YxP**	38290	38210
Variable costs			**Variable costs**		
Seed cost	1350	1350	Seed cost	1350	1350
Fertilizer cost	2140	2140	Fertilizer cost	2140	2140
Chemicals	2800	2800	Chemicals	2800	2800
Labor cost	5500	5500	Labor cost	5500	5500
Combiner harvesting	2328	2391	Combiner harvesting	2297.4	2292.6
Cost of transport, sacks	250	250	Transport, sacks	250	250
Total variable costs (TVC)	14368	14431	TVC	14337.4	14332.6
Fixed costs			**Fixed costs**		
Cost of land	2500	2500	Cost of land	2800	2800
Total fixed costs (TFC)	2500	2500	TFC	2800	2800
Total Cost (TC) = TVC+TFC	16868	16931	TC = TVC+TFC	17137.4	17132.6
Gross Margin (GM) = TR-TVC	24432	25419	GM = TR-TVC	23952.6	23877.4
Profit= GM-TFC	21932	22919	**Profit= GM-TFC**	21152.6	21077.4

Capacity development

Training

The following table 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 80 participants attended the training.

Table 5: Number of farmers participated trainings

Training topic	No of participants												
Bread wheat , production and management	Farmers			DA'S			SMS			Others			Overall total
	M	F	Total	M	F	Total	M	F	Total	M	F	Total	
	40	25	65	1	1	2	2	0	2	10	1	11	80

Field day

Field days were also conducted on the demonstration sites to enhance farmers' knowledge and skill on bread wheat production and management, to observe the performance of the varieties and collect feedbacks for future technology development and dissemination activities related with bread wheat in general and the varieties in particular. The field days were conducted at the maturity stages of the crop. A total of 268 participants, among which 69 male and 35 female farmers, attended the field days.

Table 6: Number of field fay participants

Field day topic	Participants							
Visiting bread wheat fields	Farmers			DA'S			SMS and Others	Overall total
	M	F	Total	M	F	Total	157	268
	69	35	104	4	3	7		

Feedback and farmers preferences

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

Table 7: Rank of varieties demonstrated based on farmers preferences

Varieties	**Rank**	**Reasons**
Ogolcho	1st	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

Conclusions and Recommendations

As a follow-up of participatory variety selection (PVS) activity, this study focused mainly on demonstrating farmers preferred bread wheat varieties on a bigger land size than PVS stage. The results indicated that both varieties demonstrated gave promising yield having 73.6% yield advantage over farmers' variety (*Hawi).* Furthermore, both varieties' were evaluated in their economic return. The results indicate that both varieties are profitable with an average return of 21,770.25birr in one production season. In addition the technology index and yield gap analysis also shows as the varieties are feasible for farmers in the study area. In terms of farmers preference *ogolcho* variety was selected as first choice by the participating farmers due to its characteristics of good yield, good plant height, uniformity on heading and maturity, good tillering capacity and attractive seed colour/size for market. Therefore, based on farmers' preference *ogolcho* is recommended for pre-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.

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Pre-Extension Demonstration of Improved Chickpea Varieties at Dugda District

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Abstract

Pre-extortion demonstrations of chick pea varieties were conducted in 2017 at Dugda district of East shoa zone. Improved chickpea variety (Minjar) was used for demonstration as a follow up of participatory variety selection activity. The objectives were to demonstrate and evaluate the performance of the variety along with its management practices under farmers' circumstances and to raise farmers' knowledge and skill on chickpea production and management practices. Sites were selected in collaboration with respective district agricultural office experts and development agents. Trainings were given for farmers, development agents and experts and other stakeholders. The Participating farmers were also capacitated through frequent follow up, exchange visits and field days. Recommended seed and fertilizer rates were used for the demonstration trial establishment. According to the results, a mean yield of 14.7qt ha^{-1} was harvested. In terms of economic return the results indicated that an average return of 32,710.00 Birr obtained from chickpea production in one production season from a hectare in the study area.

Key Words: Chickpea, Minjar, Demonstration, Pre-extension, Rift valley

Introduction

Ethiopia has suitable agro-climatic conditions for production of both Desi and Kabuli type chickpeas. The crop is highly integrated into the farming system and ecologically friendly for growing in many areas that suffer from soil nutrient depletion (Haile, 2010). The chickpea cultivated in the country, currently occupies about 225,607.53 hectares of land with estimated production of 4,441,459.26qt (CSA, 2016/17).

The production of chickpea is very limited at Dugda districts despite its potential contribution towards alleviating mono cropping and improving soil fertility and hence improving production and productivity. Chickpea production in the area has been affected by different constraints. Some of the constraints include limited knowledge about its production and unavailability or lack of improved varieties. Access to improved agricultural technologies and practices is also one of the factors affecting its production in the central rift valley areas; including the study area. As its production is still new to most of the farmers in the area other agronomic management for improved productivity are also considered as constraints. Despite the constraints there are opportunities for chickpea production and improving its productivity in lowland areas.

To this end, in 2016/17, participatory variety selection trial was conducted in the area using five chickpea varieties namely *Minjar, Teketay, Ejere, Habru and Arerti*. Although there was erratic rainfall during PVS experimentation, the performance of these varieties, are shown in Table 1 below.

Among the tested varieties two varieties (*Minjar* and *Habru*) were found outstanding in their grain yield per ha and maturity (in terms of period and uniformity). The study also tried to see farmers' preferences among the tested varieties using matrix ranking. The ranking was done in such a way that farmers were let to rank preferred characteristics they look for in chickpea varieties. After ranking the characteristics the farmers then selected the tested varieties. Accordingly, basing on their characteristics, farmers selected *Minjar* and *Habru* varieties, respectively. Therefore this study was proposed as a follow up of the Participatory variety selection with an objective of demonstrating one of these farmers selected varieties in at Dugda districts, East Shoa rift valley areas of Oromia, Ethiopia.

Table 1: Effect of varieties and location on agronomic characteristics of chickpea

Varieties	PNPP	SPP	GYQtHa
Habru	101a	124a	23.33ab
Teketey	66b	66bc	19.56ab
Natoli	50c	54cd	19.48ab
Arerti	41cd	74b	16.25b
Minjar	38d	63bc	25.65a
Ejere	31d	47d	16.55b
SE (±)	6.27	9.05	4.21
$LSD_{0.05}$	11.4	16.5	7.7
CV (%)	11.5	12.7	20.9

Materials and Methods

Description of the study areas

The study was conducted in selected districts of East shoa zone. East shoa zone is one of the administrative zones of Oromia regional state, Ethiopia. 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 district is the study districts where this demonstration activity took place.

Dugda district is located at 135km from the capital city of Ethiopia, Addis Ababa and 100 km from East shoa's zonal capital, Adama. The district covers 5.2% of East shoa zone with area of 751km2. Dugda has 18 Kebele's among which one kebele was selected for this study. The district has an average 636mm annual rainfall and 26^{o}c average temperature. The major crops produced are wheat, teff and maize.

Site and farmers selection

The demonstration was conducted in selected Kebele (Tepho choroke) of Dugda districts of East Shoa zone. Farmer's research and extension group (FREG) approach was followed to select farmers and group under trial farmers. A total of 1 FREG's was organized having 22 members (14 male and 8 female). Among the FREG member a total of 3 (three) interested trial farmers were selected in both districts. The trial farmers were selected based on their willingness to contribute a land size of 625m^2. Packaged production technologies (seed rate, seed treatment, spacing, fertilizer management and weed management) recommended for chickpea production was used to establish the trials. Plots were kept free of weeds. Field days and field visits were also be organized at the maturity and harvesting stage of the crops.

Planting materials

Adaptable early maturing chickpea variety (*Minjar*) was used. Planting material (Seed) were acquired in advance from Debreziet Agricultural Research center.

Table 1: Characteristics of the variety used for the demonstration

Characteristics	**Minjar**
Type	Desi
Days to maturity	86-143
Altitude	1800-2600
Rainfall	120-140
Yield (Qt ha^{-1})	20-40

Technology gap and Index

The technology gap shows the gap in the demonstration yield over potential yield. The observed technology gap is attributed to dissimilarities in soil fertility, salinity and erratic rainfall and other variability of weather conditions (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. Furthermore, 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 value of technology indexes the more the feasibility of the varieties. To this end, the technology gap and technology index of demonstrated varieties in this study was calculated using the following formulas and presented in the following table.

Technology gap= Potential yield qt/ha – demonstration yield

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

Data collected

Agronomic characteristics like plant height, pod per plant, seed per pod, grain yield, thousand seed weight, were recorded. Farmers' feedbacks and costs and income gained involved were also collected.

Data analysis

The collected agronomic and financial data were analyzed and presented using tables. The technology gap and technology index were calculated using the above formulas as given by (Samui et al., 2000).

Results and Discussions

Yield performance of the varieties demonstrated

The following table shows the combined analysis result on yield performance of the variety demonstrated in the study area. According to the result a mean yield of 14.7qt/ha was harvested.

The demonstration result obtained was lower than what was reported during the participatory variety selection (PVS) stage of the variety conducted in the rainy season of 2016. The PVS result was reported as 25.65qt/ha (Dagnachew et al., 2017). This reduction in yield could be associated with the higher rainfall availability during the duration of the activity compared with the PVS stage. It could also be associated with the planting date and the effective rainfall requirement of the crop as the effective rainfall which is the most determinant factor for yield is very variable by planting dates (Lemma et al., 2016).

Technology gap and Technology index

Table 2: Technology (Yield) gap and index for Minjar chickpea varieties at Dugda and Lume districts

Parameter	Variety (Minjar)
Yield gap	25.3
Technology index (%)	63.25

As shown on the above table the gap between the potential yield and the demonstration yield is 25.3qt/ha. This is higher yield gap given the potential of the variety in another potential area. This yield gap difference reduction in the demonstration yield obtained could be associated with the higher rainfall availability in the year which was not suitable for chickpea production. Similarly the technology index is also higher being 63.25%. This higher yield gap and technology index percentage makes the feasibility of the variety uncertain.

Capacity development

Training

The following table 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 80 participants attended the training.

Table 3. Number of farmers and other participants participated on trainings

Training topic	No of participants												
	Farmers			DA’S			SMS			Others			Overall total
Chickpea production and management	M	F	Total	M	F	Total	M	F	Total	M	F	Total	80
	40	25	65	1	1	2	2	0	2	10	1	11	

Financial analysis

Despite the reduced yield, in terms of profitability, the financial analysis result shows that an average return of 32,710 Birr per hectare can be gained from *Minjar* variety in one production season in the study area. This financial analysis considered land as a fixed cost. Considering there are farmers who ‘rent in’ land at a fixed cost. However, for those farmers who own land an additional income of 2500 at Dugda districts could be added to their return. Thus one can get an average net return of 35,210.00Birr in one production season by producing *Minjar* chickpea variety despite the reduction in yield in this specific production season. This return is also higher when compared to the production of other cereals (e.g wheat) in similar district.

Table 4. Financial analysis of chickpea production at Dugda districts (2017)

Parameters	**Variety: Minjar**
Yield qt/ha (Y)	14.7
Price (P) per quintal	2800
Total Revenue (TR)= TR= YxP	41,160
Variable costs	
Seed cost	3,300
Fertilizer cost	
Chemicals	400
labour cost	2500
Cost of transport, sacks	250
Total variable costs (TVC)	6,450
Fixed costs	
Cost of land	2,000
Total fixed costs (TFC)	2,000
Total Cost (TC) = TVC+TFC	8,450
Gross Margin (GM) = TR-TVC	34,710
Profit=GM-TFC	32,710

Conclusions and Recommendations

As a follow-up of participatory variety selection (PVS) activity, this study focused mainly on demonstrating farmers preferred Chickpea. The results indicated that the variety demonstrated gave lower yield compared to the potential of the varieties. Furthermore, the yield gap and technology index calculations showed the feasibility of the variety in specific and chickpea production in general to be uncertain in the study area. Nevertheless, the chickpea production is still profitable compared to other crops in the study area. But for further scaling up works agronomic and other management practices suitable for chickpea production in the study area should be known. To this end, estimation of appropriate plating dates for effective rainfall utilization should be identified. It is also vital to identify chickpea crop water requirements during its critical growth stages so that pre-scaling up works in similar areas would be done well.

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Pre-Extension Demonstration of Improved Food Barley (Hordeum vulgare L.) Varieties at Dugda and Lume districts

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Abstract

Pre-extortion demonstrations of food barley varieties were conducted in 2017/18 at Dugda and Lume districts of East shoa zone, Oromia. Two improved food barley varieties (Diribie and Bentu) were demonstrated as a follow up of participatory variety selection activity. The objectives were to demonstrate and evaluate the performance of the varieties along with their management practices under farmers' circumstances and to raise farmers' knowledge and skill on food barley production and management practices. Sites were selected in collaboration with respective district agricultural offices based on barley production potential of the area. Training was given for farmers, development agents and experts and other stakeholders. The Participating farmers were also capacitated through frequent follow up, exchange visits and field days. The recommended seed and fertilizer rate were used. Accordingly, a mean yield of 26.18 ± 1.96 qt ha^{-1} and 18.43 ± 1.93 qt ha^{-1} was harvested from Diribie and Bentu varieties, respectively. The yield harvested was found to be significantly different between the varieties at ($p<0.05$).

Key Words: Demonstration, Food barley, Pre-extension, rift valley

Introduction

Ethiopia is ranked twenty-first in the world in barley production with a share of 1.2 percent of the world's total production (Abu and Teddy, 2014). 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. In Ethiopia, barley is the fifth most important crop after teff, maize, sorghum and wheat. It 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. To this end, about 1 million hectare of land was allotted for the production of barley (CSA 2016/17).

In the process of improving the production and productivity of barley in the rift valley areas different 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. One of the ways to do this can be through participatory varietal selections. Participatory variety selections has shown success in identifying more number of preferred varieties by farmers in shorter time than the conventional system; in accelerating their dissemination and increasing cultivar diversity (Witcombe et.al, 1996).

To this end, in 2016/17, production season a 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. The performance of these varieties included in the study, though the time the PVS conducted was affected by severe shortage of moisture, yet they have shown a promising result compared to the farmers varieties.

Table 2: Main effect of varieties and location on agronomic characteristics of barley varieties during PVS

Varieties	TPP	SPP	TSW (g)	GY(QtHa-1)
Gobe	4.0	25.42c	36.37	22.5a
Dirbie	4.2	42.27ab	37.19	22.4a
Bentu	3.3	42.89a	35.03	21.8a
HB 1307	4.4	39.44b	36.20	16.9b
SE	0.33	1.051	1.03	1.21
LSD0.05	NS	2.67	3.099	3.55
Location				
Tepho chorke	2.6c	33.85b	33.7b	23.2a
Ejersa Joro	3.8b	39.17a	36.1b	21.1ab
Bika	5.6a	39.50a	38.8a	18.4b
SE	0.28	0.91	0.895	1.05
LSD0.05	0.83	3.08	2.68	3.075
CV (%)	12	8.4	8.6	17.4

Among the tested varieties two varieties (Gobe and diribie) performed well in their grain yield per ha and maturity (in terms of period and uniformity). The study also tried to see farmers' preferences among the tried varieties using matrix ranking. The ranking was done in such a way that farmers were let to rank preferred characteristics they look for in food barley varieties first. After ranking the characteristics the farmers then selected the tested varieties. Accordingly, based on their characteristics, farmers selected Diribie and Bentu varieties, respectively. Therefore, this study was proposed with an objective of demonstrating these farmers selected varieties in Lume and Dugda districts, East Shoa zone, rift valley areas of Ormia Ethiopia.

Materials and Methods

Description of the study areas

The study was conducted in selected districts of East shoa zone. East shoa zone is one of the administrative zones of Oromia regional state, Ethiopia. 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}c average 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 and temperature ranging from 18 to 28 degrees. The major crops produced include teff, wheat, chickpea and lentil.

Site and farmers selection

The demonstration was conducted in selected Kebeles of Lume and Dugda districts of East Shoa zone. Two Kebele's from Lume (Bika and Ejersa) district and one kebele from Dugda (Tepho choroke) 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 6 FREG's were organized having 68 male and 37 female members. Among the FREG member a total of 7 (seven) 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. Packaged production technologies (seed rate, seed treatment, spacing, fertilizer management and weed management) recommended for the bread wheat production was used to establish the trials. Seeds were sown at the recommended rate of 85 kgha-1 in rows (20cm between rows). Urea (46 % N) was used as a source of nitrogen fertilizer. About 2/3 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. Plots were kept free of weeds. Field days and field visits were also be organized at the maturity and harvesting stage of the crops.

Planting materials

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

Table 1: Characteristics of the varieties used for the pre-extension demonstration

Characteristics	**Diribie**	**Bentu**
Days to maturity	NA	71-99
Altitude	1700-2300	1700-2300
Rainfall	>500	>500
Yield (Qtha-1)	19-31	12-24

Data collected

Agronomic characteristics like plant height, tiller per plant, grain yield, thousand seed weight, spike length, and effective tiller were recorded. Farmers' feedbacks and costs and income gained involved were also collected.

Data analysis

The collected agronomic and financial data was analyzed using EXCEL and presented using tables. Farmers' feedbacks and preference were also analyzed qualitatively and presented using table. The technology gap and technology index were calculated using the formulas as given by (Samui et al., 2000).

Technology gap = Potential yield qt/ha – demonstration yield

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

Results and Discussions

Yield performance of the varieties demonstrated

The following table shows the combined analysis result on yield performance of the varieties demonstrated in both Dugda and Lume districts. According to the result a mean yield of 26.18 ± 1.96 qt ha and 18.43 ± 1.93 qt/ha was harvested from *Diribie* and *Bentu* varieties, respectively. The yield harvested was found to be significantly different between the varieties at ($p<0.05$).

Table 2. Grain Yield per hectare (GY) in quintal of the demonstrated varieties across the districts

Variety	N	Mean	SD	Min	Max
Diribie	7	26.18 ± 1.96	5.18555	17.75	32.75
Bentu	7	18.43 ± 1.93	5.10048	12.00	24.75

The demonstration result obtained was higher for *Diribie* than what was reported during the participatory variety selection (PVS) stage of the varieties conducted in the rainy season of 2016. The PVS result was reported as 22.4qt/ha for Diribie and 21.8qt/ha for Bentu (Dagnachew et,al 2017) varieties. This increment in yield could be associated with the rainfall availability during the duration of the activity compared with the PVS stage.

Technology gap and Technology index

The technology gap shows the gap in the demonstration yield over potential yield. The observed technology gap is attributed to dissimilarities in soil fertility, salinity and erratic rainfall and other variability of weather conditions (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. Furthermore, 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 technology index of demonstrated varieties in this study (*Diribie* and *Bentu*) was calculated using the following formulas and presented in the following table.

Technology gap= Potential yield qt/ha – demonstration yield

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

Table 3. Technology (Yield) gap and index for *diribie* and *bentu* food barley varieties at Dugda and Lume districts

Parameter	Barley Varieties	
	Diribie	Bentu
Yield gap (qt/ha)	4.82	5.57
Technology index (%)	15	23.20

As it can be calculated from the above table the average technology index percentage is 15 and 23.20 for *diribie* and *Bentu* varieties, respectively. In-terms of their yield gap Diribie showed a yield gap of 4.82qt/ha and Bentu gave 5.57 qt/ha. This shows that the demonstration yield is close to the potential yield of the varieties. Similarly an average of 19.1 technology index percentage shows as the varieties are feasible for farmers in the study area.

Financial analysis

In terms of profitability the financial analysis result show that an average return of 18,146.6Birr and 11,105.3 birr per hectare can be gained from *Diribie* and *Bentu* varieties respectively in one production season in the study areas. Yet, this financial analysis considered land as a fixed cost. Considering there are farmers who rent in land at a fixed cost. However, for those farmers who own land the additional income of 2500 and 2800 at Dugda and Lume districts could be added to their return.

Table 4. Financial analysis of food barley production at Dugda and Lume districts (2017)

Location : Dugda			Location: Lume		
Parameters	Variety		Parameters	Variety	
	Diribie	Bentu		Diribie	Bentu
Yield qt/ha (Y)	27.03	20.08	Yield qt/ha (Y)	25.31	17.89
Price (P) per quintal	980	980	Price (P)	980	980
Total Revenue (TR)= TR= YxP	26489.4	19678.4	TR= YxP	24803.8	17532.2
Variable costs			Variable costs		
Seed cost	900	900	Seed cost	900	900
Fertilizer cost	1200	1200	Fertilizer cost	1200	1200
Chemicals	150	150	chemicals	150	150
labor cost	3000	3000	labor cost	3000	3000
Cost of transport, sacks	250	250	Transport, sacks	250	250
Total variable costs (TVC)	5500	5500	TVC	5500	5500
Fixed costs			Fixed costs		
Cost of land	2000	2000	Cost of land	2000	2000
Total fixed costs (TFC)	2000	2000	TFC	2000	2000
Total Cost (TC) = TVC+TFC	7500	7500	TC = TVC+TFC	7500	7500
Gross Margin (GM) = TR-TVC	20989.4	14178.4	GM = TR-TVC	19303.8	12032.2
Profit= GM-TFC	18989.4	12178.4	Profit= GM-TFC	17303.8	10032.2

Capacity development

Training

The following table 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 80 participants attended the training.

Table 5. Number of farmers participated trainings

Training topic	No of participants												
Bread wheat , production and management	Farmers			DA’S			SMS			Others			Overall total
	M	F	Total	M	F	Total	M	F	Total	M	F	Total	
	40	25	65	1	1	2	2	0	2	10	1	11	80

Field day

Field days were also conducted on the demonstration sites to enhance farmers' knowledge and skill on bread wheat production and management, to observe the performance of the varieties and collect feedbacks for future technology development and dissemination activities related with bread wheat in general and the varieties in particular. The field days were conducted at the maturity stages of the crop. A total of 268 participants, among which 69 male and 35 female farmers attended the field days.

Table 6. Number of field fay participants

Field day topic	No of participants							
	Farmers			DA'S			SMS and Others	Overall total
	M	F	Total	M	F	Total		
Field visits and field days on demonstration of bread wheat varieties	69	35	104	4	3	7	157	268

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 it was their first choice.

Table 7. Rank of varieties demonstrated based on farmers preferences

Varieties	**Rank**	**Reasons**
Diribie	1st	Good yield, Good plant height, uniformity on heading and maturity, good tillering capacity, disease tolerant, attractive seed color /size for market
Bentu	2nd	Good yield, Early maturing, disease tolerant, very good crop stand, , medium seed size/color for market

Conclusions and Recommendations

As a follow-up of participatory variety selection (PVS) activity, this study focused mainly on demonstrating farmers preferred food barley varieties. The results indicated that both varieties demonstrated gave promising yield. Furthermore, both varieties' were evaluated in their economic return. The results indicate that both varieties are profitable with an average return of 18,146.6Birr and 11,105.3 birr per hectare in the one production season by producing *Diribie* and *Bentu* food barley varieties, respectively. In terms of farmers preference *Diribie* variety was selected as first choice by the participating farmers due to its characteristics of good yield, good plant height, uniformity on heading and maturity, good tillering capacity and attractive seed colour/size for market. Therefore, based on farmers' preference *Diribie* is recommended for pre-scaling up.

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Pre-Extension Demonstration and Participatory Evaluation of Improved Sorghum Varieties: In Case of Kellem and West Wollega Zones, Western Oromia

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Abstract

Pre-extension demonstration of improved sorghum varieties was carried out in Lalo Asabi, Seyo and Anfilo districts of Kellem and West Wollega zones during 2017/18 cropping season with the objective of evaluating best performing and preferred sorghum varieties under farmer's management condition. Three varieties of sorghum (Chemada, Gemadi and Lalo) were evaluated with full participation of FREG members. Training was given for farmers and other stakeholders on sorghum production and management. At maturity stage the varieties were evaluated jointly by farmers, agricultural experts, development agents and researchers. Seed color, marketability, yield, thresh ability, seed size, stock, lodging, disease resistance and shitability for home consumption were the selection criteria used by farmers. Grain yield and lodging percentage were collected and analyzed using descriptive statistics in order to evaluate the performance of the varieties. Accordingly, the yield obtained from Chemada, Gemadi and Lalo varieties were 26.88 qt ha^{-1}*, 29.95 qt ha*$^{-1}$ *and 35.4 qt ha*$^{-1}$*, respectively. With regard to lodging percentage the lodging percentage with magnitude of 5.74%, 2.29% and 2.06% was obtained for Lalo, Gemadi and Chemada, respectively. Based on farmer's preference, Chemada and Gemadi varieties were selected to be popularized on large scale on farmer's fields.*

***Key words**: Farmers feedback, Participatory Evaluation, Sorghum*

Introduction

Sorghum (Sorghum bicolor L. Moench) thrives best under wide range of agro ecology including adverse environments (Fetene 2011). It is the favorite crop in drier and marginal areas due to its drought tolerance. Among cereals under production in Ethiopia it ranks 5th in total production. Sorghum is one of major crop in Ethiopia in general and Oromia in particular. Sorghum is an important cereal crop in Oromia Region, ranking 5th in total production to cereals with magnitude of 18,846,301 quintals and out of which 73.79% is used for house hold consumption. Similarly, among cereal crops grown in west and kellem wollega zones, sorghum is widely produced next to maize with area coverage of 63,051.63 hectares in west wollega and 37,426.25 hectares in kellem wollega zone with average yield of 29.98qt/ha and 31.50qt/ha quintals per hectare in west and kellem wollega zones respectively (CSA, 2015/16).

Even though sorghum is the major cereal crop grown in west and kellem wollega zones with high yield relative to other parts of the country, most of the farmers in the area use the local variety which is the reason behind low productivity in this locality. Therefore, keeping this fact into account demonstrating improved sorghum varieties to farmers of the area has paramount importance.

Materials and Methods

Description of the study area

Anfilo

Anfilo district is located in the south western part of Kellem Wollega Zone at a distance of 42 km away from zonal capital (i.e. D/Dollo town). Astronomically the district is located between $8^0$17'-$8^0$49' north latitude and $34^0$13'-$34^0$46' east longitude. The district generally lies within an altitudinal range of 500-2500meters. The major rainy seasons in the district includes spring (March-May), summer (June-August) and autumn (September-November). Average annual rainfall of the district is about 1736 mm. It is bounded by Gambella Regional State in the south and southwest, Sayo district in the east and southeast, Yemalogi Walel district in the north east, Gidami district in the north and North West.

Seyo

Seyo district is located in the south western part of Kellem Wollega Zone & the zonal capital was found in it (Seyo district). Astronomically the district is located between $8^0$12'-$8^0$44' north latitude and $34^0$41'-$35^0$00' east longitude. It is bounded by Gambella Regional State in the south, Ilubabor Zone in the south east, Hawa Galan &Yemalogi Walal district in the north and east and Anfilo district in the west and North West. The district has a total area of 127,800 km^2. The district generally lies within an altitudinal range of 1300-2000 m.a.s.l. The major rainy seasons in the district include spring (April-May), summer (June-August) and autumn (September-November).

L/Asabi district

Lalo Asabi is one of the 21 districts of west wallaga zone. It is bordered on the south by Yubdo, on the west by Aira Guliso, on the north by Boji, on the east by the Benishangul gumuz, and on the southeast by Gimbi. The administrative center of this woreda is Inango

A survey of the land in Lalo Asabi shows that 80.39% is cultivated or arable, 5.26% pasture, 9.08% forest, and 5.26% infrastructure or other uses. Coffee is an important cash crop of this woreda. Over 50 square kilometers are planted with this crop.

Site and Farmers Selection

Three AGP-II Beneficiary districts from Kellam and West Wollega zone were selected based on their sorghum production potential. These districts were *Anfilo and Seyo* from Kellem Wollega and *Lalo Asabi* from West Wollega zone. From Lalo Asabi district, two representative model kebeles were selected, whereas from Seyo and Anfilo one representative kebeles were selected for this demonstration.

One FREG (Farmer Research and Extension Group) was established in each operational kebeles which consists of 80 members in general out of whom 59 were male and 21 were female. The FREG formed was gender inclusive (the participation of male, female and the youth group as well). Before starting the field work, selection of experimental farmers was done in collaboration with researchers, extension agents and the FREG members by taking in to consideration the farmers' interests and motivation, land ownership, and other important socio-economic aspects

Three varieties of sorghum Chemada and Gemedi, Lalo (standard check) were used for demonstration with participation of farmers with recommended fertilizer rate of both DAP and UREA.The trial was carried out on selected farmer's fields in such a way that three improved varieties were planted side by side on equal sized plots of 10m x 10m with a gross area of 100m^2. Sowing was done with spacing of 75 cm between rows and by drilling replicated by the number of participant farmers. The spacing between plants was adjusted to 15cm during thinning time.

Technology evaluation and demonstration methods

Before implementing demonstration trial on farmers' field, training was given to the farmers on approaches and principles of FREG, the role and responsibility of the FREG members in managing the trial, necessary packages for sorghum production and management practices, and monitoring required for the trial. Mini-Field day was organized in one representative potential Kebele in each district. During the field day important experience sharing among farmers of different level was done and farmers evaluation of sorghum varieties at different growth stage was done to enable farmers to select the well performed and preferred sorghum varieties among demonstrated varieties.

Results and discussions

Training of farmers and extension workers

Training and mini field days were among the tools used to capacitate farmers and extension workers as well as to evaluate the technologies under farmers' conditions. Multi-disciplinary team composed of researchers, experts, development agents were participated on the above listed events to share their experience and aware farmers about improved sorghum production. Accordingly, training was given in Seyo, L/Asabi and Anfilo districts were a total 96 stakeholders participated on training out of whom 80 were male and 16 were female.

Table 1. Participant of training on production and management of Chemada and Gemedi Sorghum Varieties

District	Participant	Male	Female	Total
Anfilo	Farmer	15	2	17
	Expert	1	-	1
	DA'S	2	1	3
Seyo	Farmer	15	5	20
	Expert	2	-	2
	DA'S	1	2	3
L/Asabi	Farmer	36	4	40
	Expert	3	1	4
	DA'S	5	1	6

Mini field day

Mini field was a tool used to evaluate and share knowledge among the different level farmers (Model farmers, middle level farmers and laggard farmers) development agents, Agricultural experts and researchers. Accordingly, a total of 64 stakeholders out of whom 54were male and 8 were female participated on varieties evaluation at green stage.

Table 2. Mini field day participants

District	Participant	Male	Female	Total
Anfilo	Farmer	15	2	17
	Expert	1	-	1
	DA’S	1	1	1
L/Asabi	Farmer	30	4	34
	Expert	2	-	2
	DA’S	5	1	6

As tried to indicate in the above table Farmers and stakeholders attended mini-field day in order to share their experience during demonstration. Accordingly, 61 participants were attended mini field day.

Yield performance of Varieties

Yield Data and lodging percentage were objectively collected and analyzed to evaluate the performance of varieties.

Table 3. The mean grain yield of Sorghum Varieties

Varieties	**Grain yield qt/ha**	**Lodging percentage**
Chemada	26.88	2.06%
Gemadi	29.95	2.29%
Lalo(standard check)	35.4	5.74%

Source: On Farm Demonstration Data

The figurative result of combined analysis of variance summarized in the above table revealed the mean yield grain of Lalo variety is the highest among demonstrated sorghum varieties with magnitude of 35.4 qt/ha while Gemadi and Chemada gave 29.95qt/ha, 26.88 qt/ha of yield per hectare respectively. The analysis again revealed that Lalo variety has highest lodging percentage with 5.74% fallowed by Gemadi and Chemada with magnitude of 2.29% and 2.06 percentage. The yield obtained has slight difference when compared with result obtained at Bako Agricultural research center. Chemeda and Gemedi gave an average grain yield of 3.2 and 3.3 t ha-1on research stations and 2.5 and 2.8 t ha-1 on farmers’ fields, respectively at BARC (Girma et al, 2013).

Participatory evaluation and selection of varieties

Pairwise raking of sorghum variety traits was conducted to identify major traits of importance to farmers. Accordingly, resistence to diseases, seed color, food value/consumption, marketability and grain yield were the top five important traits identified by farmers (Table 4). Gemedi variety was ranked first for its Seed color, thresh ability, marketability, seed size, home consumption and grain yield followed by Chemeda and Lalo varieties(Table 5).

Table 4. Pair wise ranking of sorghum traits by farmers

Variety Trait	Consumption	Marketability	G/Yield	D/Resistance	S/Color	Lodging	Stalk	Thresh ability	Seed size	Frequency	Rank
Consumption	X									6	3rd
Marketability	0	X								5	4th
G/Yield	0	2	X							4	5th
D/Resistance	4	4	4	X						8	1st
S/Color	5	5	5	4	X					7	2nd
Lodging resistance	0	2	3	4	5	X				1	8th
Stalk	0	2	3	4	5	6	X			0	9th
Thresh ability	0	2	3	4	5	8	8	X		3	6th
Seed size	0	2	3	4	5	9	9	8	x	2	7th

Table 5. Direct matrix ranking of varieties

Number	Variety	Rank	Traits
1	Gemadi	1	Seed color, thresh ability, marketability, seed size, home consumption and grain yield
2	Chemada	2	Seed color, home consumption, seed size, low thresh ability, marketability, stock
3	Lalo	3	Grain yield, stalk, thresh ability, taste(not good for consumption), high lodging, and low market price

Conclusions and Recommendations

In this study it is understood that in-terms of grain yield and lodging percentage Lalo variety was highest among demonstrated sorghum varieties. However, the demonstrated varieties Chemada and Gemadi possess special trait which attracted farmers over the standard check (Lalo). These characteristics were disease resistance, seed color, consumption, marketability, threshes ability, seed size and comparable grain yield. Accordingly, Gemadi, Chemada and Lalo were selected first, second and third respectively. The participant farmers selected Gemadi and Chemada varieties based on their special traits rather than their yield performance. Therefore, based on farmers preference not on objectively measured trait varieties Gemadi and Chemada varieties were selected to be scaled up/out to address many more farmers and popularize these varieties in mid altitude of West and Kellem Wallaga Zones.

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Pre-extension Demonstration and Participatory Evaluation of Improved Bread Wheat Technologies in Selected AGP-II Districts of East and Horro Guduru Wollega Zones

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Abstract

*Pre-extension Demonstration of Bread wheat varieties were conducted in Jarte Jardaga, Jimma Rare, Guduru, Jimma Geneti and Gida Ayana districts of Western Oromia in 2017/18 with the objective of demonstrating recently released Bread Wheat varieties, Buluq and Liban with their agronomic recommendations. One potential PA was selected from each district based on their accessibility and bread wheat production potential. The two newly released varieties were planted along with the standard check (Senate variety) on 20m*10m adjacent plots on 32 farmers' fields. All recommended agronomic recommendations were equally applied to all the demonstration plots and the fields were closely supervised by researchers and development agents (DAs). In all study sites, the standard check (Senate variety) gave the highest yield (61.25qt/ha) and also preferred most by farmers particularly for its higher seeds per plant, threshability and tolerance to stem rust. Therefore, further scaling up/out of the variety is quite important to reach wider area and more number of farmers.*

Keywords: Bread wheat; pre-extension demonstration, Participatory evaluation

Introduction

Wheat is a major crop in Ethiopian high lands. It the fourth most important cereal that covers more than 1.7 Million ha with annual production of 3.1-3.4 metric ton, mostly produced by small holders. Regarding the volume of production, it is placed in the second place while ranked third with regard to area coverage (CSA, 2014). In developing countries like Ethiopia it is believed to cover up to about 25 % calorie requirements of the population (Kebede et al., 2013). Wheat is a staple food crop in all high land areas of Western Oromia. In Horo Guduru and East Wollega Zones where this study was conducted, wheat is the third and fifth important cereal crop respectively in terms of area coverage (CSA, 2016/17).

Despite its greater economic and nutritional contribution to our population, the national average does not exceed 2.2 ton/ha. Shortage of improved seed, disease,limited use of necessary inputs are among the factors that contribute to the low productivity of the crop (Kebede et al., 2013). To tackle such challenges, Bako Agricultural Research Center has been conducting intensive research work on the crop and has recently released two bread wheat varieties that have better disease tolerance than the previous ones. Hence, it is important to demonstrate these varieties on farmers' fields so as to familiarize to the farming communitie.

Materials and Methods

Site and Farmers' Selection and FREG Establishment

The activity was conducted in some purposively selected districts of East and Horro Gudru Wollega zones. Selection of the districts was based on Bread wheat production potential, accessibility for supervision and compatibility with the AGP II criteria. Accordingly, Gida Ayana, Jimma Geneti, Jardega Jarte, Guduru and Jimma Rare districts were selected based on the aforementioned criteria. One potential PA from each district was selected based on accessibility and potential for bread wheat production. In each PA, 1 FREG unit comprising of 15 farmers were established. Gender balance was considered while establishing each FREG unit to meet the target set by the project (at least 35%). 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.

FREG member farmers were selected based on willingness to participate and to share information to other farmers, ownership of sufficient land to accommodate the trials and capacity of handling experimental plots. After establishing FREGs, a theoretical training session was arranged to farmers, DAs and district experts. Multi-disciplinary team of researchers trained farmers and DAs on issues like economic and nutritive importance of bread wheat, suitable ecologies and weather condition for its production, agronomic practices and post-harvest managements.

Field design and management

Two bread wheat varieties Liben and Buluq were planted along with Senate variety (the standard check) side by side 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 by researchers and DAs.

Variety evaluation and selection

Participatory variety evaluation was conducted at crop maturity stage using ten different criteria (Tolerance to lodging, early maturity, spike length, tolerance to yellow rust, number of seed/spike, tolerance to head blotch, seed color, seed size, tillering capacity and yield performance) set jointly by farmers, development agents and researchers. A five point scale (1=very poor, 2= Poor, 3= Medium, 4=superior and 5= highly superior) was used for rating the varieties against the above mentioned criteria by participant farmers. Finally, the varieties were ranked in all districts based on the total and mean score. The total score for the variety was calculated by adding individual score given for the variety for each criterion. The yield advantage of the new varieties over the standard check was calculated using the following formula:

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

Data Collection and Analysis

Data related to yield performance of demo and control plots, farmers and other stakeholders training, field days, farmers' preference and perception were collected through field observation, participant interview and group discussion. The collected data were analyzed using descriptive statistics such as mean and frequency distribution.

Results and Discussions

Training and field visits

Participatory training was given by multi-disciplinary team of researchers consisting of breeder, agronomist, pathologies, extensionist and economist on issues like nutritive and economics importance of bread wheat, suitable ecologies and weather condition for bread wheat production, crop production management. Accordingly, a total of 65 farmers (52 male and 13 female), 20 DAs (15 male and 1 female), and 3 experts were participated on the training. Besides; field visit was arranged to facilitate experience sharing among the experimenting and others neighboring farmers (Table 1).

Table1. Participants of training and field visit

No	**Events**	**Participants**					
		Farmers		**Development Agents**		**District experts**	
		Male	Female	Male	Female	Male	Female
1	Training	52	13	19	1	15	0
2	Field Visit	89	22	19	1	15	0

Participatory Variety Evaluation and Selection

As shown in table 2 below, variety ranking was done based on the total and mean score calculated for all varieties in each districts. Accordingly; Liban and Senate varieties were ranked first and second in Jarte Jardaga district while Senate and Liban were ranked first and second respectively in Guduru distrct. Similarly, Senate and Buluq were ranked first and second in Jimma Rare while Senate and Liban were ranked first and second respectively in Gida Ayana district). The difference in variety rankings across the districts shows that there is varying preferences for varieties among the districts.

Table 2: Total and mean score and ranks given to the varieties in the study areas

Variety	**Guduru**			**Jimma Rare**			**Jarte Jardaga**			**Gida Ayana**		
	Total Score	Mean Score	Rank	Total Score	Mean Score	Rank	Total Score	Mean Score	Rank	Total Score	Mean Score	Rank
Liban	35	3.89	2nd	33	3.67	2nd	35	3.89	1st	36	3.6	2nd
Senate	38	4.22	1st	34	3.78	1st	38	4.22	1st	40	4	1st
Buluq	34	3.78	3rd	31	3.44	3rd	36	4	2nd	35	3.5	3rd

Yield performance of the varieties

Yield performance of the demonstrated varieties and the standard check is shown in figure 1 below. The overall mean yield of all districts was 51.75 qt/ha for Buluq, 55.75 qt/ha for Liban and 61.25 qt/ha for Senate varieties. Senate variety was selected by all its traits including yield followed by Liban variety. Senate variety had 15.5% and 9% yield advantage over Buluq and Liben varieties respectively. The variability in yield performance might have stemmed from difference in the status of soil fertility, difference in management (usage of recommended cultural practices and others.

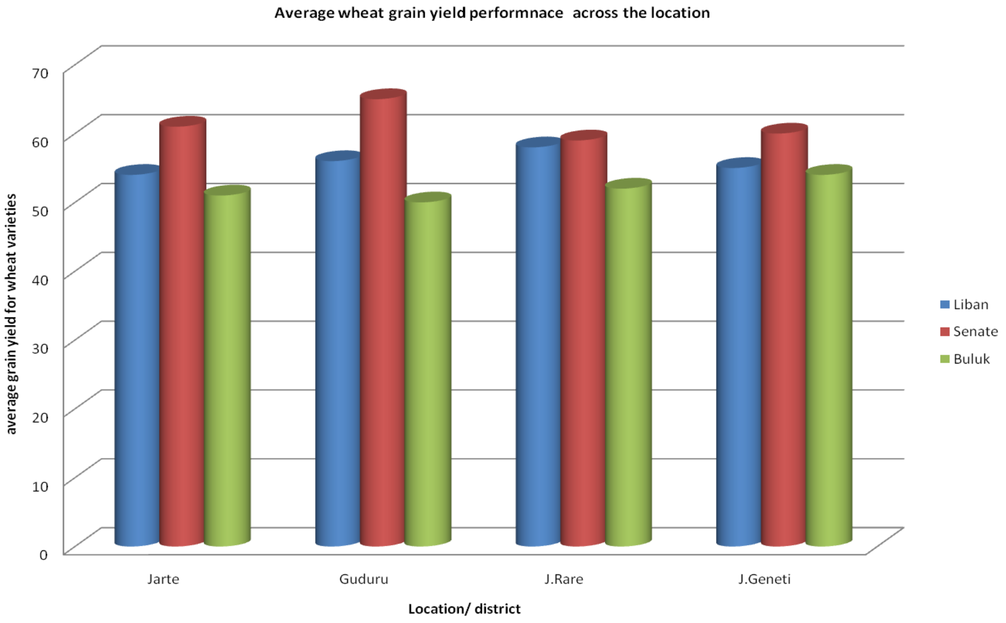

Figure 1. Yield performance of the varieties

Conclusions and Recommendations

The study was conducted in Jarte Jardaga, Jimma Rare,Gida Ayana, Jimma Geneti and Guduru districts of Western Oromia with the objective of demonstrating recently released Bread Wheat varieties, Buluq and Liban with their agronomic recommendations. In the course of demonstration, the two recently released varieties were compared with the Senate variety (the standard check) against jointly set criteria such as tillering capacity, disease tolerance, seeds per spike, plant height, crop stand, overall yield, seed size, resistance to lodging, time of maturity, spike length, seed color and threshability. Accordingly, in all districts, the standard check (Senate variety) gave better yield (61.25qt/ha) than the recently released Kena and Guduru varieties. Senate variety was also preferred most by farmers particularly for its higher seeds per plant, threshability and tolerance to stem rust. Hence, Senate variety recommended for pre-scaling up on wider plots to reach wider areas and more number of farmers.

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Pre-extension Demonstration and Participatory Evaluation of Improved Teff Technology in Potential AGP-II Districts of East & Horro Guduru Wollega Zones

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Abstract

*Pre-extension Demonstration of tef varieties were conducted in Gida Ayana, Wayu Tuqa, Jarte Jardaga, Guduru, Jimma Geneti and Jimma Rare districts of Western Oromia with the objective of demonstrating the recently released teff varieties, Kena and Guduru to the farming communities in 2017/18. The study districts were purposively selected based on their tef production potential. One potential PA was selected from each district based on accessibility and tef production potential. The two tef varieties; Kena and Guduru were planted along with the local check 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 by researchers and Development Agents (DAs). At maturity stage, the varieties were jointly evaluated with a team composed of researchers, farmers and DAs. In all the districts, Kena variety gave better yield (19.25qt/ha) with 126.5% yield advantage over local check followed by Guduru (17.5qt/ha) and the commercial check (8.5qt/ha). Kena variety was also preferred by farmers for its better yield, resistance to lodging and diseases and other traits considered. Hence, further scaling up/put of Kena variety is important to reach wider areas and more number of farmers.*

Keywords: Tef, Participatory evaluation, pre-extension demonstration, Kena, Guduru

Introduction

Among cereals, Teff, maize, sorghum and wheat took up 22.95% (about 2,866,052.99 hectares), 16.91% (about 2,111,518.23 hectares), 14.85 % (about 1,854,710.93 hectares) and 13.33% (about 1,664,564.62 hectares) of the grain crop area, respectively (CSA 2016). Tef is second (to maize) in terms of quantity of production (CSA 2016). However, because its market price is often two or three times higher than maize, Tef accounts for the largest share of the total value of cereal production. Tef is grown by a total of 6.2 million farmers. Since Tef farm operations such as land preparation, weeding and harvesting are highly labor intensive, with limited availability of suitable mechanical technology, there are no large scale Tef farmers in the country. Many farmers grow Tef 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), Tef 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 Tef 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 also gaining popularity as a health food in the western world. Studies show that Tef is a gluten free crop, which makes it suitable for patients with celiac disease (Dekking and Koning, 2005).

Despite the existing huge potential, the productivity of tef 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*., 2000). 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 al*., 2013).

In order to increase productivity of this crop, the National Agricultural Research System (NARS) has been making great efforts over the past years to develop and release large numbers of teff crop varieties and associated production technologies for diversified agro ecology of the country. In spite of the availability of several improved tef technologies generated by the research system, most of the farmers in the country in general and in the Oromia region in particular depend on the local varieties and traditional management practices. Therefore, this project is initiated with objectives of demonstrating improved tef varieties; Kena and Guduru recently released by Bako Agricultural Research Center (BARC) so as familiarize the farming communities with the new teff varieties and in turn enhance its adoption process.

Materials and Methods

Site and FREG Selection

The activity was conducted in some purposively selected districts of East &Horro Guduru Wollega zones. Selection of the districts was based on potentiality for tef production, accessibility for supervision and compatibility with the AGP II criteria. Accordingly, Wayu Tuka, Gida Ayana, Guduru, Jardega Jarte, Jimma Rare and Jimma Geneti were selected based on the aforementioned criteria. One potential PA from each district was selected based on accessibility and potentiality for teff production. In each PA, 1 FREG units comprising of 15 farmers was established. Gender and youth balance in each FREG unit was strictly considered.

In each FREG unit 4 experimental farmers were selected with the rest being participant farmers. Development Agents and woreda experts were collaborating in site and farmer selection. The FREG member farmers were selected on such criteria as: willingness to be held as member, accessibility for supervision of activities, good history of compatibility with group dynamics, willingness to share innovations to other farmers. In addition to these criteria, the experimenting farmers were selected based on having suitable and sufficient land to accommodate the trials, vicinity to roads so as to facilitate the chance of being visited by many farmers, good history of handling experimental plots in the past or loyalty to entrust trials to and genuineness and transparency to explain the technology to others.

After the establishment of the FREGs a theoretical training session was arranged and delivered to farmers, DAs, and district experts. At this juncture multi disciplinary team of researchers drawn from BARC trained the farmers on issues like economic and nutritive importance of teff, suitable ecologies and weather condition for teff production, agronomic practices, post harvest and storage strategies of teff.

Field Design and management

Three tef varieties Guduru, Kena and one commercial check were planted on adjacent plots of 10m x 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. Eventually, at maturity participatory variety evaluation platform was arranged and attended by the experimenting farmers, neighboring farmers, researchers from BARC the previous stake holders. The varieties were then be evaluated based on the farmers' selection criteria.

Data collected

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.

Data analysis

The data was analyzed using descriptive statistics such as mean, frequency distribution, and percentages. Besides; pair wise ranking techniques was used to evaluate and select best bet variety/ies and /or technology/gies as well as to score and rank their criteria and parameters according to real situation of the area.

Results and Discussion

Training and Field Exchange events for stakeholders

Participatory training was given by multi-disciplinary team of researchers consisting of breeder, agronomist, pathologies ,extensionist and economist drawn from Bako agricultural research center were given the training to stakeholders on issues like nutritive and economics importance of teff, suitable ecologies and weather condition for teff production, crop production management. Totally 105 farmers (male 85 and 20 female), 24 DAs (20 male and 4 female) and 15 experts (all male) were participated on this training. Besides, exchange visit was arranged for sharing experiances and information among the experimenting and others neighboring farmers (Table 1).

Table1. Gender disaggregated stakeholders participated on training and field exchange events

No	Events	Participants					
		Farmers		**Development Agents**		**District experts**	
		Male	Female	Male	Female	Male	Female
1	**Training**	85	20	20	4	15	0
2	**Field Visit**	84	11	20	4	18	0

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 pair-wise 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. The variety/ies selected, accordingly, will be proposed for further scaling up. 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, where 1 being very poor and 5 being the highest score representing superiority.

Teff yield, lodging and disease tolerant was considered as the most selection criteria for each teff varieties. Based on overall mean score the best preferred variety/ies was/ were evaluated and ranked. Accordingly; in all the districts, based on overall mean score and rank, Kena was selected firstly in all of its traits and then followed by Guduru. This underlines the importance of testing of improved varieties in farmer's fields across districts. Scoring of farmers selection criteria was based on a ranking scale from 1-5, with 1 as the most important to 5 as the least important.

Table 2. Total and mean score and ranks given to the varieties in the study areas

Variety	**Jarte Jardaga**			**Guduru**			**Jimma Geneti**			**Overall Rank**
	Total score	Mean score	Rank	Total score	Mean score	Rank	Total score	Mean score	Rank	
Kena	18	2.57	1st	20	2.86	1st	20	2.86	1st	1st
Guduru	16	2.29	2nd	14	2.00	2nd	16	2.29	2nd	2nd
Commercial check	11	1.57	3rd	11	1.57	3rd	9	1.29	3rd	3rd

NB: 1-7 farmers' selection criteria set;1= Lodging tolerant, 2=early maturity, 3= Disease tolerant, 4= seed color, 5=seed size, 6=Thillering capacity and 7=high yielder

On-farm performance of the varieties

In spite of the inevitable variability in performance between and even within locations, yield performance of the varieties was still promising. The variability in yield performance might have stemmed from difference in the status of soil fertility, difference in management (usage of recommended cultural practices) and others. Despite this fact an average yield of 19.25 qt/ha for Kena, and 17.5 qt/ha for Guduru, respectively was reported as compared to the local variety that yields only 8.5 qt/ha.

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

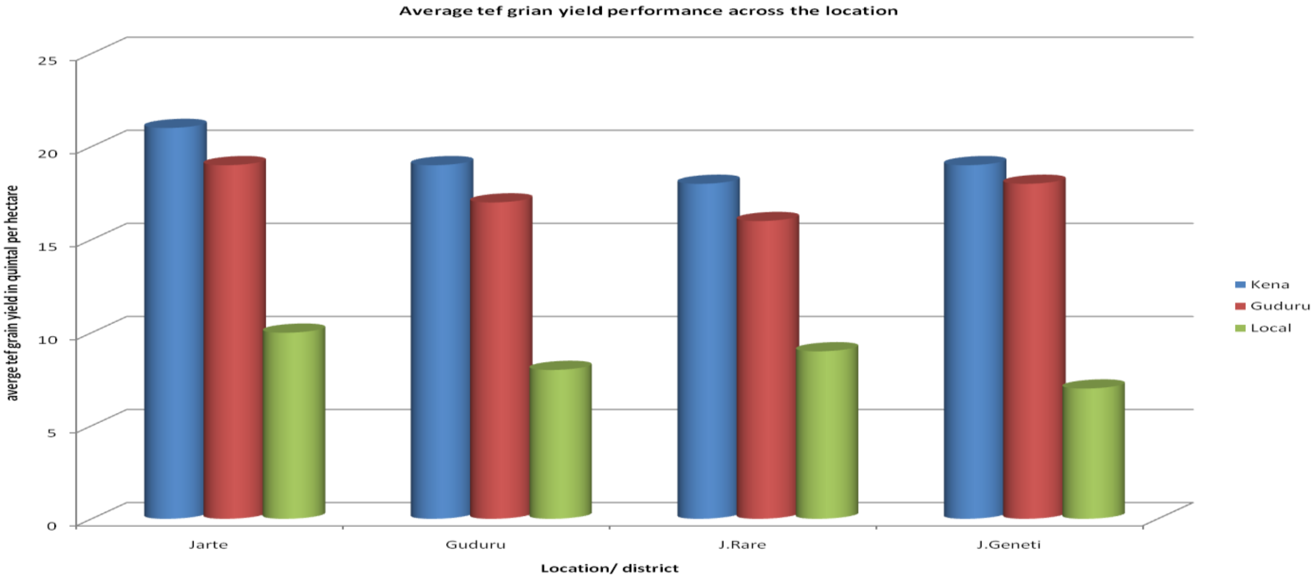
$$\text{Yield advantage \% for Kena} = \frac{19.25\text{Qt/Ha} - 8.5\text{Qt/Ha}}{8.5\ \text{Qt/Ha}} \text{ X } 100$$

Yield advantage of Kena over commercial check= 126.47%

$$\text{Yield advantage \% for Guduru} = \frac{17.5\text{Qt/Ha} - 8.5\text{Qt/Ha}}{8.5\ \text{Qt/Ha}} \text{ X } 100$$

Yield advantage of Guduru over commercial check= 105.88 %

From the above result one can deduce that both Kena and Guduru had better yield advantage which is 126.47 % and 105.88 % over the commercial check.



stemmed from difference in the status of soil fertility and site specific varying weather conditions (for instance, ice rain, rainfall intensity i.e. flooding or shortage). The overall harvested mean yield of Kenna, Guduru and local variety was 19.25 qt/ha, 17.5 qt/ha and 8.5 qt/ha respectively. Above all, in all of their traits, almost all of the farmers' selected Kenna in the first place followed by Guduru. Hence, Teff variety (Kenna) was selected and recommended for pre-scaling up activity on wider plot (at least 0.25ha per trial farmer) for popularization. Technical advice and support to smallholder farmers is highly required to improve teff production and productivity, to attain food self sufficiency and bring the required impact. To this end, establishing and strengthening FREGs/FREGs is one of the extension approaches, which make the farmer to be central to agricultural research, technology promotion and dissemination. Moreover, there is a need to strengthen the linkage among stakeholders.

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Pre-extension Demonstration and Participatory Evaluation of Improved Food Barley Technology in Selected AGP-II Districts of East and Horro Guduru Wollega Zones

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Abstract

*Food barley variety HB-1307 was demonstrated in Jarte Jardaga, Jimma Rare, Guduru and Jimma Rare districts of western Oromia in 2017/18. These districts were purposively selected based on potentiality for food barley production; and one potential PA from each district were selected on the basis of accessibility and potentiality. After establishing and training One FREG unit in each PA, two varieties of food barley, HB-1307 and the local check were planted on 20m*10m adjacent plots on 12 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 stage, 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, disease tolerance, seed color, plant height, yield, pest resistance, tillering capacity seed Size, lodging resistant, earliness and spike length, threshability were the common selection criteria across all locations. In almost the criterion, HB-1307 performed better than the local check and has met the criteria set and impressed the farmers. With regard to yield, 66.8qt/ha and 37.25qt/ha were obtained from HB-1307 and local check, respectively. HB-1307 showed yield advantage of 79.33 % yield advantage over the local check, putting on the first rank. As the variety has met criteria and liked, the pre-scaling up activity should follow the next season.*

Keywords: Food barley, FREG unit, HB-1307, index, Participatory evaluation; technology gap

Introduction

Food barley is an important crop in Ethiopian high lands that can be used as food in many forms. It is the fifth in area coverage following tef, maize, wheat and sorghum. Despite its enormous economic and nutritive importance productivity is very low as compared to other cereals (1.2 tone/ha). There are a lot of factors that contributed to the lower productivity of the crop viz production on sloppy fields, low soil fertility, limited improved variety, water logging, leaf and grain diseases, pests, weed competition and others. 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 different varieties. Among them is a variety known as HB-1307 which has better productivity and disease resistance compared to local and other released 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 objectives of demonstrating improved baley (HB-1307) varieties so as familiarize the farming communities with the best variety which in turn will facilitate the adoption process and bridge the productivity gap.

Materials and methods

Site and FREG selection

This activity was conducted in some purposively selected districts of Horro Guduru Wollega zone. Selection of the districts was based on potentiality for food barley production, accessibility for supervision and compatibility with the AGP II criteria. Accordingly, Guduru, Jardega Jarte, Jimma Rare and Jimma Geneti districts was selected based on the aforementioned criteria. One potential PA from each district was selected based on accessibility and potentiality for barley production. In each PA, 1 FREG units comprising of 15 farmers was established. A total of 4 FREG units were established. 40% of the participants were women farmers and 60% were male. This gender balance applies for the rest of activities, as well.

In each FREG unit 4 experimental farmers were selected with the rest being participant farmers. Development Agents and woreda 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. Besides; the experimenting farmers were selected based on: availability and accessibility of sufficient land to accommodate the trials; vicinity to roads so as to facilitate the chance of being visited by many farmers; good history of handling experimental plots in the past or loyalty to entrust trials; genuineness and transparency to explain the technology to others.

After the establishment of the FREGs a theoretical training session was arranged to farmers, DAs, and district experts. At this juncture multi disciplinary team of researchers drawn from BARC were trained the farmers on issues like economic and nutritive importance of barley, suitable ecologies and weather condition for barley production, agronomic practices, post harvest and storage strategies of barley.

Field Design

The plots were properly ploughed and made ready for planting ahead of the planting date. Two food barley varieties, HB-1307, and one commercial check were planted on adjacent plots of 10*20 M^2 each. All the necessary recommended agronomic practices were equally applied for all of the plots. Every field was supervised at a monthly interval to check the status and to identify gaps. At maturity participatory variety evaluation platform was arranged that attended by the experimenting farmers, neighboring farmers, researchers from BARC the previous stake holders.

Data collected

Grain yield, total number of farmers and other stakeholders' participated in training, total number of farmers and other stakeholders' participated in field visits and field days and farmers' perception

Data analysis

The data was analyzed using descriptive statistics such as mean, frequency distribution, and percentages. Besides; pair wise ranking techniques was administered and used to participatory evaluate and select best fit variety/ies based on their own set criteria.

Results and discussions

Training and Field Visit

Participatory training was given by multi-disciplinary team of researchers consisting of breeder, agronomist , pathologies ,extensionist and economist drawn from Bako agricultural research center were given the training to stakeholders on issues like nutritive and economics importance of food barley, suitable ecologies and weather condition for food barley production, crop production management . Totally 60 farmers (male 52 and 8 female), 16 DAs (15 male and 1 female), 12 from district office (all male) and 9 researchers (all male) were participated on this training. Besides; experience sharing event; exchange visit, was also arranged to share their experiences and exposure among the experimenting and others neighboring farmers. Accordingly; gender disaggregated number of farmers', DAs, district experts and researchers participated on field day and training events were summarized in below table.

Table1. Gender disaggregated stakeholders participated on training and field exchange events

No	**Events**	**Participants**							
		Farmers		**Development Agents**		**District experts**		**Researchers**	
		M	F	M	F	M	F	M	F
1	**Training**	52	8	15	1	12	0	9	
2	**Field Visit**	57	3	15	1	12	0	5	0

N.B. * M= Male, F= Female

Participatory Variety Evaluation

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 pair-wise ranking technique. 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, where 1being the highest score representing superiority and 5 being very poor.

Accordingly, food barley yield, lodging and disease tolerant were considered as the most selection criteria for each food barley varieties. Based on overall mean score the best preferred variety was evaluated and ranked. Accordingly; in all the districts, based on overall mean score and rank, HB-1307 was selected firstly in all of its traits. This underlines the importance of testing of improved varieties in farmer's fields across districts.

Table 2: Average mean ranking for Food Barley variety by FREG farmers for the districts

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

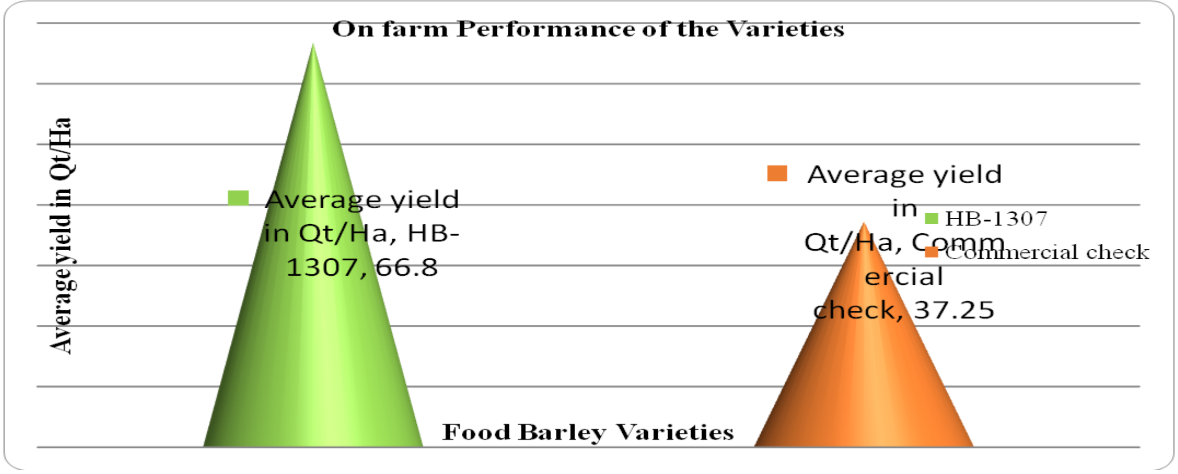
NB: 1-7 farmers' selection criteria set;1= Lodging tolerant, 2=early maturity, 3= Spike length, 4= No. of seed/spike 5= Disease (Rust) tolerant, 6= seed color, 7=seed size, 8=Thillering capacity and 9=high yielder

On-farm performance of the varieties

In spite of the inevitable variability in performance between and even within locations, yield performance of the varieties was still promising. The variability in yield performance might have stemmed from difference in the status of soil fertility, difference in management (usage of recommended cultural practices) and others. Despite this fact a yield of 66.8 qt/ha for HB-1307 and to the local variety that yields only 37.25 qt/ha.

- Yield advantage % = $\frac{\text{Yield of new variety - Yield of standard check}}{\text{Yield of standard check}}$ X 100
- Yield advantage % for HB-1307 = $\frac{\text{66.8 qt/Ha – 37.25qt/ha}}{\text{37.25qt/ha}}$ X 100

Yield advantage % for HB-1307 = 79.33qt/ha % over the commercial check



Conclusions and Recommendations

In spite of the inevitable variability in performance between and even within locations, yield performance of the HB 1307 variety was still promising. The overall harvested mean yield of HB 1307 and the local variety was 66.8 qt/ha and 37.25 qt/ha, respectively. Besides, HB 1307 has 79.33 % yield advantage over the local check. Hence, there is a need to further scale up the variety in the study areas and other similar agro-ecologies. Technical advice and support to smallholder farmers is highly required to improve barley production and productivity, bring the required impact. Now days, farmers' group are seen as the smallest unit of the farmers. Hence, establishing and strengthening FREGs/FREGs is one of the extension approaches, which make the farmer to be central to agricultural research, technology promotion and dissemination. Strengthening the linkage among stakeholders is of paramount importance to achieve the goal.

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Pre-Extension Demonstration of Improved Potato Technologies in Western Oromia

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Abstract

This activity was conducted during the 2017/18 main cropping season at Jarte Jardaga, Jimma Rare and Guduru districts of Horro Guduru Wollega Zones to evaluate and select farmers' preferred potato varieties based on their selection criteria and to create awareness on the importance of the improved potato technologies. Three potato varieties namely Belete, Horro, and Gudane were evaluated and demonstrated on 12 farmers' fields on a plot sized 100 m^2. In each PA, one FREG unit comprising of 15 farmers were established to evaluate and select the varieties. The collected data were analyzed using descriptive statistics (mean and standard deviation) and qualitative narrations. The agronomic result shows that Belete variety performed better in terms of yield (3950 Kg/ha) followed by Horro variety (2700 Kg/ha). The two varieties were also preferred by farmers for their resistance to disease, large tuber size, marketability, high number of tubers per plant, good color and other traits. On the other hand, pair wise ranking of variety traits revealed that yield potential, disease resistance, tuber size, marketability, color and number of tubers per plant were the major criteria selected by farmers. , Therefore, Belete and Horo varieties were recommend for further scale up/out in Guduru, Jarte Jardaga and Jimma rare to reach wider area and more number farmers.

Keywords: *Participatory, Evaluation, Demonstration, Potato, Technologies, Farmers research Group*

Introduction

Potato is an important crop for smallholder farmers in Ethiopia, serving both as cash and food security crop. It is one of the root crops widely grown in the country with the highest rate of growth because increasing demand and emerging markets are providing great opportunity for resource-poor farmers to generate additional income (Mulatu *et al*., 2005). Although potato has a relatively short history of cultivation, today it is a widely grown crop in Ethiopia. It is planted in around 164,000 ha of land producing an estimated tuber yield of over 940,000 tons every year (CSA, 2015). This is mainly because of the favorable climatic and edaphic conditions in many parts of the country that favor potato production. In Ethiopia potato production can fill the gap in food supply during the hungry months of September to November just before harvesting of the grain crops. Potato is a known cheap source of energy and supplies good quality food within a relatively short period. In many regions of the country, it is possible to grow potato throughout the year, which offers a way to ensure a continuous supply of potato and become a reliable source of income to small scale farmers.

Regardless of all the above fact, the average productivity of the crop both at National and Regional level is very low (4.77-5.72t/ha) as compared with the world average yield of 16.45t/ha (FAO, 2008). Various factors such as shortage of disease resistant, adaptable and high yielding varieties, appropriate crop management practices and post-harvest management technologies are some of the major challenges affecting potato production. To solve these problems, more than 27 potato varieties were formally released from regional and national research centers. However, these technologies are not well verified and demonstrated by involving farmers and other stakeholders at grass root level. Therefore, this activity was designed to evaluate and select best improved potato varieties and demonstrate the selected variety to farmers on farmers' fields.

Materials and Methods

Description of Study Areas

The activity was conducted in three districts namely Guduru ,Jarte Jardaga and Jimma Rare of Horro Guduru Wollega Zones of Oromia Region during the 2017/2018 Meher season. Overall, description of the study area is presented in Table 1 as follow.

Table 1: Description of each study sites

Description	**Selected districts for pre-extension demonstration**		
	Jarte Jardaga	**Guduru**	**Jimma Rare**
Distance (km)	380 from A.A	290 from A.A	145 from A.A
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
Temperature (^{0}C)	12^- 20	15- 22	12-22
Major soil type	red and black clay loams soil Availability of well drained and suitable soils potato	Distich Nit soil and Artic Aero soil Which well drained and suitable soils for potato	Dystric Nitosols and OrthicAcrisols which well drained and suitable soils potato
Agro-ecology	Humid and sub-humid types of climate.	Sub-humid types of climate.	Sub-humid types of climate.
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

Source: District BoFD, 2017

Site and Farmers Selection

The activity was conducted in Guduru, Jarte Jardaga and Jimma Rare districts of Horro Guduru Wollega Zone. Selections of the districts were based on potentiality for potato production and accessibility for supervision. Accordingly, one potential kebele was selected from each district based on the aforementioned criteria. In each kebele one FREG unit comprising of 15 farmers was established. Gender balance was considered in establishing FREGs. In each FREG unit, 4 experimental farmers were selected to host the trial while the rest group members remained as participants. The experimenting farmers were selected based on ownership of suitable and sufficient land to accommodate the trials and vicinity to roads so as to facilitate the chance of being visited by many farmers. A total of ten hosting farmers were selected from three kebele of the districts.

Stakeholders training

After the establishment of the FREGs a theoretical training was given to farmers, Development agent and district experts. The training was given by multi-disciplinary team of researchers composed of breeders, agronomists, pathologies, extensionist and economists on issues like economic and nutritive importance of potato, suitable ecologies and weather condition for potato production, agronomic practices, and post-harvest management.

Field design and management

Three improved varieties (Belete, Horro & Gudane) were planted side by side on adjacent plots of 100 m^2. The demo plots were replicated by experimenting farmers. Plots were managed jointly by the researcher, extension workers and farmers. Spacing of 70 cm and 30 cm between rows and plants respectively were used for the experiment. The recommended fertilizer rate (200 kg/ha of DAP and 100 kg of UREA) was used for all plots. All other recommended agronomic practices were maintained equally for all plots.

Variety preference ranking

Before beginning of the selection process, selected farmers from the districts were asked to set their priority selection criteria. Selection criteria of farmers in the study area were based on an extensive discussion and agreement and farmers set criteria during maturity and harvest stage of the crop. Thus, the criteria farmers used in identifying the suitable varieties depend on the existing constraints and opportunities farmers faced in their vicinity. 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 the highest score representing superiority and 5 being very poor. Researchers and DAs personnel were assist farmers during scoring. The farmers also provided overall score for each variety based on all important traits.

Data Collection and Analysis

Agronomic data, total number of farmers participated in training, field visits and field days, farmers' perception on the characteristics of technology, stakeholders participation, marketable tuber yield, unmarketable tuber yield 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 discussions

Training of farmers, Experts and DAs

Training was given by multi-disciplinary team of researchers consisting of breeders, agronomists, pathologists ,extensionist and economists drawn from Bako agricultural research center to farmers, experts, supervisors and DAs on issues like nutritive and economic importance of potato, suitable ecologies and weather conditions for potato production, crop production management, post-harvest and storage strategies. A total of 42 participants (332 farmers, 33 DAs and Supervisors and 22 agricultural experts) were participated on this training (Table2).

Table2: Stakeholders training participants across three demonstration districts

Participants	**Districts**			**Total**
	Guduru	Jimma Rare	Jarte Jardaga	
Experts	8	6	8	22
DAs and supervisors	11	11	11	33
Farmers	90	122	120	332
Total	109	139	139	387

Source: own data, 2017

On- farm yield performance of the varieties

Yield performance of the three varieties was analyzed for each district and all districts together. The on-farm yield performance result showed that Belete variety stood first with average yield of 39 ton/ha followed by Horro (30 ton/ha) in all the districts. The two varieties had a yield advantage of 40% and 20% respectively over the local variety. The local variety Gudane gave lower yield (26 ton/ha) (fig 1).

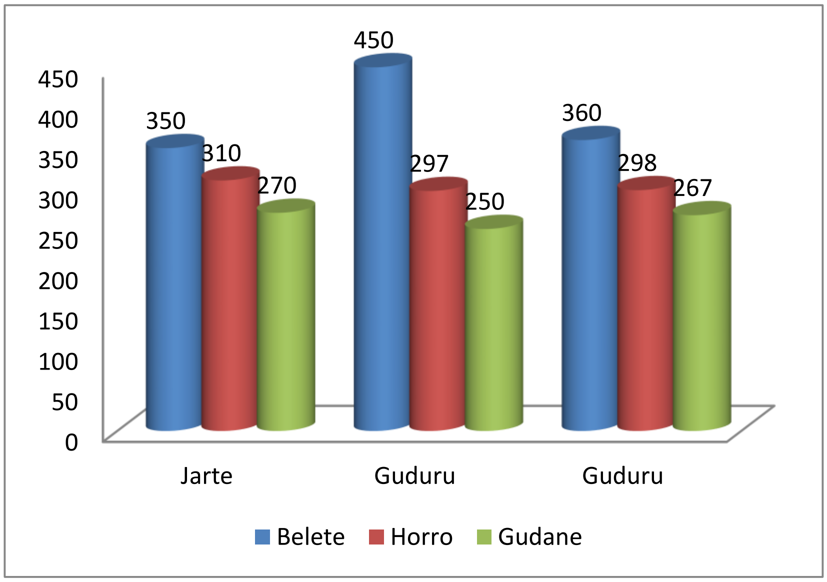

Figure 1. on farm yield performance of demonstrated varieties

Farmer's variety evaluation and selection

Potato tuber yield, number of tuber per plant, crop stand, plant height, earliness of maturity time, Disease resistance, sweetness/ taste, cooking quality, tuber size and marketability were identified as the most important farmer's selection criteria. A total 170 farmers composed of men and women were participated in the selection process. Participant 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 the highest score representing superiority and 5 being very poor. Potato tuber yield was considered as the most important selection criteria for each potato varieties. The total and mean score result showed that Belete variety ranked first followed by Horro in Jarte Jardaga district, Horro and Gudane in Guduru and Horro and Belete in Jimma Rare districts respectively(Table 3). The overall preference score of all districts showed that Belete and Horro were the most preferred varieties were Horro and Belete ranked as first and second by participants for further scaling up and multiplication because of higher productivity, earliness of maturity time, disease resistance, sweetness/ taste, cooking quality, tuber size and marketability while Gudane variety was ranked least because of susceptibility to Bacteria late blight diseases and less productivity per unit area. Generally variety preference varied from one district to the other due difference in farmers' selection criteria. This underlines the importance of testing of improved varieties in farmer's fields across districts.

Table 3: Ranking of Potato varieties at three locations

Variety	**Jimma Rare**			**Guduru**			**Jarte Jardaga**			
	Total score	Mean score	Rank	Total score	Mean score	Rank	Total score	Mean score	Rank	Over all rank
Horro	35	3.5	1	29	2.9	1	42	4.2	2	1
Belete	40	4	2	47	4.7	3	25	2.5	1	2
Gudane	45	4.5	3	40	4	2	46	4.6	3	3

Scoring of farmers selection criteria was based on a ranking scale from 1-5, with 1 as the most important to 5 as the least important, NB: 1-10 farmers' selection criteria set; 1= potato tuber yield, 2= number of tuber per plant, 3= crop stand, 4= plant height, 5= Earliness/maturity, 6=Disease resistance, 7= sweetness/ Taste 8= cooking quality, 9= Tuber size ,10=Marketability, (Market demand).

Stakeholders' feedback on potato technology

Farmers' opinion towards the new technologies are also collected and documented as feedback information for future research and extension endeavors. Accordingly, participant farmers' have appreciated the new varieties for their good yield, cooking ability with small amount of energy, relatively resistant to early and late blight and higher market price.

Conclusions and recommendations

Generally, the on-farm evaluation and demonstration result showed that the demonstrated potato varieties were preferred by participant farmers for their better agronomic performance and market demand. Through the participatory evaluation and demonstration process, many farmers became awareness of the importance and quality of technologies as compared to the one under production Based on these facts, the study recommended Belete and Horro varieties for further scale up and scale out for Jima rare, Jarte Jardaga and Guduru districts and other similar areas. Therefore, unions, research organizations, agricultural development offices, NGOs, private and public seed sectors, farmers and others should work on seed multiplication and distribution and scaling up/out of the recommended technologies.

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Demonstration of Improved management of F1 cow for farmers around Meki area for livelihood improvement

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Abstract

Demonstration of F1 cows was done with farmers' research & extension group (FREG) comprising of eight participating farmers in Bekele Gressa kebele of Dugda district during 2016/17 & 2017/18. The distribution was done when they were 7 month pregnant heifers, with the objective of improving farmer's livelihood through improving milk production. Training was delivered to the participating farmers on how to feed and manage the cross breed cows. The result of the survey conducted before the commencement of the demonstration activity indicated that the average milk yield of local cattle in the study area was 1.06± 0.15 lt/cow/day. The on farm average milk yield for the F1 demonstrated crossbred cattle in the study area was found to be 6.55±0.048 lt/cow/day for the year 2016/17 and 6.59±0.06lt /cow/day for the year 2017/18, respectively. This in turn had positive impact on the income diversification and fulfilling protein requirement of the household, finally improved livelihood.

Introduction

Ethiopia, despite its large livestock resource base (99.4% indigenous and the rest crossbreds) and an ecological setting suitable for dairy production, is not yet self-sufficient in milk production (FAOSTAT, 2010). As a consequence, the per capita milk consumption appears to have declined from 26 liters per annum in 1980 to 16 liters in 2008 which ranked Ethiopia one of the least in the world (Zegeye et al., 2003; Azage et al., 2006; ELDMPS, 2007; FAOSTAT, 2010). Livestock productivity in Ethiopia is said to be poor due to a number of reasons among which low genetic capacity of indigenous cattle is one (Mukasa Mugerewa, 1989). In Ethiopia, poor genetic potential for productive traits, substandard feeding, poor health care and management practices, are the main contributors to low productivity (Zegeye et al., 2003).

In order to improve the low productivity of local cattle, selection of the most promising indigenous breed or breeds and crossbreeding with high producing exotic cattle has been considered as a practical solution (Tadesse, 2002). Study conducted in North Shoa zone indicated that 50% cross breeds produce more amount of milk (1511.5 L) than local breeds (457.89 L) per lactation (Mulugeta and Belayneh, 2013). Belay et al. (2012) reported that mean milk production per lactation from Horro and Holstein Friesian cross was 2333.63 L. This could be either due to complementary or heterosis effect to the achievable environment. Available information indicates that the productive and reproductive performance of indigenous cattle breeds is low (Addisu, 2013) However, information on the actual potential of indigenous breed(s) is not satisfactory due mainly to the absence of recording system. Attempts so far done at on farm condition in the mid-rift valley of east shoa zone and elsewhere in the country to improve the performance of indigenous breed through crossbreeding indicated an encouraging result in improving milk yield and growth rate. Though the demand for F1 crossbred dairy cows was high it was not a simple task to fill this demand in the past but recently the government is applying on farm production through synchronization. This activity therefore, was designed to demonstrate the F1 cross bred animals to the farmers with the objective of increasing farm gate milk production through provision of improved cross bred animals and their management packages and Improve the income of the farmers through improved milk production

Materials and Methods

Description of the Area

The study was conducted in Gressa kebele near Meki town, East Shoa Zone of Oromia regional state Gressa Kebele is located on the main road from Addis Ababa to Hawassa at a distance of 137 km, and elevation of 1664.88 meters above sea level (masl) with coordinates of 8°9'18.69"N and 38°49'32.79"E (www.distancesto.com) The area gets about 64% of annual rainfall from June to September. Its mean annual temperature is 20.3^{0}C while average annual precipitation is 774 mm. The air relative humidity of the study area is 66% on average (JICA, 2002). The Area is irrigation based horticulture producing rural villages.

Farmers Selection

Farmer selection was done based on the information collected from the woreda experts, development agents (DAs) and the discussion held with the kebele farmers. Relatively poor farmers were selected to observe the impact of the F1 dairy cow on the livelihood of the farmers. The selection criteria used to identify the farmers

- Willingness of the farmer
- Possession of adequate land for the cow management
- Number of family members (the larger the better)
- Relatively low income so that the impact of having cross bred on the livelihood could be pointed out simply
- Previous experience on dairy cow management
- Willingness to manage the cross bred dairy cow as per the instruction of the researcher
- Experience on saving money so that they could repay the purchase price
- Commitment to sale the second F1 heifer to the neighboring small holder farmer as a means of scaling up activity

Animal purchase and technical training

The activity was done in Girissa kebele of Dugda District (one of the AGP II districts) in East Shoa zone. Eight F1 pregnant heifers were sold to the farmers with subsidized price from ATARC (Adami Tullu Agricultural Research Center) in the kebele to see the performance of the F1 dairy heifers with improved management practice in the mentioned kebele. The cost was totally covered by the farmers themselves. Training was given to all participating farmers, DA, expertise of the respective district stakeholders and other concerned bodies. The areas of training were on how to improve productivity of cross bred cattle, management system. Advantages and dis- advantages of genetic improvement for higher milk production and the contribution of record keeping and animal identification were also addressed.

Supplementary feeds

Noug cake was purchased by AGP II project funding and wheat bran and salt was purchased by the farmers to be used as supplemental feed on farm. After formulation of the feed based on maintenance and production requirement the supplemental feed mix up was done on farm in collaboration with the farmers and delivered to the F1 cows. Four of the five lactating F1 cows were used as experimental animal in a feeding trial conducted in and around meki town through another project in 2016. Two supplemental feed were used in the experiment formulated of locally available feed namely linseed cake, wheat bran and molasses in the first group and cotton seed cake Atela (local brewery) and wheat bran in the second group.

Data collected

Data regarding milk yield, type of feed, milking practice, conventional management system, and price of supplemental feed, medicament and all cost related to F1 were analyzed using the partial budget analysis.

Partial budget Analysis

The partial budget analysis was calculated to compare the benefit F1 cows as compared to the local cows under on farm management conditions. Some of the costs like herding and grazing (basal diet) are considered to be uniform for both F1 and local cattle so it is not considered. But All the supplemental feed cost and medicament were included in the partial budget. According to (Ehui et al. 1992) Net income (NI) was calculated as the amount of money left when total variable cost (TVC) was subtracted from total returns (TR). In this experiment the variable costs included purchase of supplemental feed and cost for medicaments. While total return (TR) was estimated by the selling price of the Average milk yield selling price of 1lt of milk which was 15 birr during of the experimental period. Therefore, a formula of **NI= TR- TVC** was used for the calculation of profitability.

Baseline data collection

Baseline information on the socioeconomic status of the participating farmer was collected before the distribution of the animals to the farmers.

Results and Discussions

The baseline data indicated that education status of the respondents was about 50%, 33.3% and 16.7% of the farmers were illiterate, got elementary school and got high school study, respectively. House hold source of income comprised of crop-livestock production 66.8%, while the rest did additional work over the crop-livestock production like daily labor (16.6%) and government employment (16.6%) as their off farming activity. Average milk yield of local cow per head per day, according to respondent farmers was 1.06± 0.15 L. The result is comparable with the finding of (Ketema, 2014) which indicated milk yield of 1.15±0.386 L for local cattle in kersa malima woreda. Slightly lower than the finding of (Yesihak, 2011) reported 1.99±0.77 kg/day for Ogaden breed at Haramaya University.

Dairy cattle management practice

Regarding the dairy cattle management practice of the area about 50 % of the respondents practice spraying as a means of control for external parasite and about 33% of the respondents practice deepening in naturally existing water containing Mineral rich type of soil immersed in water locally called Bole. All the respondent practice routine vaccination and 83.3 % practice castration bulls at the age between three to four years, and all the respondents use animals' coat color as a means of identification of the individual animal, all the farmers use hand milking. With respect to livestock house the roofing material was categorized as grass (33.4 .%), corrugated iron sheet (33.3%) and plastic sheet (33.3%) while the wall material consisted of wood (33.3%) and Mud material (66.7%) and the floor material at the current situation was fully earthen floor.

Dairy animal feed and feeding practices

There were clear variations among the farmers with respect to supplementation of the animal at hand at the beginning of the experiment. The variation was both in type and amount the supplemental feed. The supplemental feed mentioned includes sole wheat bran (16.7%) , wheat bran with Atela (locally brewery) 33.3%, wheat bran and oil seed cake (16.7%) and combination of wheat bran Atella and cake (33.3%). One of the major problems with dairy cattle supplementation in the area was absence of regular supplementation. The frequency of supplementation was as low as twice in a month. Amount of wheat bran purchased ranged from 25-250 kg per month, while amount linseed purchased ranged from 0-100 kg per month. Price of wheat bran, oil seed cake and Atella according to the farmers were 2.50 birr/kg, 12 birr /kg and 20 birr/20L respectively. The most common basal diet in the area were crop residue comprising of maize Stover, wheat straw, teff straw and barley straw in addition to lake side grazing and weeds from horticultural fields. The feeding trial done on four of the eight F1 cows helped the participating farmers obtain practical training on how to feed their dairy cows based on the requirement and their production. The performance of the F1 cows distributed to the farmers indicated that the average milk yield of the cross breed animals for the year 2016 was found to be 6.55± 0.048 the detailed information is indicated in Table 1 below.

Table 1. Individual farmers and average milk yield of the F1 cows distributed from ATARC through AGPII year 2016

Farmers	Milk yield (mean ± SE)	N	Standard deviation	Min	Max
Farmer 1	6.75±0.108	55	0.804	4	8.5
Farmer 2	5.873±0.055	55	0.410	4.5	6
Farmer 3	6.84±.069	55	0.508	6	8
Farmer4	5.87±0.055	55	0.411	4.5	6
Farmer5	7.39±0.056	55	0.416	6	8
Total	6.55±0.048	275	0.794	4	8.5

The performance of the F1 cows distributed to the farmers indicated that the average milk yield of the cross breed animals for the year 2017 was found to be 6.59± 0.065/day/cow the detailed information is indicated in table 2 below.

Table 2. Individual farmers and average milk yield of F1 cows distributed from ATARC through AGP II year 2010 EC

Farmers	**Milk yield(Mean ± SE)**	**N**	**Standard Deviation**	**Min**	**Max**
Farmer 1	6.88±0.122	60	0.93	5	8
Farmer 3	6.53±0.118	40	0.75	5	8
Farmer 4	5.61±0.074	59	0.57	5	6.5
Farmer 5	7.32±0.072	60	0.56	6	8
Total	6.59±0.065	219	0.97	5	8

The present average milk yield result was 6.55±0.048 L/day/cow and 6.59±0.065 L/day/cow was comparable with the finding of (Asamnew and Eyassu, 2009) average milk yield of 5.2 L in Bahirdar Town for cross bred dairy cattle. And overall average milk yield of 8.45±1.23 L per day per cow was reported (Belay et.al, 2012) from study conducted in Jimma town. but higher than the average milk yield record of (4.73±3.2 L) for cross bred cows in kersa malima (Ketema 2014). The present result lower than the finding of (Adebabaye, 2009) which indicated 10.96±1.73 L in Bure district. Pregnant heifers of similar age and breed were distributed to the famers at the same time. However, because of the variation in breeding management there was great variation in time of calving, some of them calved twice other only once. This might be because some of the farmers were valuing the milk (preferred milking the cow for longer time). This in turn had disrupted the proper time of breeding service. Intensive training was delivered to the participating farmers on how to feed the animals according to their production and milk yield.

Financial benefits of milk from F1 cow

The financial advantage of the F1 cows over the local could be calculated in terms of milk yield multiplied by 15 birr/lit of milk taking into consideration of the supplemental feed cost for the F1 and considering zero cost for supplemental feed for local animal. And considering family labor for both types of animals the only variable cost to be considered was feed cost and medicament cost for F1 cows and only medicament cost for local cows,. Accordingly the net benefit of F1 cow was found to be 56.275 birr /cow/day while of the local cow was found to be 9.9 birr/cow/day (Table 3). Moreover cross bred calf produced be it male or female is added benefit for those farmers who had the F1 cows.

Table 3. Simple Comparison of economic benefit of milk from F1 cow versus Local cow using partial budget analysis

Particulars	**F1 cows**	**Local cow**
Lin seed cake cost/cow/day	16 birr	-0
Wheat bran cost /cow/day	15.95 birr	-0
Salt cost /cow/day	0.075 birr	-0
Labour cost /cow/day	(Family labor)	(Family labour)
Medicament cost/cow/day	10 birr	6 birr
Total variable cost (TVC)	41.975 birr	6 birr
Total Return (TR)	6.55lt x 15 birr = 98.25 birr	1.06lt x 15birr = 15.9 birr
Net income (NI)	98.25 birr – 41.975 birr = **56.275 birr**	15.9 birr – 6 birr = **9.9 birr**

Farmer's opinion

In order to improve the low productivity of local cattle, crossbreeding of these indigenous breed with high producing exotic cattle has been considered as a practical solution (Tadesse, 2002). The present study indicated similar result as that of previous work. The demand of the farmers for the technology is very high. There is continuous request of the farmers for F1 cow. High price and scarcity of F1 cow dictate the use of Artificial insemination on local cattle to have cross bred animals at the farm gate.

Conclusions and recommendations

The results of the present study indicated that pregnant heifers distributed to the farmers in Gressa kebele from Adami Tullu Agricultural research center through AGP II project brought significant increase in milk yield per day/cow for the farmers. This in turn had an positive impact on the income diversification of the farmers and solved the protein requirement of the house hold, thereby improving the farmers livelihood to some extent. The use of F1 dairy cows at the on farm level have to be accompanied by the full package management technologies to have optimum milk production One way of achieving this is through practical and intensive training on dairy cow management. Small holder farmers having F1 dairy cows in the study area should have appropriate market linkage both for input supply and sale of milk to have sustainable dairy production and this indicated that the distribution of dairy heifers should be encouraged in the study areas and in other areas with similar characteristics.

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Participatory evaluation and demonstration of improved forage crop varieties for smallholder farmers in selected districts of West Arsi and East Shoa zones

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Abstract

Participatory evaluation and demonstration of improved forage crop varieties were conducted at Dugda and Dodola districts with the objectives of evaluating the performances of improved forage crops with farmers' participation and demonstrating their production and utilization practices in 2016/17 & 2017/18. Accordingly, two Farmers Research and Extension Groups (FREGs) having 18 members were established at Dugda (Bekele-Girisa kebele) and FREGs with 16 members were established at Dodola (Deneba kebele). Theoretical and practical training on improved forage production and utilization was given for FREGs, district livestock experts and development agents. Among the groups, 5 farmers who have accessible land for forage production were selected as trial farmers at each site. Land area with a size of 100m^2 was used for establishment of each forage varieties. At Bekele-Girisa site the forage varieties evaluated includes; vetch, Rhodes grass, Napier grass, alfalfa, cowpea and lablab, while at Deneba kebele different oat varieties; CI-8251, CI-8237, CI-8235, Bonabas and Bonsa were evaluated. Farmers' ranked their preferred forage type according to their selection criteria. The major selection criteria they considered when choosing their preferred forage variety type were herbage yield, seed yield, maturity period, tolerant to moisture stress, applicability in area of land shortage and resistant to disease and pests. Ranking of varieties were done on a scale of 1-5, 1 being very poor and 5 being very good. Accordingly, at Bekele-Girisa site, the result of farmers' evaluation indicated that cowpea obtained the highest total score followed by lablab and Rhodes grass. Most of the participant farmers appreciated the performances of cowpea and lablab especially with regards to herbage and seed yield, earliness for its maturity, tolerance to moisture stress and their suitability for intercropping with maize. Early maturing forage varieties were preferred by the groups since the rainy season is very short and moisture stress is one of the challenges in the area. Since farmland is very scarce in the kebele, most farmers prefer forage varieties that can be under sown with maize. At Deneba site of Dodola district, farmers selected Bonsa oat variety as the best fodder oats as compared to the other varieties. Farmers chose this oat variety mainly due to its herbage yield, seed yield, free from disease and tolerance to loaging. Bonabas variety was the second best preferred by the farmers group because of its herbage yield, its tiny stem and other parameters. Generally, the performances of the evaluated forages were differing from farmers to farmers land due to variation in management and other edaphic factors such as soil fertility. The most preferred forages should be further distributed for the groups and other farmers in the area as well. Efforts also needed in organizing farmers groups for further promotion of forage technologies, market linkage of forage seeds so that the smallholder farmers can generate additional income from sale of forage crops.

Key words: Forage varieties, FREGs, Participatory

Introduction

Livestock contributes to the livelihoods of approximately 70% of Ethiopians and accounts for 15-17% of the total national GDP and 35-49% of the agricultural GDP (Gebremariam *et al.*, 2010). Moreover, livestock provides benefits such as fuel and fertilizer from animal manure and draught power for farm production. In spite of its significant contribution, the country's livestock productivity is low. Among the constraints, lack of adequate quantity and quality of feed is a major factor for poor livestock production and productivity.

To tackle the feed shortage problem, developing different feed technologies suitable to smallholder farmers' conditions is very crucial. Improvement of the feed resource sector is also one of the priority area to achieve the objectives of the GTP II and livestock master plan (LMP) for livestock development that could contributes for poverty reduction and economic growth of the country (Shapiro *et al* 2015). One of the alternative options to improve feed resource constraints could be the cultivation and utilization of improved forage crops. Cultivated forage crops play a vital role in livestock development as they produce good quality and quantity of forages. Forage legumes enhance soil fertility, improve yield and nutritive value of crop residues, sustain feed production during the dry season, suppress weed and combat erosion (Humphrey, 1994). Beside this advantages, improved forage could generate additional income if the marketing system of forage (herbage and seed) established very well (Etsubdink, 2014, Sahlu *et al*, 2008).

Various perennials and annual improved forage crops have been identified and recommended for west Arsi and east Shoa zones (Dawit *et al.*, 2017). However, the utilization of these improved forage crops at the farmers' level are very minimal mainly due to the shortage of seed/planting materials and lack of adequate awareness. In addition, technology selection only by researchers' decision could not lead to speed their dissemination afterwards. In Ethiopia, most of the forage evaluation studies were conducted only from researcher evaluation point of view. However, few studies of forage evaluations were conducted at on-farm with farmer participation (Mekoya *et al.*, 2008, Tewodros and Meseret 2013). A participatory approach to technology development can help to ensure that new technologies are appropriate to farmers' and increase the likelihood of adoption (Conroy *et al.*, 1999; Reijntjes *et al.*, 1992). The approach has been employed to evaluate, identify and disseminate different crop varieties/genotypes on farmers field as per farmers tastes regarding various traits and their perception and aspirations about varietal specification(Ojehomon *et al.*, 2012, Yadavendra and Witcombe 2013). Different authors also emphasized that participatory variety selection is a more rapid and cost effective way of identifying farmer preferred cultivars if suitable choices of cultivars exist (Uzma *et al.*, 2015).

Hence, to promote adoption of improved forage crop technologies by the smallholder farmer's, there is a need to evaluate and select the forage varieties at on-farm condition according to the farmers perceptions and demonstrate improved forage production and utilization systems to end users. However, forage evaluation and selection were not assessed according to the farmers' selection criteria and the forage varieties were not well demonstrated for the farmers in the west Arsi and east Shoa zones. Therefore, the project was conducted to evaluate the performances of improved forage crops with farmers' participation, demonstrate improved forage crops production and utilization practices and to creat awareness for smallholder farmers on improved forage production and utilization practices

Materials and Methods

The study was conducted at two selected kebeles of Dugda and Dodola districts with the objectives to evaluate the performances of improved forage crops with farmers' participation and to demonstrate their production and utilization practices for smallholder farmers. Dugda and Dodola districts are found in east Shoa and west Arsi zones and lies at an altitude from 1500 to 2300 and 2600-3230 m a.s.l, respectively. Dodola usually have a reliable rainfall to support good crop/forage production while insufficient rainfall and recurrent drought are prevalent in Dugda district. Dugda districts have one cropping seasons.

Prior to activity establishment, discussions were made with districts livestock experts regarding on the aim of the project, feed shortage problems and possible intervention options. Then the respective kebeles were selected considering the seriousness of feed shortage problems in the area. Accordingly, two FREGs having 18 members (12 male and 6 female) and FREGs with 16 members (12 male and 4 female) were established at Dugda, Girisa kebele and Dodola, Deneba kebele, respectively. The farmers were selected based on the criteria including interest of the farmers in producing forage on his land, having land for forage production, farmers who have dairy cows and enough labour for forage production.

Theoretical and practical training on improved forage production and utilization was given for FREGs, district livestock experts and development agents at Farmers Training Centers (FTCs) of the two sites. Among the groups, 5 farmers who have accessible land were selected as trial farmers for forage production and evaluation. Land area with a size of 100m2 was used for each forage varieties. A total of 5 forage varieties were established at on-trial farmers land and FTC sites. At Bekele-Girisa site the forage varieties evaluated includes; vetch, rhodes grass, alfalfa, cowpea, lablab and napier grass while at Deneba kebele different oat varieties; CI-8251, CI-8237, CI-8235, Bonabas and Bonsa were evaluated. Seed rates for vetch, lablab and cowpea were 30 kg/ha, while 80 kg/ha were used for oat and 10 kg/ha each for both alfalfa and Rhodes gasses. Vegetative propagation (cuttings) was used for Napier grass establishment. The other agronomic practices were used for establishing the forages as per their recommendation. The trial farmers were involved in land preparation, routine management and participate in all training and forage evaluation activities. Then on-farm forage evaluation was conducted when the established forage attained 50% flowering/heading stage.

Participatory forage evaluation was conducted at the two sites involving all farmers (FREGs) on the field trials using the rating and voting exercise. Farmers' ranked their preferred forage type according to their selection criteria. Among the trial farmers, three of them which have managed very well were visited and the assessment data were taken accordingly. Before beginning of the selection process, farmers were asked to set their priority selection criteria. The major selection criteria they considered when choosing their preferred forage variety type were herbage yield, seed yield , maturity period, tolerant to moisture stress, applicability in area of land shortage and resistant to disease and pests. Ranking of varieties were done on a scale of 1-5, 1 being very poor and 5 being very good.

Data on number of farmers and stakeholders attended on training, farmers' perception and forage varieties assessment by FREGs were recorded. Farmers' selection data were analyzed using simple ranking method.

Results and discussions

Training

Theoretical and practical training on improved forage production and utilization was given for FREGs, district livestock experts and development agents at FTCs of the two sites. Accordingly, training was given for different stakeholders on topic "Improved forage production and utilization system". The total of 59 members of FREG farmers (43 male and 16 female), 7 development agents and 5 district experts were participated on training. Practical trainings were given for the FREGs and the other surrounding farmers at the spot (on-farm sites) during forage establishment and harvesting time. Farmers have raised their opinions and questions regarding on the improved forage production, utilization system, importance and advantages of each forage varieties, their agronomic practices, side effect and the likes. They were very interested to use improved forage so that to benefit the advantage of these forage crops. However, they raised the queries from where they get adequate seeds whenever they required. They are more interested to forage legumes that can be intercropped with other food crops due to cultivated land scarcity.

Forage evaluation

The forage varieties preference assessment by FREGs of Bekele-Girisa kebele is indicated in the table 1. According to farmers' evaluation cowpea forage variety had got the highest total score followed by lablab and Rhodes grass while the least score were recorded by vetch forage. Most of the participant farmers appreciated the performances of cowpea and lablab especially with regards to herbage and seed yield, earliness for its maturity, tolerance to moisture stress and their suitability for intercropping with maize. Early maturing forage varieties were also preferred by the groups since the rainy season is very short and moisture stress is one of the challenges in the area. Similarly, studies conducted by Tewodros and Meseret (2013) also indicated that the major forage species selection criteria were based on its biomass yield, tillering capacity, maturity and the like.

Since farmland is very scarce in the kebele, most farmers prefer forage varieties that can be under sown with maize. Farmers who have better land resources and also interested to Rhodes grass because of its yield and re-growth ability. According to Tewodros and Meseret (2013) the result of farmers' evaluation criteria revealed that Rhodes grass was scored the highest value, followed by desmodium while alfalfa scored the least value mainly due to their herbage yield. In contrary, some farmers in the study area who have limited land are not interested to Rhodes grass. Hence, Rhodes grass is not applicable in areas where land for forage production is very limited. On the other hand, Napier grass and Alfalfa were also chosen by those farmers with irrigation facilities. Vetch forage variety was scored the least rank by the FREGs mainly due to its low herbage yield, poor tolerance to moisture stress and its least applicability in area where availability of land for forage production is limited.

Table.1 Forage varieties preference assessment result by FREGs in Bekele-Girisa kebele of Dugda district

Farmers selection criteria	**Forage type**					
	Vetch	**Rhodes**	**Alfalfa**	**Cowpea**	**Lablab**	**Napier**
Herbage yield	2.83	3.58	2.16	3.33	3.33	2.75
Seed yield/planting material	2.83	3.41	2.50	3.91	3.50	3.83
Maturity (Earliness)	3.16	3.83	3.00	3.92	3.50	2.92
Tolerant to moisture stress	2.66	3.41	2.58	3.50	3.16	2.58
Applicability to limited land resource	2.66	2.41	2.41	3.66	3.83	2.91
Free from disease & pests	3.16	4.16	3.25	2.41	2.83	3.83
Multipurpose advantage (soil fertility improvement and the like)	3.00	2.00	4.00	4.00	4.00	2.00
utilization periods	3.00	4.00	4.00	3.00	3.00	4.00
Overall score	23.30	26.80	23.90	27.73	27.15	24.82
Average score	2.91	3.35	2.99	3.47	3.39	3.10
Rank	6	3	5	1	2	4

* Ranking of forage varieties were done on a scale of 1-5, 1 being very poor and 5 being very good

The fodder oat varieties preference assessment result by FREGs at Deneba kebele of Dodola district are presented in table 2. The major evaluation criteria considered oat variety selection were plant height, tillering ability, herbage yield, seed yield, maturity, tolerant to loadging, softness, tolerance to disease and pests. Uzma *et al.*, (2015) also indicated that the major fodder oat variety selection criteria used includes number of tillers, fodder yield, seed yield, maturity, resilience to insect pests and diseases and high moisture content. According to FREGs evaluation of this study, Bonsa variety was selected as the best fodder oats as compared to the other varieties. Farmers chose this oat variety mainly due to its herbage yield, seed yield, free from disease and tolerance to loaging. Bonabas variety was the second best preferred by the farmers group because of its herbage yield, its thinly stem and other parameters indicated in the table 2. The least ranked oat variety was CI-8237. The performance of this variety is low in most farmers' selection criteria. The maturity differences of the oats varieties are not the big concern for most of the farmers however early maturing varieties are more preferable as shortage of rain could also be happened in the area.

Table 2: Forage oat varieties preference assessment result by FREGs at Deneba kebele of Dodola

Farmers selection criteria	**Fodder oats varieties**				
	Bonsa	**CI-8237**	**Bonabas**	**CI-8235**	**CI-8251**
Plant height	4.16	3.66	5.00	3.83	4.50
Vigorousity and tillering ability	4.66	4.00	4.50	4.00	4.66
Herbage yield	3.83	3.00	4.00	3.00	3.83
Seed production	4.00	3.16	2.33	3.16	2.66
Maturity (Earliness)	3.83	3.00	2.50	3.00	2.83
Tolerance to loadging	4.33	3.16	3.00	3.16	2.66
Softness for its palatability	3.83	3.00	4.33	3.00	3.66
Disease tolerance	4.33	2.33	4.50	2.83	2.66
Overall score	**32.97**	**25.31**	**30.16**	**25.98**	**27.46**
Average score	**4.12**	**3.16**	**3.77**	**3.25**	**3.43**
Rank	**1**	**5**	**2**	**4**	**3**

* Ranking of forage varieties were done on a scale of 1-5, 1 being very poor and 5 being very good

The performance of the evaluated forages was differed from farmers' to farmers' land due to variation in management and other edephic factors such as soil fertility. Generally, at Bekele-Girisa site, most of the participant farmers do not have irrigation facilities to supplement their crop/ forage during the dry periods hence, they prefers forage varieties which can be produced with limited rainfall. But those farmers who have irrigation are showing interest to establish such perennial forage especially Napier grass for its perenniality and ease of establishment at the marginal lands, boarders of their farms and at the backyard system. Similarly, at Deneba site, the farmers were very happy to have these fodder oats varieties in their area and requesting for the seed to establish on their farm as other food crops.

Conclusions and Recommendations

The activity has significant role in forage variety technology adaptation, demonstration and promotion in short time than conventional approach. The FREGs had the opportunity to be familiar with different forage types, their production and utilization practices. According to FREGs of Bekele-Girisa site, cowpea had get the highest rank followed by lablab mainly due to their yield and suitability for intercropping with maize while at Deneba site, oat variety known as " Bonsa" was chosen as the best fodder oat among the tested oat varieties mainly because of its potential for herbage and seed yield. These selected forage types which are best adapted and suitable to the area should be further distributed for the groups and other farmers in the area as well. Efforts also needed in organizing farmers groups for further promotion of forage technologies, market linkage of forage seeds so that the small holder can generate additional income from sale of forage crops. Other stakeholders involving in livestock development should also be involved in promotion, multiplication and distribution of forage varieties for interested farmers as well.

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Pre-extension and Demonstration of Improved Lablab purporeous Technology in Selected AGP-II Districts of West Shewa and East Wollega Zones of Oromia, Ethiopia

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Abstract

*Demonstration of Lablab purporeous varieties was conducted in four AGP II districts; Boneya Boshe, Wayu Tuka and Diga from East Wollega and Bako Tibe from West Shewa zones to evaluate, demonstrate and popularize with active participation of farmers' through FREG approaches. 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, ownership of suitable land, willingness and ability to perform cultural practices as per recommendation and gender equality. One farmers' research group (FREG) comprising of 16 farmers was established in each PAs of which four are trial farmers and the rest are participant farmers. Training was given for farmers, DAs and experts. After training, two recently released Lablab purporeous varieties; Gebis-17 and Beresa-55 were planted on 20 m * 10 m adjacent plots. Farmers' participatory evaluation was conducted in all the study sites. Accordingly, data generated from demonstration plots showed that, on average, Gebisa-17 variety had performed better giving herbage Dry Matter yield of 11.86 ton ha^{-1} followed by Beresa-55 which gave 9.32 ton ha$^{-1.}$ However, in terms of seed yield, Beresa-55 variety had performed better (22.44 Qt ha^{-1}) compared to Gebisa-17 which gave19.84 Qt ha^{-1}. Therefore, further scaling up/out of the two improved Dolichos lablab varieties in the study areas and other places with similar agro-ecologies in collaboration with other stakeholders is quite important.*

Keywords: Farmers' research group, Herbage dry matter, Lablab purporeous

Introduction

Dolichos lablab *(Lablab purpureus (*LP*)* is an herbaceous, climbing, warm-season annual or short-lived perennial fodder legume with a vigorous taproot which 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 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), and can able 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 to 86°F. In fact, it can grow at 37°F for short period and can tolerate light frosts. *Lablab purpureus* better adapted to cold compared to other warm-season forages such as velvet bean (*Mucuna pruriens)* or cowpea (Cook *et al*., 2005).

Lablab purpureus is used as commercial crop, animal feed and as cover crop/green manure. Maass *et al*. (2010) observed that LP 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 simultaneously planted intercrop (Abubeker *et al*., 2003). The leaf has crude protein of about 21 to 38 % and seed contains about 20 to 28 % (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 were used agro-industrial by-products such as different oil seed cakes and brans from edible oil and flour processing industries to supplements 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. Dolichos lablab genotype selection activities have been conducted at Bako agricultural research center and similar agro-ecologies of western Oromia. As a result, two varieties of LP were released and officially registered. However, demonstration and popularization of these varieties were not conducted at on farmer level. 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 areas; Boneya Boshe, Wayu Tuka, Diga and Bako Tibe districts are dominated by midland with altitude ranges between 1500-1800 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, filed pea, banana, mango, papayae.tc. Important livestock species abundantly reared in the districts include; cattle, shoat, equines and chickens.

Site 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 group (FREG) comprising of 16 farmers was established in each PA. In each FREGs, 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, vicinity 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.

Field design and management

Two Dolichose lablab varieties; Gebis-17 and Beresa-55 which are recently released varieties were planted on 20 m * 10 m adjacent plots. The treatments were replicated on 16 different hosting farmer plots. All agronomic managements were equally done for all the plots.

Training and experience sharing

Theoretical training was given for farmers, DAs, and experts by researchers drawn from Bako Agricultural Research Center regarding production, management and forage utilization as well as issues like economic and nutritive importance, suitable ecologies and weather condition for forage production. Experience sharing program (field day) was arranged to supplement the theoretical training.

Participatory evaluation of the varieties

Farmers' participatory evaluation was conducted across the study sites. Both technical groups and farmers were evaluated the varieties based on their own preferences and preset criteria. The demonstrated varieties were ranked against the criteria by participant farmers through discussion across districts.

Results and Discussions

Training of farmers and other stockholders

Prior to implementing the activity, training was given to farmers, district experts and DAs to improve their knowledge and skills on improved forage production in general and Dolichos lablab in particular. Accordingly, a total of 70 farmers (50 male and 20 female), 6 experts, 3 supervisors and 11 DAs were trained (Table 1). Of the total trainees, 73.3 % were male and the rest 26.7 % were females.

Table 1. Training given to farmers and extension workers in 2017

Districts	Participants											
	Farmers			Experts			Supervisors			Das		
	M	F	T	M	F	T	M	F	T	M	F	T
Bako Tibe	10	5	15	1	-	1	1	-	1	2	1	3
Boneya Boshe	13	4	17	2	-	2	1	-	1	2	-	2
Wayu Tuka	12	5	17	1	-	1	1	-	1	1	2	3
Diga	15	6	21	2	-	2	-	-	-	2	1	3
Total	50	20	70	6	-	6	3	-	3	7	4	11

Note: M=Male F=Female, T= Total

Farmers' varieties evaluation and selection

Technical groups (Researchers, Experts and DA's) and farmers were evaluated the varieties based on jointly set criteria. Accordingly, Gebisa-17 was ranked first for its better herbage dry matter yield while Beresa-55 was ranked the same for relatively better seed yield (Table 2).

Finally, the participant farmers selected both varieties; Gebis-17 and Beresa-55 for their special attributes.

Table 2: Participatory Evaluation of *Lablab purporeous* varieties in the study areas

No	Evaluation criteria	Variety ranks					
		Diga		Boneya Boshe		Wayu Tuka	
		Gebis-17	Beresa-55	Gebis-17	Beresa-55	Gebis-17	Beresa-55
1	Growth habit (fast or slow)	1st	2nd	1st	2nd	1st	2nd
2	Early reach at 50% blooming stage	2nd	1st	2nd	1st	2nd	1st
3	Biomass (plot cover)	1st	2nd	1st	2nd	1st	2nd
4	Plant height	1st	2nd	1st	2nd	2nd	1st
5	Leaf greenness	1st	2nd	1st	2nd	1st	2nd
6	Leafiness	1st	2nd	1st	2nd	1st	2nd
7	Disease/pests	1st	2nd	1st	2nd	2nd	1st
8	Pod per plant	2nd	1st	1st	2nd	1st	2nd
9	Seed per pod	1st	2nd	2nd	1st	2nd	1st

Herbage yield performance of the varieties

Herbage dry matter and seed yields of the varieties were measured for all demonstration plots in all the study districts. Accordingly, the average herbage dry matter yield of Gebisa-17 variety was found to be 11.86 ton ha^{-1} while that of Beresa-55 was 9.32 ton ha$^{-1.}$ In terms of seed yield performance, Beresa variety gave higher seed yield (22.44 Qt ha^{-1}) as compared to Gebisa-17 which gave 19.84 Qt ha^{-1}.

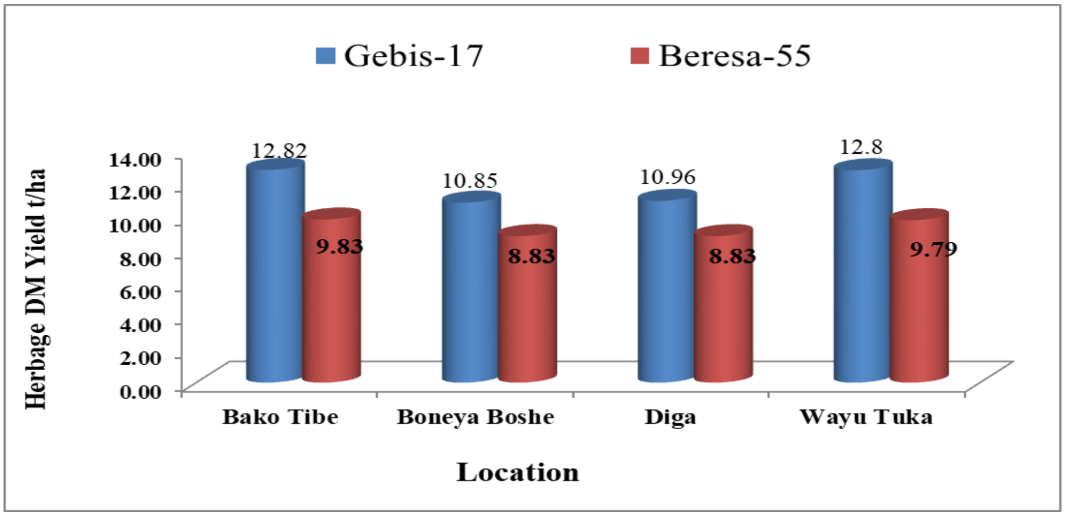

Figure 1: On farm herbage dry matte (DM) yield performance of the varieties

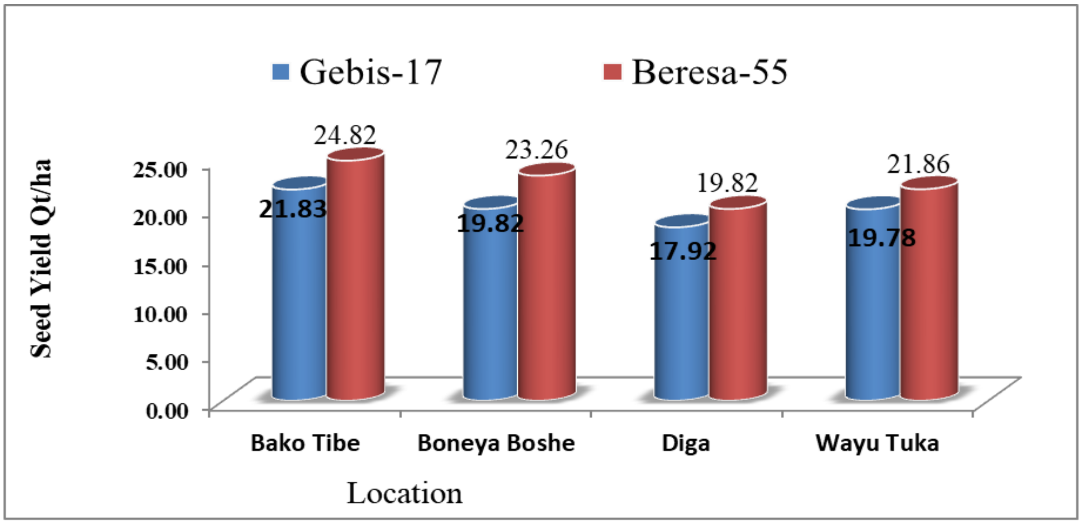

Figure 2: On farm seed yield performance of the varieties

Conclusions and Recommendations

The demonstration activity was conducted in four AGP II districts with the participation of FREG groups during 2017. The improved Lablab varieties, 'Gebis-17 and Beresa-55' were used for demonstration. The on-farm demonstration and evaluation result showed that both varieties were found to be good in terms of biomass and grain yield, adaptability and also preferred by farmers at all locations. Based on their selection criteria, farmers preferred Gebis-17 for herbage DM yield and Beresa-55 for grain yields. Generally the participant farmers appreciated the performances of the varieties and showed willingness to produce in wide-scale. The participant farmers also had better knowledge and skill of forage production. Therefore, further scaling up/out of the two improved Dolichos lablab varieties in the study areas and other places with similar agro-ecologies in collaboration with other stakeholders quite important.

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Demonstration of Concentrate Based Goat Fattening Technologies at Lume and Dugda Districts of East Shawa Zone

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Abstract

Demonstration of concentrate based Goat fattening technologies was carried out at Lume and Dugda districts of East Show Zone in 2017/18 with the objectives to demonstrate and compare effects of supplementation of wheat bran mixed with noug cake, or Cotton seed cake mixed with wheat bran at different proportion and to introduce and transfer those promising goat fattening technologies to smallholder farmers. Farmers were selected purposely based on their traditional goat and cattle fattening practice and organized in FREG. Two AGP kebeles per district were selected based on numbers of goat flock and their interest on goat or cattle fattening. A total of six FREG group (three per districts) consisting of 15 members of farmers considering gender were established. Trainings were given to the FREG member farmers on concept of concentrate based cattle and small ruminant fattening and how to utilize locally available animal feed resources. Nine members of FREG farmers contributes two yearling male goat while the lead farmers contribute three up to four goats to be fattened at one specific site, so that about 60 goats were fattened per district. Supplements consisted of 50% wheat bran, 49% noug seed cake and 1% mineral supplement (Ration 1) fed to the animals at five sites and supplement with 65% wheat bran and 35% cotton seed cake (Ration 2) was fed at one site. The supplements were offered at 2.5% of live body weight based on the nutrient requirement of animals. The supplemental feed was given to the animals half in the morning and half in the afternoon after eight hour grazing in the day time. The result of the study revealed that initial body weights were 16.79gm and 16.23gm while final body weight were 22.69gm (SE=0. 42) and 23.21gm (SE= 0.40) and average daily weight gain were 98 and 116 gm with (SE= 8.0). IBW was similar among the rations at all FREG groups in all the six sites in both districts while FBW was grater for Ration 2 (P<0.05) at final experimental days. The difference between return from animal sale and supplement cost were 403.2 and 569.7 birr per animal for ration 1 and ration 2, respectively. In conclusion, based on average daily gain and the greater concentration of metabolizable energy in cotton seed vs. noug cake, energy appeared relatively more limiting to performance than protein. Supplementation of goats with available byproduct feed stuffs offers a means of achieving marketable body weight and profit with suboptimal grazing conditions.

Key words: Concentrate, demonstration, goat fattening, wheat bran

Introduction

In rural areas of many countries such as Ethiopia, small ruminants are often not supplemented with concentrate feed stuffs, resulting in slow growth and relatively old age at market. This causes a large proportion of consumed nutrients to be used for maintenance rather than growth, with an associated low efficiency of production. There are many reasons why such management practices to achieve fast growth at young ages are not employed, among which is the cost of supplemental feed stuffs. However, in some cases farmers simply may not be aware of the potential benefits of preferred technologies, which could be adopted if first demonstrated at on-farm. There is also technical and financial limitation to use available feeding technologies to maximize gains from fattening enterprises. To address the underlying problems many demand driven research activities has been conducted to generate and disseminate promising goat fattening technologies for smallholder farmers. The goats fattening technology that has been generated at Adami Tulu Agricultural Research Center by using different feeding rations indicated that the goats had gained, 80gm, 118gm, 100gm and 134grams per day (Mieso G., *etal* 2004, 2007, and 2008) which bring them to market weight as early as possible. Byproducts are most common supplemental feed stuffs for small ruminants in rural areas of Ethiopia and in other developing countries of the world as well. One such byproduct in Ethiopia is noug (*Guizotia abyssinica*) cake. Noug cake has a moderate crude protein (CP) concentration. Another byproduct in Ethiopia and more widely available around the world is Cotton seed meal. Cotton seed meal is also moderate in CP and higher concentration of metabolizable energy compared to Noug seed cake. Oilseed meals high or moderate in CP are typically mixed with other byproducts lower in CP such as wheat bran.

Ideally on-farm research to study and demonstrate attributes of supplementation includes a negative control treatment, entailing animals not receiving a supplement. However, this is difficult to achieve under practical conditions, as farmers may not be willing to participate without the incentive of free supplement. Thus, frequently an approach taken is to include one or more types of supplements with different ingredient composition, with at least one treatment being considered a ‘standard’ for comparison. In addition to economic comparisons, based on characteristics of different supplement ingredients it may be possible to ascertain the nutritional condition most limiting to animal performance. In this regard, the experiment was initiated with the objectives to demonstrate and compare effects of supplementation of wheat bran mixed with noug cake, or Cotton seed cake mixed with wheat bran with different proportion and introduce and transfer those promising goat fattening technologies to smallholder farmers in the study areas.

Materials and methods

Sites and animals selection

The experiment was conducted from January to march of 2018, during the dry season, in six villages of the Lume and Dudga (three per districts) located 80 to 150 km east south of Addis Ababa. A total of six Farmers Research Extension Groups (FREGs) were formed in each village. Initially there were seven villages and FREG, but one was excluded because of animal sale before the experiment was completed. FREG consisted of fifteen farm households, nine contributing two animals to the experiment and one providing three or four. Farm households were selected based on animals available and interest and willingness to participate as directed. Farmers were trained in the necessary activities before the experiment, along with frequent visits and continual monitoring by researchers during the experiment.

One lead farm in each FREG was selected for construction of a simple barn. Because of additional involvement of these lead farmers, they were allowed to contribute three or four animals rather than two. Feeding pen or simple bans with 3 meters by 6 meters were constructed from locally available materials at each lead farmer to accommodate 20 to 22 yearling (based on dentition) intact male Arsi- Bale goats.

Supplements

Supplement feeds consisted of 50% wheat bran, 49% noug seed cake and 1% mineral (salt) supplement (Ration 1) at five FREG farmer sites and 65% wheat bran and 35% cotton seed cake 1% mineral supplement (Ration 2) at one FREG farmer site were used for this experiment. After approximately 8 hrs grazing at nearby pastures with alternating management by the different households of the FREG farmers during the day time goats were supplemented with feeding ration in the evening and morning.

The tropical feeding standard information indicates that for feed stuff samples in Ethiopia lists concentrations (dry matter basis) of CP of 32, 28, and 13% and total digestible nutrient (TDN) of 77, 75 and 67 % for noug seed cake, cotton seed cake, and wheat brans, respectively. Thus, predicted concentrations (DM basis) in ration 1 and ration 2, were 22.18% CP and 9.08 MJ/kg ME and 18.3 % CP and 10.55 MJ/kg ME. The feeding rate was 2.5% of the most recent body weight (BW) determination. Supplements were completely consumed throughout the experiment. The experiment lasted for 60 days, preceded by a 15-day adaptation period. Animals were weighed periodically, with periods 15, 20 and 25 days in length.

Statistical analysis and economic evaluation

Data were statistically analyzed with GLM procedures of SAS (1990). The model consisted of Ration, FREG x FREG, and farmer (FREG). Ration x FREG was used to test significance of Ration. Initial BW was used as a covariate for analysis of BW and average daily gain (ADG). Means were separated by least significant difference when the overall treatment F value was significant ($P < 0.05$). This experiment was conducted considering when the farmers maximize his net profit so that an economic evaluation was conducted. This was based on feed stuff prices of 5.0, 6.5, 7.5 and 4 birr /kg for wheat bran, cotton seed, Noug seed cake and salt, respectively. At the end of the experiment animals in the Lume district were sold to the Modjo Modern Export Abattoir. While the animals at Dugda district were sold at local markets considering one of the big Ethiopian festivals. An economic evaluation was done based on the assumption of previous finding in the center for the same breed. The dressing percentage for Arsi- Bale goat breed was found to be 52% and price of goat meat assumed to be 250Br/kg.

Results and discussions

Body weight and average daily gain

IBW was similar among the rations at all FREG groups in all the six sites in both districts while FBW was greater for Ration 2 ($P<0.05$; table 1) at final experimental days. In accordance, average daily gain was higher for ration 2. Average daily gain in this experiment was relatively similar compared with previous findings of supplementation studies with similar animals ((Mieso G., *etal* 2004, 2007, 2008). Reasons for higher ADG of goats supplemented with ration 2 cannot be conclusively discerned from measures of this experiment, however, the higher ME concentration in cotton seed cake than noug seed cake suggests that energy was most limiting to performance rather than protein.

Table 1: Effects of different concentrate supplements on body weight and average daily gain of yearling male Arsi-Bale goats in the Lume and Dugda districts of Ethiopia.

Feeding Ration[1]

Item	Ration 1	Ration 2	?????	SE
Body weight, kg				
Day 0	16.79[a]	16. 23[a]		0.42
Day 60	22.69[a]	23. 21[ab]		0.40
TWG(kg)	5.9	6.98		
Average daily gain, g				
Day 1- 60	98[a]	116[b]		8.0

[1] Ration, Ration 2 = supplement offered at 2.5% body weight, consisting of 50% wheat bran, 1% salt, and 49% noug seed cake and 65% wheat bran and 35% cotton seed cake and 1% salt.

[a,b] Means in a row without a common superscript letter differ ($P < 0.05$).

Economic evaluation

As noted earlier, without a negative control treatment it is not possible to definitively evaluate economic returns from supplementation. Although from anecdotal evidence and BW and the appearance of other animals of the villages of the same age, BW suitable for market could not have been achieved without supplementation. Based on change in BW and supplement cost, all supplements were profitable (Table 2). However, greater profit was achieved from ration 2.

Table 2: Effects of different concentrate supplements on costs and returns with yearling male Arsi-Bale goats in the Lume and Dugda districts of Ethiopia.

Item[2]	**Ration 1**	**Ration 2**
Total supplement intake, kg/animal	29.25	29.25
Total body weight gain, kg/animal	5.9	6.98
Total carcass gain, kg/animal	3.01	3. 6
Gross return, ETB/animal	752.5	900
Cost, ETB/animal		
Wheat bran	73.1	95.1
Noug cake or Cotton seed cake	107.5	66.5
Salt	1.2	1.2
Labor cost	157.5	157.5
Health treatment	10	10
Total	349.3	330.3
Profit, ETB	**403.2**	**569.7**

Conclusions and Recomendations

A supplement of 65% wheat bran, 1% salt, and 35% cotton seed cake meal given at 2.5% BW resulted in greater ADG by intact male Arsi-Bale goats in the Lume and Dugda districts of East show zone than supplements with 50% wheat bran, 49% noug cake and 1% salt. Energy absorption appeared relatively more limiting to performance of goats than protein during grazing in the dry season of rangeland with deteriorated vegetation conditions in the districts. Supplementation with available byproduct feed stuffs and eight hours grazing is a means for farmers to achieve marketable BW of goats and profit with poor grazing conditions for grazing.

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Pre-extension Demonstration of Fish-Poultry-Horticulture Integration Farming System in Dugda and Yaya Gulele Woreda

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Abstract

Fish-poultry-horticulture integrated farming system is a method of diversified food production to combat nutritional insecurity at small scale farmers' level under low cost and new to Ethiopia. Demonstration of the integrated farm was conducted at two different districts, Yaya Gulele, a high land at altitude of 2,650 m.a.s.l, and Dugda, lowland within central rift valley at altitude of 1650m.a.s.l. The experiment was conducted in 2016/17 & 2017/18 with the objective of evaluating, and demonstrating this integration technology. In each selected sites of the districts, one FRG having 12 member farmers considering gender participation was established. Earthen fish pond of 81 m^2 at Yaya Gulele (Nono Chemeri) and 71 m^2 at Dugda (Girisa) were prepared and stocked with three fish species, Nile tilapia, common carp and African catfish. Simultaneously rearing poultry and horticulture farms were conducted as components of the integration. Thirty and 26 Egg producing Lohmman brown type pullets were used in the integration at Yaya Gulele and Dugda districts, respectively to produce egg and fertilize fish pond and then vegetable farm. Large disparity was observed in yield of all the products. Fish Daily Growth Rate (DGR/g) was 0.16 and 0.68 for Nile tilapia 0.28 and 0.65 for common carp and 0.60 and 0.60 for African catfish at Yaya Gulele and Dugda, respectively. Peak egg production in poultry were March at Yaya Gulele (82.4% of the chicken lay egg daily) and in July at Dugida (84.5%). Training on the importance of integrated fish-poultry-horticulture farming and its management was given to farmers and subject matter specialists of the districts before and after establishing the integrated farms at both sites. All products were evaluated and demonstrated. Knowledge and skill was obtained from this integrated farming systems in that different agro-ecologies where temperature fluctuation played great role on fish growth performance, poultry egg production and horticulture production. The fish-poultry-horticulture integrated farming system technology practices were equally applied on both sites. The technology is, therefore, recommended to both locations & areas with similar agro-ecologies.

Key Words: demonstration, Fish, horticulture, integration poultry, pre-extension demonstration

Introduction

Aquaculture is a part of agriculture which is rearing aquatic organisms, plants and animals including fish under controlled condition. Fish culture can be integrated with livestock and agronomy, especially vegetables using as one waste input for the other and enable to produce organic production. To alleviate animal source protein problem in the country, fish culture is essential to support terrestrial animal protein sources obtains from cattle, sheep, goat and poultry. Aquaculture can create job opportunity, generate income, and ensure food security and contributing to national/regional economy.

Fish culture began in recent time in Ethiopia. Research conducted shows that farmers in Oromia region practiced extensive fish farming in small ponds using Nile tilapia since 2008 (DabaTugie, 2010). Pond management with poultry, fish and vegetables was proofed to be excellent approach for sustainable production, income generation and employment opportunity of the resource poor rural households (Alam *et al.,* 2009). Addition of organic fertilizers like poultry droppings to a fish pond increases fish production (Enamul Hoq *et al.*, 1999: Abbas *et al.,* 2004). The problem of fish feed faced in aquaculture development can be resolved by integrating fish farm with poultry.

In the integrated farming of fish-poultry-vegetable, waste from one component is used as input for the next component. In this case, waste from poultry is used to fertilize fish pond substituting feed supplement for the fish, and nutrient rich water from fish pond is used to irrigate the Vegetable/horticulture crop during the water exchange for fish, substituting fertilizer use in crops. This technique recycles waste for food production and saves environment from pollution. Provided the advantages of the integrated livestock-fish culture, this experiment was required to find a better approach of fish pond culture that can be practiced among farmers as a strategy for poverty reduction, ensuring nutritional security, creating job opportunity and diversifying income. This farming system helps to boost sustainable production and enable farmers producing nutrient rich production on small scale farm, diversifying their products, minimizing their input cost and increasing production per unit area and enhances agriculture production. Therefore, the aim of this study was to evaluate the fish growth performance under poultry pond and vegetables production using waste from fish pond and demonstrate the integrated farming system to the farming community.

Materials and methods

Descriptions of the study area

This research was conducted in two zones of Oromia region, Yaya Gulele district of North Shoa zone, 120 km from Addis Ababa, in north direction and Dugida district of East Shoa zone, 130 km from Addis in south direction on the way to Hawassa. The two districts are located in different agro-ecologies; the farm in Yaya Gulele was established at a village called Nono Chemeri which is situated in highland agro-ecology at an altitude of 2650 m.a.s.l whereas the farm in Dugda district was situated at Girisa village in mid rift valley with an altitude of 1650 m.a.s.l.

Inhabitants of the districts are practicing mixed-agriculture, rearing cattle, sheep and goats where this animal rearing activity became challenging due to scarcity of grazing land. Ethiopia, including Oromia region is a large country with more than hundred million populations where food insecurity had been chronic with 44% of the population undernourished, 47% of children under five are underweight, and 52% stunted (Haan *et al.*, 2006). Yaya Gulele district is categorized in three agro-ecology zones, the highland 27.5%, mid -altitude 41.17% and low land 31.78% with the population of 66,336 (male 35,829 and female 30507). According to information from the agricultural office of the district, the district's average annual rainfall is 800-1000 mm and average temperature 16-20^{o}C. Major livestock in the district are cattle, sheep and poultry while from large crop diversity produced in the district, the majors are *teff*, wheat and beans.

Site selection for the technology

The two districts Yaya Gulale and the Dugda were purposely selected from the AGP beneficiary districts. The experimental sites in (Kabales within the respective districts were selected based on criteria of water resources availability and accessibility to culture fish in pond. As the farm is integrated, land availability and suitability for horticulture and poultry farming was also considered. After these criteria were fulfilled, host harmers' interest to receive the technology and manage the farm was assessed. Besides the host farmers' interest and land suitability, gender and age of the recipient farmers was also considered as criteria.

FRG members' selection

Selection of FRG members was based on farmers' who have interest and irrigation access to implement the activity in their own lands. In each of the selected AGP-II districts, one Farmers Research Group (FRG) with 12 member farmers considering gender balance, were established. Selection of member farmers was conducted by multidisciplinary team including experts from districts' livestock and fishery office, DAs, Kebele representatives. These FRG members were trained and followed each of the production and management activities of the integrated fish-poultry-horticulture farming activities at the host farmers' site.

Fish pond construction and fish production

Fish pond constructions were carried out after training of the target groups/ FRG members and stakeholders (concerned livestock office staffs, DAs and Kebele chair persons). At Yaya Gulele, earthen pond of 81 m^2 surface area with 1 m depth was prepared in participatory approach by involving the farmers. The pond was stocked with 105 Nile tilapia, 140 common carp and 33 African catfish, totally 363 fingerlings poly-cultured in one pond at stocking density of 4.5fish/m^2. Sizes of the stocked fingerlings were 5.6 cm total length (TL) and 3.2 g weight (TW) for Nile tilapia, 6.6 cm TL and 33g TW for common carp and 9.4 cm TL and 15.6 g TW for African catfish. The fish was grown in pond under integration for a year and used for home consumption, subsistence use. Similarly, in Dugda, earthen pond of 71 m^2 surface area with 1 m depth was prepared in participatory way. The pond was stocked with 86 Nile tilapia, 98 common carp and 30 African catfish, totally 214 fingerlings at stocking density of 3fish/m^2. The fish were grown in the pond under integration for a year and used for income generation.

Poultry house construction and production

Poultry house within the integrated farming in both districts were constructed from locally available materials after fish ponds were constructed. Walls of the house was built from eucalypts wood and plastered by mud at Yaya Gulele while it was built from mud bricks at Dugda. Roof of the poultry house was covered by iron sheet at both sites. The poultry house had two compartments, with the first half 1.5 m X 4 m lying on ground and used for a night time resting place for the chicken and also used as a place to lay egg. The second half of the house with area 1.5 m X 4 m was open to air and light, hanging over part of the fish pond and used as feeding and drinking place for the chicken during day time. This part of the house lying over the pond was covered by mesh wire to protect chickens from predator birds, cats and others predators. Thus, after the house was constructed, 30 and 26 pullets of 3 months age were purchased and stocked to the poultry houses at Yaya Gulele and Dugda districts, respectively. The chicken were fed adlib by commercial poultry feed purchased from animal feed processing company at Bishoftu. The chicken started laying eggs at the age of 5 months. The egg was collected every day and stored for sell.

Vegetable production

Horticulture production activities were carried out simultaneously with fish and poultry rearing. At Yaya Gulele/Nono Chemeri, Tomato (*Lycopersicon esculentum*) Galila variety, Adama Red Onion (*Allium cepa*), Gurage Cabbage *(Brassica oleracea)* and Carrot were cultivated on plot of 497 m^2 total area. While on Dugida/Girisa Tomato (*Lycopersicon esculentum*) Galila variety, Adama Red Onion (*Allium cepa*) and Gurage Cabbage *(Brassica oleracea)* was cultivated on plot of 344 m^2total area.. The vegetables were grown by water coming out of the fish pond. Management of the horticulture was done according to their agronomic recommendation during the experimental period. Finally, the horticulture products were harvested and soled.

Trainings on management of the integrated farm

First training on FRG group organization and Fish-horticulture-poultry Integration farming system was given for 24 FRG farmers (19 males and 5 females) and 10 (male) SMS from zonal and district. The second training was by the combination of theoretical and practical activity demonstration given for 91 farmers (74 M and 17 F) and 109 SMS (90 M and 19 F). Totally 200 (164M and 36F) participants attended the training.

Data analysis

Fish growth performance was expressed in terms of daily growth rate (DGR) using length and weight data taken monthly during the experimental period. The fish growth performances are presented in graphs and tables to compare the results at the two sites. Poultry and horticulture production data of the two sites were recorded from the plot and extrapolated to standard units of expression.

Fish Daily Growth Rate was calculated using the following formula

$$\text{Daily Growth Rate(DGRg/day)} = \frac{Final\ weight(g) - \text{Initial weight(g)}}{Experimental\ days}$$

Results and Discussions

Training

After FRG members were selected, training has two major components the importance of FRG group organization and management of Fish-horticulture-Poultry Integration Farming system was given for 24 FRG farmers (19 males and 5 females) and for10 male Subject Matter Specialist (SMS) invited from zonal and district governmental offices. The second training has the components of theoretical and practical activity demonstration given for 91farmers (74 M and 17 F) and 109 SMS (90 M and 19 F) totally 200 (164M and 36F) participants attended. The farmers and the stakeholders have got knowledge on the importance of the fish-poultry-horticulture integrated farming. At the practical training on production system, the farmers have got knowledge on fish pond management, fish harvesting, fish dish preparation and eating practices. The FRG members and also other local farmers have learnt the indoors poultry management fed commercial feed to produce better egg production. They also learned horticulture production by irrigating the field with water coming from fish pond under poultry house substituting inorganic fertilizer application.

Fish Production

The cultured fish species, Nile tilapia, common carp and African catfish which used as poly-culture for pre-extension demonstration in different agro-ecologies high land of Yaya Gulele and Dugida district located in mid rift Valley in both where mixed agriculture(crop and livestock) practiced. These warm water fish species growths influenced by warm temperature. Nile tilapia, Common carp and Catfish attained in 300 rearing days an average weight at Yaya Gulele and Dugida were 108.30 and 183; 88.93 and 224.61 and 152.25 and 205.80 g, respectively.

Table 1: Summary of fish data in the fish-horticulture-poultry integration farm

Description	**Yaya Gulele site/Nono Chemeri**			**Dugida/Girisa site**		
	Nile tilapia	**Common carp**	**Catfish**	**Nile tilapia**	**Common carp**	**Catfish**
Altitude m.a.s.l.	2,650			1,650		
Rearing period/ days	300			300		
Initial average fish seed weight (g)	3.20	7.19	15.60	3.20	7.19	15.60
Final fish weight (g)	108.30	88.93	152.25	183.00	224.61	205.80
Final weight range(g)	57.6-168.34	65-120.5	125.30	48-292.02	157.42-374	132-262
Fish Daily Growth Rate(g) (DGR (g)	0.35	0.28	0.60	0.68	0.65	0.59

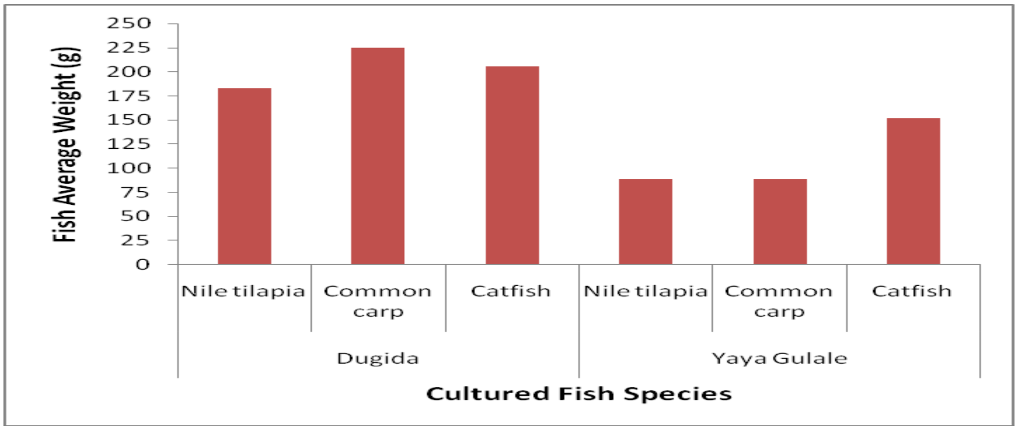

Fig 2: Growth performance of Nile tilapia in the integrated pond during the culture period.

Where similar experiment, integration farming system conducted in east Wallaga zone, Wayou Tuka district mid high land with an altitude of 1910 m.a.s.l. where fish growth performance was obtained better compared with this experiment DGR/g Nile tilapia 0.65, Common carp 4.01 and Catfish 3.25 g.

Egg Production

After poultry house was constructed for Yaya Gulele and Dugida districts activity 30 and 26 pullets of 3 months age were purchased and stocked, respectively. The stocked chickens started laying eggs at the age of 5 months. By feeding commercial poultry feed, in average a hen in Yaya Gulele and Dugida districts laid 18 and 20 eggs per month, respectively. The production fluctuation occurred in this experiment was not appeared in earlier research documents, (Lama Abara 2017, Daba, *et. al.*, 2017). The egg production in both sites in November and December 2017 were declined due to lack of commercial feed.

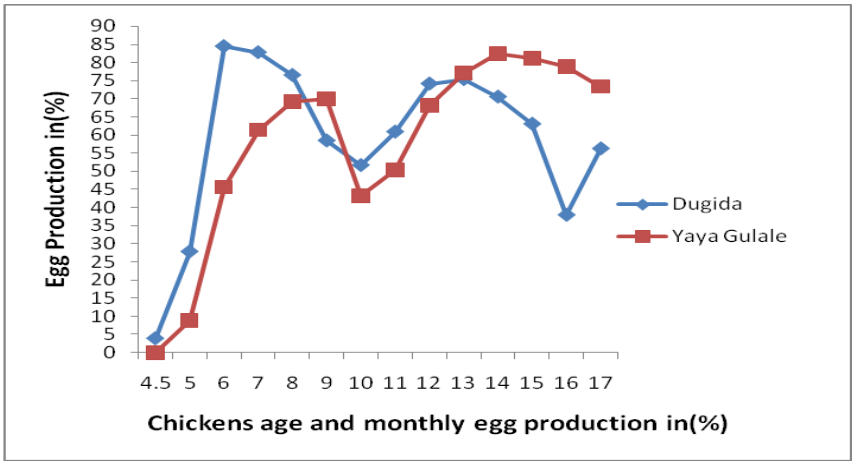

Figure 3: Egg production per chicken over time at Yaya Gulele and Dugda

Egg production was decreased in Nono Chemeri in cool season and raised in warm season from January 2018. The egg production was almost similar comparing with earlier work (Lama Abara, 2017).

Horticulture production

Horticulture production activities were carried out simultaneously with fish and poultry rearing. At Yaya Gulele/Nono Chemeri, Tomato(*Lycopersicon esculentum*) Galila variety, Adama Red Onion (*Allium cepa*), Gurage Cabbage*(Brassica oleracea)* and Carrote were cultivated total on 497m^2 area plot while on Dugida/Girisa Tomato(*Lycopersicon esculentum*) Galila variety, Adama Red Onion (*Allium cepa*) and Gurage Cabbage*(Brassica oleracea)* was cultivated total on 344 m^2 plot. The horticulture production were estimated in the experimental plots and extrapolated to hectare's production (table 2).

Table 2: Horticulture production

Location	Type of Vegetable	Plot area(m^2)	Yield Kg/m^2	Estimated yield kg	Sale in Eth.birr	Estimated yield Kg/ha	Sale in Eth.birr
Dugida/ Girisa	Tomato	80	1	80	1200	10000	70000
	Onion	92	3	276	1370	30000	148800
	Gurage cabbage	172	0.40	60	680	3488.4	39535
	Total	344			*2630*		*258335*
Yaya Gulele/ Nono Chemeri	Tomato	252	2	500	1200	20000	48000
	Onion	119	0.42	50	237.50	4200	19950
	Gurage cabbage	72	0.44	32	320	4400	19580
	Carrot	54	4.82	260	1300	48200	192800
	Total	497			*3057.50*		*280330*

Partial budget analysis

The products from the integrated farms were sold to market and also consumed at home by the family members. The consumed products were also estimated in terms of money to estimate the profitability of the farms as a source of income. Production cost and revenue generated from the products were presented below in table (table 3).

Table 3: Summary of partial budget analysis of fish, egg and horticulture production

Fish					
Production cost (in birr)	Dugda	Yaya Gulele	Revenue generated from Fish (in birr)	Dugda	Yaya Gulele
Fingerling purchase (variable)	107	181.50	Fish selling (27.35 birr/kg x 42.88Kg at Dugda	1172.75	25kg x 35br = 875.00
Estimated labor cost	150	150	Profit (revenue-cost)	141.25	(156.5)
Fishing net depreciation	300	300			
Pond depreciation cost	400	400			
Total cost in fish component	950	1031.50			
Poultry					
Cost	Dugda	Yaya Gulele	Revenue	Dugda	Yaya Gul.ale
Pullets purchasing	2600	3000	revenue from egg production	17,749	19,774.25
Poultry feed purchase	13,220	13,220	Estimated value of poultry at the end of the trial(Cull out hen)	2300	2800
Poultry feeders & equipment	300	300	Estimated value of equipments	200	200
Estimated labor cost	1650	1650	Total revenue from poultry	20249.0	22774.25
Poultry house depreciation	800	700	Total profit in poultry	3339.0	3604.25
Total cost in poultry	18,570	18,870			
Vegetable					
Production cost	Amount (Eth.birr)		Revenue generated	Amount (Eth.birr)	
	Dugda	Yaya Gulele		Dugda	Yaya Gulele
Estimated cost for land preparation, weeding, etc	300	300	Selling of horticulture production	3250	3057.50
Purchase of onion seedling	250	250	Profit in vegetable	2,550.0	2,357.5
Purchase of pesticide	150	150	Total profit in the system	6,030.45	6,118.25
Total cost	700	700			

At the experimental plot sample level, the profit obtained at Dugda, the lowland was 6,030.45 birr while that of Yaya Gulale, the highland was 2,201.0 birr. When this production is extrapolated to a ha of tilapia pond which is about 125 fold of the current experimental ponds, the profit becomes at a level of 750,000 birr at Dugda, in the lowland and 275,000 birr at Yaya Gulele, in the highland. Moreover, the products are diversified and gear towards nutritional security at subsistence farmers' level.

Conclusions and recommendations

Generally, production of the integrated fish-horticulture-poultry farming system was valuable, so it contributes for further sustainable development to mitigate food insecurity in the region as well as in the country. The yield and production of egg and fish in the integrated farm were affected by temperature, during demonstration and evaluation of the technology on the field.

Effective and efficient delivery of technical advices to support farmers is highly required for proper management of this production system and to enhance production and productivity. Large fish pond with area above 100 m^2 and depth 1.50m, specially in the high land area at altitude of 2000 m.a.s.l. and above are recommended to maintain water temperature in required range and enough space for photosynthesis to produce sufficient natural feed in pond. Further follow up and support to the farmers as well as stocking fish for other FRG members is required.

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Pre extension Demonstration of Improved Plastic Milk Churner Technology

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Abstract

Demonstration of improved plastic milk churner was done to a total of twenty farmers organized in two farmers research extension group (FREGs) namely Deneba kebele of Dodola district and Tullu Boke kebele of Kofele District of west Arsi zone in 2016/17 ad 2017/18. The result indicated that it required 41.03±0.59 min and 46.5±0.54 min to churn 5.3lt of sour milk in Deneba and Tullu Boke kebele, respectively. The butter yield was found to be 301.53±10.33 gm and 303.00±10.32 gm from the same amount of sour milk in Deneba and Tullu Boke, respectively. Participating farmers believed that the demonstration of improved plastic milk churner enabled boys to participate in milk churning activity in the study area.

Keynotes: demonstration, milk churner, pre-extension, technology

Introduction

Milk production and processing is an important activity of small holder farmers in Ethiopia. However, a fraction of total milk production enters the formal processing channel. Thus most of the milk produced in the country is either sold as fluid milk or processing traditional technologies. The small holder traditional milk processing is based on sour milk (O'Connor CB 1994). After milking, the milk is accumulated in clay –pot and kept closed at room temperature for several days by adding fresh milk to the already accumulated until it is sour. A clay pot is then used to churn the sour milk (Lemma 2004). Churning efficiency is measured in terms of the time required to produce butter granules by the loss of fat in the butter milk. Efficiency is influenced markedly by churning temperature and by the acidity of the milk of cream (O' Conner CB 1994). However, the most the traditional methods of butter making are reported to be slow and inefficient. The traditional method of churning is time consuming perhaps, taking more than two hours (O'conner et al 1993).

The author reported that in on-farm trails in the Debre Birhan areas, an average churning time of 57 minutes was obtained with the agitator fitted into the clay pot, while a churning time of 139 minutes was obtained the average when using the clay pot only .O' Mahony and peters (1987) also reported that they give low yield butter per unit of sour milk and require high labor input. Similarly the amount of butter obtained from traditional milk churner is lower than the yield obtained from improved churner (Lemma 2004). As per the result of the research conducted by Alganesh (2002), using the ILCA internal agitator reduced churning time by 22% from an average of 28 minutes is gourd churn to 23 minutes. Also ,she reported that the average butter obtained using gourd churn and the internal agitator was 359.7 grams and 376.9 grams per 6 liters of sour milk ,respectively.

Using ILCA agitator reduced churning time from an average of 139 minutes in traditional clay pot to an average of 61 minutes in the on farm trail in the Debre Birhan areas(O'Mahony and Bekele 1985).Under on-farm trails in the on farm trail in the central highland of Ethiopia ,churning time was reduced from an average of over two hours to less than half an hour while butter fat recovery increased from 71% to 93% using the ILCA internal agitator (O'Mahony and

Peters,1987) .Yilma Z et al (2007) reported that 475g of butter was obtained using clay pot with the churning time of 191 minutes (3.7hr) whereas 492g of butter was obtained from internal wooden agitator which is developed by International Livestock Research Institute (ILRI) With the churning time of 80 minute (1.3hr) .The milk was churned after 62hr of fermentation and ten litters of milk were used for both butter –making methods. The average time of traditional milk churner 65min and the modified milk churner (wood made) 43.54+5.06 was reported by Tesfaye et al (2008) around Adami Tulu area .Using improved milk churner reduces churning time by 25.23% from the average 65min to maximum time of 48.6min per 10 litter of sour milk .According to the report of Feyisa et al (2009) in Adami Tulu area time required for butter making is 33.29 minutes and 80.97minutes for plastic milk churner and traditional clay pot churner respectively. Recent on farm evaluation of improved plastic milk churner and clay pot in west Arsi (Fetiya and Estefanos unpublished data) indicated that time taken for butter making was reported to be 44 min and 1:05 min and the butter yield was 180 vs 174 gm, respectively from average of 3.5lt.

There is a highly growing demand for the improved plastic milk churner in areas were it is demonstrated because of its advantages over the local churner namely; time efficiency, reduction of women workloads since any member of the house hold can churn with the modern churner unlike the traditional one which is culturally allocated to women, ease of cleaning. So this project is designed to address farmers request through accessing the improved plastic milk churner and reduce women farmers work load and time consumed in milk churning process.

Materials and Methods

Description of the Area

Geographically, the area is located at 70 11’ 33” N altitude and 380 35’ 33” E longitude. The area has an annual average temperature ranging from 120c to 280c. The rainfall ranges from 1500-2000ml (OFEDO, 2009). Kofole is also located in West Arsi Zone of the Oromia Regional State. The area has an altitude and longitude of 70 00” N 380 45 E/ 7 N 38.750 E. The annual average rainfall of area is about 1232 ml with a mean monthly rainfall of 102.6ml. The mean monthly minimum and maximum temperatures are about 5.40C and 19.80C, respectively (OFEDO, 2009). Dodola Deneba kebele lies between 06°54'20"N and 6°54'3"N latitude and between 39°8'19"E and 39°13'50"E longitude with an elevation ranging between 2490–3218 m a.s.l. the mean minimum and maximum temperature of the study area is 3.6 and 24.3°C, respectively. The mean annual rainfall is 964 mm, of which 70-80% was received in main wet season of June to early September and 20-30% from remaining less pronounced wet periods (Digital soil and Terrain Data base of East Africa, 1997).

Farmers’ selection

A total of 20 Farmer having cross bred animals were given priority on the assumption that cross bred animals produce larger amount of milk than the local and the second emphasis was on those farmers having 2-or more local milking cows at the time of distribution of the milk churner.

Farmers training

Technical training was given to the participating farmers about clean milk production, milk chemical and physical properties, impact of animal management on milk production, milk hygiene, milk processing and handling methods, milk volume vs milk processing material volume relationship, FREG concept and importance of animal health on clean milk production. Technical guidelines on the operation, cleaning and maintenance of the plastic milk churners was also be prepared and provided for participating farmers.

Stakeholder linkage in churner production

Stakeholder linkage is an important part of demonstration works. For this demonstration activity efforts made to link milk churner producers with farmers. Priorities were given to medium and small enterprises available in the district who are involved in metal works. Linking the metal working workshops with the farmers in the area helps in creating access to the dairy producing farmers in finding the milk churner within their vicinity. Moreover with improved access contributed in reaching many farmers. Furthermore it is also an opportunity in creating business chances for the small and medium business enterprises

Data collection

Time taken to churn, butter yield amount of milk used for each churn were collected.

Data analysis

Descriptive statistics were applied to analyze the data collected

Results and Discussions

Twenty farmers organized in two group farmers research groups (FREGs) from two kebeles namely Tullu boke and Deneba of west Arsi zones been high land and mid altitude, respectively were participated in the evaluation of the plastic milk churners. Milk from both local and cross bred mostly of HF type were used in the form of mixture (composite form) for the evaluation. The milk was stored in a container to be fermented naturally usually for three days (farmers practice) to be churned. The capacity of the plastic milk churner used for the experiment was 10lt. literally the amount of milk that should be churned by the 10lt capacity of milk churner better be 5lt that is half the capacity of the milk churner for efficient churning in terms of time. The overall result of the demonstration in the two kebeles could be summarized as indicated in Table 1 below

Table.1. Summary of Amount of milk churned, time taken and butter obtained at the time of demonstration

Characters	Time taken (min)	Amount of milk churned (lt)	Butter yield (gm)
Mean ±SE	43.77±0.53	5.3±0.12	302.27±7.24
N	60	60	60
SD	4.14	0.94	56.09

The present result (Table 1) butter yield was found to be 302.27±7.24 gm from average milk of 5.3±0.12 and (Fetiya et.al 2017) indicated 180.54± 6.4 gm of butter from an average of 3.3±0.078 lt of milk in shahsemene and kofele areas of west Arsi zones of Oromiya. While (Feyissa et.al.2009) reported butter yield of 570gm from an average 10 lt of milk in a trial conducted in Adami tullu agricultural Research. The average time taken for churning in the present study was 43.77±0.53 but (Fetiya et.al 2017) indicated 39±0.01 min for 3.3 lt of milk in the same agro ecology might be because of the difference in amount of milk churned. While

(Feyissa et.al.2009) reported 40 min for 10 lt of milk in a trial conducted in Adami Tullu Agricultural Research Center.

Table 2.Time taken butter yield and amount of milk churned as indicated by Kebele (Deneba)

characters	Time taken (min)	Amount of milk churned (lt)	Butter yield (gm)
Mean ± SE	41.03±0.59	5.3±0.17	301.53±10.33
N	30	30	30
SD	3.25	0.95	56.60

Table3. Time taken butter yield and amount of milk churned as indicated by kebele (Tullu Boke)

Characters	Time taken (min)	Amount of milk churned (lt)	Butter Yield (gm)
Mean ± SE	46.5±0.54	5.3±0.15	303.00±10.32
N	30	30	30
SD	2.98	0.94	56.56

The slightest difference in butter yield in the two kebeles Deneba and Tullu Boke (Table 2 and3) might attributed to the environmental variation between the two kebeles Deneba being mid altitude and Tullu boke being high land. Moreover, the variation in the feed management. Animals feeding on higher proportion of grass have higher fat content. On the other hand there is a significant difference at ($p<0.05$) level of significance in time taken to churn 5.3lt in the two kebeles namely Deneba and Tullu Boke which might be because of the variation in environmental temperature between the two kebeles.

Farmer's opinion

According to the information from the participating farmers traditionally it was believed that milk churning activity was the chore of the female in the area were the demonstration activity was done, the demonstration activity enabled members of the household especially boys to participate in the churning activity. There by reduced the women work load related to the churning activity.

Conclusions and Recommendations

The result of the demonstration of the plastic milk churner in the study area indicated that time taken to churn milk influenced by different factors like environmental temperature churn temperature churn volume evidenced by the variation of time taken to churn 5.3 lt of milk between the two agro ecology 41 min for Dodola and 46 min for Tullu boke .Ease of operation participation of family members especially boys in the churning activity makes the plastic milk churner more preferable. Specification of type of metal used for different size (capacity) of milk churner to have a long lasting and economical milk churner production should be one area of research for the mechanization research groups. Transfer of the technology with specification to the small and medium producer should be given due attention so that the farmers could get the churner within their vicinity.

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Pre-extension Demonstration of Napier Grass (Pennisetum purpureum) Silage on Lactating Crossbred Dairy Cows in selected AGP-II Woreda of West Oromia

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Abstract

Pre-extension Demonstration of Napier Grass (Pennisetum purpureum) Silage on Lactating Crossbred Dairy Cows was conducted in Guto Gida district of East Wollega zone in 2016/17 ad 2017/18 to create awareness on the importance of the Napier grass silage among the rural farmers and to enhance the farmers' knowledge and skill on the technology usage. It also aimed to evaluate the feeding value of Napier grass silage as basal diet in comparison with locally produced feeds on milk yield of crossbred dairy cows. Sixteen dairy cows (Horro X Friesian) were used for the experiment. All the cows were drenched with broad-spectrum anti- helminthics (Albendazole 500mg) prior to the start of the experiment. The experiment was carried out with full participation of FREG farmers. Farmers were participated in the selection of best performed feeding options. Mean daily milk yield of crossbred dairy cows fed Napier grass silage and locally produced feeds differed significantly between treatments (P<0.01); cows fed Napier grass silage produced more milk yield than those feed locally produced feeds. Accordingly, farmers preferred Napier grass silage feeding to locally feed due to its high biomass and milk yield improvement. Thus, it can be concluded that cows fed Napeir grass silage with recommended concentrate mix optimized both biological and economic benefits as compared to cows consumed locally prepared feeds. The technology is liked by farmers and therefore, it needs further extension through pre-scaling up with its full package.

***Key words**: Crossbred, Demonstration, Locally practiced feed, Napier grass silage*

Introduction

In the mixed crop-livestock production systems of the Ethiopian highlands, feed resources for livestock mainly come from marginal pasturelands, crop residues, and crop aftermath grazing (Bogale *et al*. 2008). As most of the lands are occupied by the crops, the importance of crop residue remain high. Nevertheless, forages from marginal pasturelands and crop residues are of generally low quality. Thus, the nutritional requirements of pregnant and lactating cows are not sufficiently met. Under such circumstances, cows in early lactation as well as high producing cows are typically in a negative energy balance. Factors associated with a negative energy balance are known to have adverse implication on reproductive efficiency and milk production and body weight loss of animals (Emebet and Zeleke, 2008). This is further aggravated by the fact that yield and nutritive value of tropical grasses decline sharply as dry season approaches (Babayemi *et al*., 2009), leading to reduced feed intake, greater weight loss, and low milk production from cows raised in extensive production systems (Smith, 2001).

The situation may be reversed during the wet season when there is more forage than being used (Higashiyama and Hirata, 2006) and opportunity to cultivate forage is high. Thus, surplus and cultivated quality forages should be conserved during the wet season for use during the dry season. To this effect, silage making is a common means of preserving surplus forage that could be fed to livestock during periods of scarcity (Wong, 2000). By conserving excess forage produced during the wet season to silage (Wong, 2000), the low production and productivity of dairy animals during the dry season due to scarcity of forage can be ameliorated. For such purpose, Napier grass, a high yielding tropical grass with great potentials for making silage, could be used.

Napier grass (*Pennisetum purpureum*) is recommended as basal forage for intensive cattle production as its high biomass fresh dry matter yield 40 t/ha compared to other grasses (ILRI, 2001). Napier grass is tall growing perennial grass, which is indigenous to tropical and subtropical climates. Bako Agricultural Research Center, Pennesitum purpureum (ILRI 1681) was found to be promising in terms of biomas, this material was used for the preparation of the silage meant for the present study.

Generally supplementing Napier grass with concentrate or leguminous forage plants was reported to improve the procuction performance of animal (Solomon, 2001). On station evaluation of Napier grass (*Pennisetum purpureum*) silage with comparative evaluation of natural grass hay on milk yield, milk composition and body weight of lactating crossbred dairy cow were conducted and significant increment were seen on milk yield by Napier grass silage as compared to natural grass hay (Tesfaye et al., 2016). Therefore, in order to verify the importance of the Napier grass silage at farmer's level, undertaking the work on-farm was found to be worthwhile. Hence, the present work was proposed with the following objectives: to create awareness on the importance of the technologies among the rural farmers, to enhance the farmers' knowledge and skill on the technology usage and to evaluate the feeding value of Napier grass silage as basal diet when offered with locally practiced feed on milk yield of crossbred dairy cattle.

Materials and Methods

The present work was conducted in purposively selected district of East Wollega zone. Two potential Kebeles, namely *Nagasa* and *Gari* from district of Guto Gida were selected based on accessibility and potentiality for dairy production. In each Kebele one FRG unit, comprising of 16 farmers was organized. Gender and youth balance in each FRG unit were considered. In each FRG unit, eight experimental farmers per kebele were selected with the rest being participant farmers. Development agents and district experts were collaborative in site and farmer selection.

The FRG member farmers were selected based on; willingness to be a member of the FRG, 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 FRGs a theoretical training session were arranged to farmers, DAs, and district experts. Researcher from different discipline,drawn from Bako Agricultural research Center (BARC) trained the farmers on dairy nutrition, disease, breeding, milk post-harvest handling and forage conservation and preservation strategy. This training was believed to help the farmers in aspiring the overal objectives of the work.

Napier grass (Pennisetum purpureum) planting

Napier grass *(Pennisetum purpureum) 16801 accession* was planted on plot of 30mx30m on each trial farmers' land. A spacing of 50 cm between plants and 60 cm between rows was used. All the necessary recommended agronomic practices were equally applied for all of the plots on each farmers land.

The Napier grass silage feeding for dairy cattle was evaluated against local practice of dairy cattle feeding by farmers' selection criteria. At this juncture, the farmers were assisted to jot their own evaluation criteria, which was used to rank the technologies (treatments). Napier grass silage feeding for dairy cattle was evaluated against the criteria setted by farmers, and 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 were made on the way ahead.

Experimental animals and management

A total of 16 crossbred lactating cows (Horro x Fresian) were selected from the dairy cow keeper farmers and the feeding trail was conducted at each farmer site. Amoung the 16 crossbred lactating cows, demonstration of Napier grass silage was under taken at Guto Gida district (Nagasa and Gari kebele's) on eight hosting farmer's site and fed cows individually at each farmers site. However, cows fed locally produced feeds (grazing with home made supplement) also undertaken at the same kebele' on another eight lactating crossbred cows at each farmers site. All the cows were drenched with broad-spectrum anti-helminthics (Albendazole 500mg) prior to the start of the experiment. Farmers, DA and district experts were participated on training of silage preparation.

Formulating concentrate mix

A concentrate mix sufficient for the entire experimental period were formulated on-station using milled maize grain and noug seed cake as main ingredients. The formulated ration is composed of 49.5, 49.5, 1% maize grain, noug seed cake, and salt, respectively. It was established at BARC that the mix fully meet the requirement for major nutrients of lactating crossbred cows with milk yield and butter fat content as described in (ARC, 1990) when fed at the rate of 0.5 kg/l of milk.

Methods of silage preparation

Napier grass were harvested at 1m height and the harvested plant were wilted to overcome the high juice losses associated with the ensiling of immature forage. The wilted plants were chopped to lengths of about 5cm using manual chopper. Locally available materials (*Hyparrhenia rufa)* were used to line the sides of the silo. The chopped material were placed into the plastic-lined pit and spread uniformly into layers of 15-30 cm and compacted. The filled silo pits were covered with polythene sheeting and then loaded by soil on the top. A small trenches were dug around the sides of the pit to ensure water does not seep into the silage material. The silage was used for feeding after one month of ensiling. During Napier grass silage preparation FRG farmers were participated and they have got experience from it

Treatments

1. Farmers practice /locally feeding their lactating cow (grazing + milled maize grain + atella + crop residues+ salt))
2. Napier grass silage *adlibtum* + concentrate mix (0.5 kg/lit of milk)

Partial budget analysis

A simple partial budget analysis was conducted by using marginal analysis of dietary treatments cost based on calculation of the total cost of supplement feed (concentrate) and basal diet, and considering milk sales price and labour cost incurred during the entire experimentation process.

Partial budget analysis by using marginal analysis was employed to compute total cost of production /cow/day, price of milk/cow/day, cost of production/litre of milk, return/cow/day, net return/cow/day and MRR return/cow/day, Calculations were employed as follow;

Net returen (NR) = Total revenue (TR) – Total variable cost (TVC)

$\Delta NR=\Delta TR- \Delta TVC$

$$\text{Marginal rate of return (MRR \%)} = \frac{\Delta NR \times 100}{\Delta TVC}$$

Statistical Analysis

The data were analyzed by the GLM procedure in the ANOVA program of the SAS (2002) software.

Results and Discussions

Farmer's ranking of the treatments

Those cows fed with Napier grass silage produced more milk than cows feeding locally produced feeds, this is might be due to the feed quality and cows saved energy lose for searching feed and heat stress .The ranking was conducted on the feeding options of Napeir grass silage feeding with recommanded concentrate and grazing with homemade supplementation. However the farmers setted createria of selection technologies by themselves and agreed up on it.

Table 1. Ranking of Napier grass silage and locally practiced feeding for dairy cattle technology by the FRG farmers.

Criteria	**Technology Rank**			
	Guto Gida (Garii PA)		Guto Gida (Nagasa PA)	
	$\mathbf{T_1}$	$\mathbf{T_2}$	$\mathbf{T_1}$	$\mathbf{T_2}$
Biomass of the feed	2nd	1st	2nd	1st
Body condition of the animal	2nd	1st	2nd	1st
Utilization methods of the feed	2nd	1st	2nd	1st
Palatability of the feed	2nd	1st	2nd	1st
Milk yield increment	2nd	1st	2nd	1st
Intensive management and input	2nd	1st	2nd	1st
Utilization and sustainability of the feed	2nd	1st	2nd	1st

Note: T1 = Control (Farmers practice) /locally feeding their lactating cattle (grazing + milled maize grain + atella + crop residues+ saltt)

T2= Napier grass silage *adlibtum* + Concentrate mix (0.5 kg/l of milk)

Milk Yield

The results of mean daily milk yield of crossbred dairy cows fed Napier grass silage and locally produced feeds were significantly different between treatments ($P<0.01$) and cows fed Napier grass silage produced more milk yield than those fed on locally produced feeds. The difference in milk yield between treatment groups could be attributed to the differences in crude protein and energy contents in the feeds (Steinshamn, 2010). There are reports in agreement with the current finding. For instance, (Adebabay et al., 2009) indicated that supplemented cows produced significantly more milk than those grazed on natural pasture alone.

Table 2. Effect of Feeding Napier grass silage and locally produced feeds on milk yield of crossbred dairy cows at Guto Gida Districts

Parameters	Feed type	
	Napier grass silage feeding (T2)	Locally produced feed feeding (T1)
Mean Milk Yield	8.44^a	5.31^b
Number of cow	8	8
Standard error	0.32	0.16

Note: T1 = Control (Farmers practice) /locally feeding their lactating cattle (grazing + milled maize grain + atella + crop residues + salt))
T2= Napier grass silage *adlibtum* + Concentrate mix (0.5 kg/lit of milk)

Farmers Feedbacks

The farmers were highly interested on the silage of Napier grass due to the high biomass of the grass, frequency of harvesting per year and suitability for preservation surplus feeds as silage. The milk yield of dairy cattle fed these silage were increased as compared to locally produced feed. However, the farmers were commented on these technology so that it has to come with full package like chopper. The farmers were used manual chopper which is time taking. Therefore, the agricultural engineering and mechanization should think over on the production of the right chopper for the Napier grass silage making.

Partial Budget Analysis

The economic feasibility of this study was analyzed using partial budget and marginal analysis approaches. According to this analysis, T2 gave higher net benefit (Birr 81.6 per cow/day), than T1 (Birr 39.53 per cow/day). The minimum rate of return acceptable by the dairy farmer was assumed to be 50% (CIMMYT, 1985). This implies that the dairy farmer expects a minimum rate of return of 50% if he is to adopt a new practice as compared to the practice he used to do.

Between treatments, the largest change in cost that varies was birr 16.27 per day and the change in net income was birr 42.07 per day resulting in 259% marginal rate of return was recorded for T2. So for each birr invested in input for a cow, the farmer would recover birr 1(one) and an additional birr 42.07 at a given prices. Therefore, on the basis of MRR the technology is recommended for increasing milk productivity of cows. The result of MRR of the present study was in the profitable range like as 158% and 131.85% reported by Shah et al (2009) who worked on an on-farm trial of urea mineral molasses blocks fed to milking cows and buffaloes, respectively. Therefore, considering milk yield and economic return in this study, it can be concluded that cows fed basal diet of Napier grass silage with recommended concentrate mix optimize both biological and economic benefits as compared to cows consumed locally produced feeds

Table 3. Partial budget analysis for lactating crossbred dairy cows fed Napier grass silage and locally practicing feed basal diet and supplemented with concentrate mix (0.5kg/kg milk).

	Treatments	
Variable	T1	T2
Milk yield (kg/cow/day)	5.31	8.44
Gross field benefit (ETB /cow/day)	95.58	151.92
Cost of grazing (ETB/ kg /cow/day)	-	-
Cost of Napier grass silage (ETB/ kg /cow/day)	-	10.67
Cost for Concentrate mix (ETB/kg/cow/day)	15.90	19.5
Cost of Tablet, salt and labour (ETB /cow/day)	40.15	40.15
Total variable cost (ETB /cow/day)	56.05	72.32
Gross income, ETB/head	95.58	151.92
Net benefit (ETB cow/day)	39.53	81.6
Change in net income (ETB)	0	42.07
Change in total variable cost (ETB)	0	16.27
MRR, %	0	259

ETB = Ethiopian Birr; MRR = Marginal rate of return;

T1= locally produced feeds *(*grazing + milled maize grain + atella + crop residues+ salt*);*

T2=Napier Grass Silage + Concentrate mix (0.5 kg/l of milk) ,Concentrate mix = 49.5% maize grain + 49.5% noug seed cake + 1% salt

Conclusions and Recommendations

The activity was carried out with full participation of FRG farmers and it was conducted on sixteen dairy cattle of selected farmers. The results of mean daily milk yield of crossbred dairy cows fed Napier grass silage were significantly improved as compared to milk from locally produced feeds. Farmers were participated in the selection of best performed feeding option. Different parameters like biomass of the feed, body condition of the animal, utilization methods of the feed, palatability of the feed, milk yield increment, intensive management and input, utilization and sustainability of the feed were evaluated for each feeding option. Accordingly, farmers preferred Napier grass silage feeding than locally prepared feed due to high biomass of the grass and milk yield improvements. The technology is liked by farmers and therefore it needs further extension through pre-scaling up with its full package. Since the silage preparation is the primary system of feed preservation and conservation strategy during feed scarcity, Napier grass is an option for silage making due to the nature of the forage and its high biomass. Thus, considering milk yield and economic return in this study, it can be concluded that cows fed with Napeir grass silage with recommended concentrate mix optimizes both biological and economic benefits as compared to cows fed with locally produced feeds.

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AGRICULTURAL ENGINEERING

Pre-extension Demonstration and Evaluation of Improved Small Scale Pulper for Wet Coffee

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Abstract

Pre-extension Demonstration of Small Scale Wet Coffee Pulper was conducted in Jimma and Buno Bedele Zones of Oromia Regional State. The objectives of the study were to evaluate the performance of improved pulper for wet coffee, to demonstrate the technology and to create awareness to the farmers in the study area. One kebele was selected from each of the three districts (Goma, Gera and Chora). Participants were organized in three FREG groups having 45 members. The evaluation result showed that the machine has pulping capacity of 173.06 kg/hour, 95.5% cleaning efficiency and with relatively less grain breakage (9%) for the pulped wet coffee. Perception response showed that the machine has good cleaning capacity by 75.6% respondents and 24.4% of the respondents ranked it to the medium performance. Moreover, majority of the respondents (82.3%) perceived that it has good efficiency and the rest 17.7% perceived as medium performance. The machine is also preferred for its minimum seed breakage, easy to operate and simple to transport. Generally the feedback data showed that the farmers have positively perceived the machine simply by observing its pulping efficiency, breakage percentage and pulping capacity as it has good performance compared to the local pulping method. Thus, the machine is recommended for for further scaling up.

Keywords: - *Demonstration, Pre-extension, Pulper, Pulping Capacity, Wet Coffee*

Introduction

Coffee *(Coffea arabica L.*) is a non-alcoholic stimulant beverage crop that belongs to the family *Rubiaceae* and genus *Coffea.* Among 100 *Coffea* species in the genus *Coffea*; *C. arabica* is the only species naturally occurring in Ethiopia (Yigzaw D., 2005). Ethiopia is the only center of origin and diversity of Arabica coffee (*C. arabica*) (Anthony *et al*., 2001). Coffee is the major source of foreign currency for Ethiopia and contributes more than 35% of the total export earnings (FAO/WFP, 2008). Thus, it is a cornerstone in the export economy of the country and it supports directly or indirectly the livelihood of some 15 million people (EEA, 2001). In Ethiopia, coffee is produced in four production systems, namely: forest, semi-forest, garden and plantation coffee in the Western, Southern, and Southwestern parts of the country (CFC, 2004).

Jimma Zone is one of coffee growing zones in the Oromia Regional State, which has a total area of 1,093,268 hectares of land (JZARDO, 2008). Currently, the total area of land covered by coffee in the zone is about 105,140 hectares, which includes small-scale farmers' holdings as well as state and private owned plantations. Out of the 40–55 thousand tons of coffee annually produced in the Zone (JZARDO, 2008), about 28-35 thousand tons is sent to the central market, while the remaining is locally consumed (Alemayehu *et al*., 2008). Now a day, Jimma Zone covers a total of 21% of the export share of the country and 43% of the export share of the Oromia Region (JZARDO, 2008). Coffee is the major cash crop of the Zone, which is produced in the eight districts namely, Gomma, Manna, Gera, Limmu Kossa, Limmu Seka, Seka Chokorsa, Kersa and Dedo, which serves as a major means of cash income for the livelihood of coffee farming families (JZARDO, 2008). According to the report from the same source, 30-45 % of the people in Jimma Zone are directly or indirectly benefited from the coffee industry. Despite the favorable climatic conditions, variety of local coffee types for quality improvement and long history of its production in Jimma Zone, coffee quality is declining from time to time due to several improper pre-and post-harvest management practices.

This is still practiced by the majority of coffee farmers/traders, from which the larger portion of the produce is obtained. Improper post-harvest processing and handling practices such as drying on bare ground, improper storage and transportation are some of the causes associated with coffee quality problems among many other (Desse, 2008). In addition to this, natural impediment such as prolonged rainy weather, particularly during harvesting and drying season can also contribute to reduced coffee quality (Desse, 2008). For instance, Desse (2008) reported that out of Jimma coffee sent to the coffee quality inspection center laboratory from 2003 to 2007, more than 60% of dry processed coffee classified into grade as compared to 80% of wet processed into grade 2 and grade 3. The author indicated the problem of post-harvest processing and handling in the area resulted in poor quality as the main contributing factor. The poor quality and the subsequent drop in earnings had severely affected coffee farmers in woredas like Gomma, Limmu Kossa, and Manna, where coffee provides a larger portion of their annual income. But Jimma Zone is known for some quality coffee types such as Limmu Enaria (Limmu) coffee, which is known for its best quality in the world market.

Processing is a very important activity in coffee production and plays a crucial role in quality determination (Mburu, 1999). Coffee is either processed by the wet or dry methods, which vary in complexity and expected quality of the coffee (Wrigley, 1988). Both sun-drying as well as wet-processing methods are operated in Ethiopia, which accounts for 70% and 30% of coffee produced in the country, respectively. Despite the favorable climatic conditions, variety of local coffee types for quality improvement and long history of its productions, still there are gaps like lack of improved small scale wet coffee pulpier to enhance wet coffee process that can minimize coffee quality problems in Jimma zone and lack of adequate information on the effects of post-harvest processing and handling techniques on coffee quality. Hence, the small scale wet coffee pulpier is introduced to promote the coffee production by minimizing the above mentioned problems of coffee growers and processors for quality coffee produce in the study areas.

Materials and methods

Materials used

Manufacturing materials such as steel shaft, galvanizes sheet metal, flat iron etc were used for Wet coffee pulper machine production.

Study areas

The study was conducted in Gera and Gomma, districts of Jimma, and Chora district of Illuababor zone. Five hand operated coffee pulpers were manufactured in Jimma Agricultural

Engineering Research Center. One Kebele was selected from each three selected districts. Three FREGs which consists of fifteen (15) members were formed at identified Kebeles. Training was given on general coffee processing technology at the hosting farmers' sites. Then technology production, evaluation, training & demonstration were carriedout by distributing sample prototypes to each farmer extension research groups. Finally data related to performance of the machine and farmers' perception on the technology were collected through observation and interview.

Training of farmers, SMS and DAs on Mini-disc wet Coffee Pulper

Both practical and theoretical trainings were given for the participant farmers and other stakeholders before actual demonstration was started on machine operation and maintenance. The training participants include the Subject Matter Specialists (SMS) from selected districts working on crop production and Development Agents (DAs) found in the selected Kebeles.

On farm Performance Evaluation

Pulping involves removal of outer red skin, white fleshy pulp, separation of the pulp and wet parchment coffee. The pulping activity was carriedout by squeezing the cherries between a pulper chopper knife and disc. The gap between them can be adjusted as per the coffee variety. This disc pulper is specially designed to pulp Arabica and Robusta coffee varieties.

The performance of the disc pulper was calculated as follows:

$$pulping\ efficiency = \frac{input - unpulp\ coffee}{input}$$

$$breakage\ persent = (1 - \frac{input - broken}{input})100$$

$$pulping\ capacity = \frac{input - unpulp}{time}$$

Demonstration procedure

Farmer to farmer learning was used to promote the technology simply by arranging pulping program at the host farmer's farm site. Farmers' feedback after the demonstration of mini disc wet coffee pulpier technology were collected based on evaluation criteria jointly set by researchers and farmers. These includes, values for visible grain damage, optimum pulper output capacity, pulping and cleaning efficiency and farmers' perception.

Average price for pulped and un-pulped coffee

Simple calculation was done to determine the price difference by considering coffee price before using pulper and after using the pulper.

Farmers' perception on the technology attributes

Data on technical operation and social perception aspects were collected and analyzed as well. Feedback was taken during and after demonstration to analyze farmers' perception about the pulper. Some of the pulper attributes used in the analysis were pulping efficiency (%), breakage percentage (%) and pulping capacity (kg/hr).

Data collection and analysis methods

The quantitative and qualitative data related to technical performance and perception were collected through interview, observation and group discussion and analyzed by using descriptive statistics.

Results and Discussions

Training of Farmers, SMS and DAs on Mini-disc wet Coffee Pulper

Both practical and theoretical trainings were given for the 45 participant farmers, 6 Subject Matter Specialists (SMS) and 12 Development Agents (DAs) on machine operation and maintenance (Table 1).

Table 1: Training Provided on Mini Disc Wet Coffee Pulper Technology

No	**Training Site**		**Farmers**				**DAs**		**SMS**		**Total**
			Adult		**Youth**						
	District	Kebele	M	F	M	F	M	F	M	F	
1	Goma	Loya Sedi	7	2	5	1	3	1	1	0	20
2	Gomma	Cedero Suse	9	3	2	1	3	2	2	0	22
3	Chora	Hawa Yember	8	2	3	2	2	1	2	1	21
	Total		24	7	10	4	8	4	5	1	63

On-farm Performance Evaluation and demonstration

On farm evaluation of the technology was conducted in collaboration with participant farmers, SMS and DAs. Evaluation of Mini Disc Wet Coffee Pulper was based on the attributes such as pulping efficiency (%), Breakage percentage (%) and pulping capacity (kg/hr). Accordingly, the evaluation result showed that the machine had pulping efficiency, breakage percentage and pulping capacity of 95.5%, 0.09% and 173.06 values respectively(Table 2). Moreover, participant farmers appreciated the machine (mini-disc coffee pulper) for its good pulping efficiency and capacity with minimum breakage due to adjustable clearance between disc and knife.

Table 2: Average performance of the Pulper (efficiency, Breakage and Pulping capacity)

No.	**Rep**	**Pulping efficiency (%)**	**Breakage percentage (%)**	**Pulping capacity (kg/hr)**
1	A1	95.1	0.05	246.64
	A2	100	0	189.1
	A3	96.65	0.02	165.8
	Av.	**97.25**	**0.02**	**200.5**
2	B1	93.6	0.06	148.1
	B2	97.6	0.1	156.4
	B3	94.5	0.3	168.2
	Av.	**95.23**	**0.15**	**157.57**
3	C1	93.65	0.06	167.49
	C2	95.68	0.04	151.34
	C3	92.84	0.2	164.53
	Av.	**94.06**	**0.1**	**161.12**
G. total		**95.5**	**0.09**	**173.06**

NB: The letters A, B & C indicate the pulper evaluated at three different sites.

Mini-Field days conducted

Mini-field days in which 155 farmers (67 Female, 88Male), 3 SMS, 13 DAs, and 4 kebele administrators have participated were organized at different sites (Table 3).

Table 3: Participants on mini field days

No	**Location**		**Participants of field days**											
			Farmers				**SMS**		**DAs**		**Stake holders**		**Total**	
			Adult		**Youth**									
	District	**Kebele**	**M**	**F**	**M**	**F**	**M**	F	**M**	F	**M**	**F**	**M**	**F**
1	Goma	Loya Sedi	20	10	8	10	1	-	3	2	1	-	33	22
2	Gomma	Cedero Suse	17	11	13	15	1	-	3	1	1	-	35	27
3	Chora	Hawa Yember	15	8	15	13	-	1	3	1	1	1	34	24
	Total		52	29	36	38	2	1	9	4	3	1	102	73

Average price for pulped and un-pulped coffee

The average price difference was calculated by deducting price of pulped coffee from un pulped ones. As shown in table 4 below, on average, 4 kg of un-pulped wet coffee became 1 kg of pulped coffee bean. However, interms of selling price, the one kg pulped coffee was sold in 37 62 Birr more during harvest and after three months respectively than the unpulped coffee bean. The price variation on selling after three months was resulted by enabling the farmers to store the crop for long time to overcome the effect of low price during harvesting time.

Table 4: Price difference between pulped and unpulped coffee beans

No.	Wet Coffee crop	Quantity (kg)	Average Price during harvest	Average Price after 3 months	Remark
1	Before pulped	4	4 kg x 7 Birr =28	-	Short period
2	After Pulped	1	1 kg x 65 Birr =65	1x90= 90	Can be stored
3	Price difference (Birr)		**65 – 28 = 37 Birr**	**90-28=62**	**62-37=25**

Farmers' perception on the technology attributes

Among the total respondents, 75.6% replied that the wet coffee pulper had good pulping capacity and the rest 24.4% ranked it to the medium performance. This shows that most of the farmers have positively perceived to this machine towards its capacity. Moreover, majority of the respondents (82.3%) perceived that it has good efficiency while the rest 17.7% perceived as medium(Table 5). Participant farmers also appreciated the machine its minimum seed breakage, easy to operate and simple to transport.

Table 5: Perception of FREG Members on Mini-Disc Wet Coffee Pulper

The pulper attributes and its acceptance degree by farmers	Scale measurement	Participant Respondents		
		Frequency	Percentage	Remarks
Criteria		(Fr)	(%)	
Pulping capacity (kg/hr).	Poor	-	-	
	Medium	11	24.4	
	Good	34	75.6	
Pulping efficiency (%),	Poor	-	-	Require adjustment precision
	Medium	8	17.7	
	Good	37	82.3	
Breakage percentage (%)	Poor	-	-	Require adjustment precision
	Medium	6	13	
	Good	39	87	

Conclusions and Recommendations

The evaluation of min-disc small scale wet coffee pulper showed that it has good performance with average pulping efficiency, breakage and pulping capacity of 95.5%, 0.09% and 173.06kg/hr respectively. The coffee producer farmers had appreciated the pulper suitable for their coffee production activities recognizing that it has good performance compared to the local manual tiresome method of pulping. Moreover, they have acquired knowledge and skill on use of wet coffee pulper through training. The introduction of the technology has motivated more coffee producer farmers where some have already expressed their demand for purchasing the machine. Thus, the concerned stakeholders should strongly work in supplying the technology by creating linkage among coffee producers and technology manufacturers in order to strengthen coffee production and marketing in a sustainable manner in the areas. Micro enterprise and coffee development offices in the respective districts and kebeles should maintain sustainable partnership in order to strength the linkage among producers and technology manufacturers. There is also a need for further modifications by researchers to upgrade it to motorized ones and with two or more disk application.

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Pre-Extension Demonstration of Hand Operated Winnower for Cereal Crops Cleaning in Jimma and Buno Bedele Zones of Oromia Regional State, Ethiopia

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Abstract

Cereal crops Winnower was demonstrated in Dedo, Gomma, Nadda districts of *Jimma Zone and Bedele & Gechi districts of Buno Bedele Zone in 2017/18. The objective was to evaluate the performance of improved winnower and demonstrate its importance to the farmers of the study area. Six FTCs were selected from five districts as hosting centers for the demonstration of the technology. Three major cereal crops such as maize, wheat, and teff were evaluated. A total of 234 farmers (90 Female, 144 Male) attended the field demonstration at different sites. The evaluation result showed that the machine has winnowing capacity (kg/min) of 7.68, 2.41 and 2.16; cleaning efficiency (%) of 97.22, 90.89, and 83.56 with relatively less product loss of 0.33, 3.33 and 6.0 for maize, wheat, and teff seeds, respectively. Therefore, there is a need to further scale this cleaning machine.*

Keywords: Pre-extension demonstration, Winnower

Introduction

In Ethiopia several agricultural production constraints are encountered at different crop growth stages. Energy and the timeliness are the major practical problem encountered in crop production activities, mainly due to lack of appropriate technologies. Estimates suggest that the magnitude of post-harvest loss in Ethiopia is remarkable ranging from 5% to 19% for maize and 5% to 26% for other cereals and pulses (Dereje, 2000). According to the African Post harvest Losses Information System (APHLIS) post harvest losses in 2012 for teff were estimated at 12.3%, for sorghum at 11.6%, for wheat at 9.9% and for maize at 16.8%. In order to help small scale agriculture increase its contribution in ensuring food security in the country, all aspects of production including harvest, threshing and post-harvest handling of the produce need equal and proper attention (Dubale, 2011).

Ethiopian farmers are totally engaged in farm works the whole year which includes land preparation, sowing, cultivating, harvesting, transporting, shelling/threshing and storing activities which are tedious process. Consequently, techniques that crush and damage grains such as beating with sticks or trampling by cattle are frequently used at Jimma and Ilubabor Zones (Kemeru, 2004). Most grain damage occurs during threshing as damaged grain is much more prone to attack by insects and fungi. Traditional threshing of crops like wheat, barley and sorghum is one of the most time consuming method which is laborious and maximum loss of grain (FAO, 2009b). The efforts to improve the post-harvest systems by different governmental and non-governmental organizations were believed to reduce the post production losses. Minimizing post-harvest loss has a great contribution to food security and raises the living standards in rural and urban areas (Abebe and Bekele, 2006).

Post-harvest activities comprises threshing, winnowing, grading, transport and storage. The winnowing operation, commonly known as grain cleaning is traditionally practiced in most part of the country using local equipment such as darba, afersa, korbi, gundo, hatola, sieve and etc. Similarly, grain loss occurs during winnowing activity of the products after threshing or shelling process. Problems like timeliness, high energy requirement, loss while blowing and removing larger chaff/straws fallen on the clean seed, seed and chaff mixing are among the common problems while using these local equipments (CSA, 2007). Because the activity depends on the natural wind, at times the threshed crop is left on the field for about 1-2 days in the absence of wind and when the wind speed is high, the seed can be taken away together with the straw/chaff. The average threshing and cleaning output per man-hour for wheat, sorghum, millet, and maize was 5.5, 6.5, 4.0, 1.5 kg/man-hour, respectively (Kaul and Ebgo, 1994).

However, literatures show that multipurpose post-harvest farm cleaning and equipments constituting winnowing and grading capabilities are now available at global level in a wide range performance levels (Tilahun, 2007). For instance, an appreciable works have been done by Bako Agricultural Engineering research centre to improve cereal crop winnower. Likewise, in some part (institutions) of our country, though not widely promoted and used by farmers, there are some improved winnowers, which can help in alleviating problems encountered in winnowing.

Therefore, the imported winnower machine is evaluated against the local practice mainly Gundo winnowing for wheat, teff, maize and sorghum seed and in view of that demonstrated in selected districts of Jimma and Buno Bedele zones by JAERC with advantages of being smaller size for transportation and manually operated comfortably, can clean maize, teff, wheat, barley and sorghum using sieves of different size interchangeably and it can be manufactured at small scale manufacturers level at the study area.

Materials and Methods

Manual winnowers for cereal crops were used to conduct the activity. The six Manual winnowers were manufactured at Jimma Agricultural Engineering Research Center (JAERC). The study was conducted in Dedo, Gomma, Nadda, Bedelle and Gechi districts. One Kebele was selected from each district. A winnower machine having a fan fitted in suitable housing used to create an air blast equipped with outer chipped wood board for delivering the specified volume of air that caries away the lighter materials (chaff or straw) and deliver the clean grain on one side when the threshed crop mixture was dropped from a hopper were used for demonstration purposes. Totally six improved manually operated winnower with three different size replaceable sieves (2mm, 6mm and 12mm) were provided to farmers in groups consisting of fifteen members. The host farmers were nominated by the groups and used for demonstration purposes on crops of different grain sizes.

A sample of three kilograms was taken from each crop namely maize, wheat and teff at three test sites that were used to show and compare the machine performance against traditional Gundo. Training was provided and demonstration was also conducted on host farmer’s field by threshing of the different crops across six selected project sites or Kebeles.

Training of Farmers, SMS and DAs on manually operated winnower

Practical and theoretical trainings were given for participant farmers to create awareness. SMS from selected districts working on crop production and Development Agents (DAs) were trained on machine operation and maintenance before actual demonstration to create awareness.

On farm Performance Evaluation and demonstration

To evaluate performance of winnower under farmers' management, six improved manually operated winnower with three different size replaceable sieves (2 mm, 6 mm and 12 mm) were provided to farmers in groups consisting of fifteen members

The performance of the Winnower was calculated using;

$$Winnowing\ capacity = \frac{weight\ of\ winnowed\ grain}{time\ taken}$$

$$Winnowing\ efficiency = \frac{Output}{Input}\ x100$$

$$Loss = Input - \frac{output}{input}\ x100$$

On farm evaluation and demonstration of the hand operated winnower technology was made in teamwork with participant farmers, SMSs and DAs. The evaluation of the technology was made in terms of the machine clearing efficiency, clearing capacity and the grain loss percentage. Farmer to farmer learning was used to promote the technology simply by arranging winnowing program at the host farmer's farm site. Farmers' feedback after the demonstration of manually operated winnower technology were collected based on evaluation criteria jointly set by researchers and farmers.

Farmers' perception on the technology attributes

Farmers' perception data during and after demonstration were collected. Data on technical operation and social perception aspects were collected. The winnower attributes used in the analysis of farmers' pereception were winnower efficiency (%), winnower capacity (kg/hr) and Grain loss (%).

Data collected

Quantitative data on the machine performance based in terms of time and labor consumed in Man-hr per kg/hr. Qualitative data through: observation and interview and feedback data and comments from participant farmers.

Data collection and analysis methods

The quantitative and qualitative data were collected about the technical performance and perception through interview, observation and group discussion and analyzed by using descriptive statistics.

Results and Discussions

Training Farmers, SMS and DAs on the improved crop winnower machine

Theorotical and practical training and awarness creation given on the topic such as improved crop winnower machine operation and maintenance for a total of 88 farmers, 15 DAs and 4 Subject Matter Specialists (SMS).

Table 1: Training Provided to Farmers, SMS and DAs on Winnower Technology

No	**Location**		**Training Participants**									
			Adult Farmers		Young Farmer		DA's		SMS		Total	
	District	Kebele	M	F	M	F	M	F	M	F	M	F
1	Goma	Kechene	6	2	4	3	2	1	1	0	13	6
2	Goma	Teso	6	1	5	2	2	0	0	0	13	3
3	Nada	N. Cala	6	2	4	3	2	0	1	0	13	5
4	Dedo	Kuno	6	2	4	2	2	1	0	0	12	5
5	Gechi	Haro	6	3	5	1	2	1	1	0	14	5
6	Bedele	Urgessa	6	2	4	3	1	1	0	1	11	7
Total			36	12	26	14	11	4	3	1	76	31

On-farm Evaluation and demonstration of improved crop winnower

Evaluation of the technology was made mainly for its clearing efficiency, clearing capacity and loss (%). On farm evaluation and demonstration of the hand operated winnower technology was made in team work with participant farmers, SMSs and DAs. The improved machine was evaluated against the local practice mainly Gundo winnowing for maize, wheat, and teff seeds. The evaluation of the technology was made in terms of the machine clearing efficiency, clearing capacity and the grain loss percentage. The evaluation result showed that the machine had an average winnowing efficiency (%) of 97.22, 90.89 and 83.56 percent, winnowing capacity (kg/hr) of 460.80, 144.60 and 129.60 and Grain loss (%) of 0.33, 3.33, 6 values for maize, wheat, and teff, respectively (Table 2).

Table 2: Average performance of the winnower for different crops (maize wheat, and teff) under the farmer's management

Rep	Time taken (Sec)	Winnowed grain (kg)	Chaff blown(kg)	Cleaning Efficiency (%)	Winnowing capacity (kg/min)	Loss (%)
Ma	20	2.895	0.09	96.33	8.76	0.67
Mb	25	2.94	0.06	98	7	0
Mc	23	2.93	0.07	97.33	7.68	0.33
Av	22.67	2.94	0.07	97.22	7.68	0.33
Wa	72	2.71	0.18	90.33	2.26	3.67
Wb	79	2.79	0.11	93	2.12	3.33
Wc	53	2.68	0.21	89.33	3.03	3.67
Av	68	2.73	0.17	90.89	2.41	3.33
Ta	63	2.53	0.37	84.33	2.23	3.33
Tb	71	2.48	0.32	82.67	2.09	6.67
Tc	68	2.51	0.26	83.67	2.21	7.67
Av	67.33	2.42	0.33	83.56	2.16	6

NB: The letters a, b & c indicate the winnower evaluated at three different sites whereas the letters M,W, & T represents Maize, Wheat, & Teff, respectively.

Mini-field days organized

Mini-field days were made at different sites namely Kuno, Sito Nada Cala, Kechene and Teso which attended by different stake holders. In view of that, 208 farmers (78 Female, 130Male), 9 SMS, 12 DAs and 15 Kebele Administrators have attended the mini field days.

Table 3 Participants on mini field days

No	Location		Participants of field days											
			Farmers				DAs		SMS		Administrators		Total	
			Adult		Youth									
	District	Kebele	M	F	M	F	M	F	M	F	M	F	M	F
1	Goma	Kechene & Teso	20	10	8	10	3	0	5	0	2	1	33	26
2	Dedo	Kuno & sito	17	11	13	15	2	0	3	0	3	0	35	29
3	Nada	Nada Cala,	15	8	15	13	3	0	0	0	2	1	35	22
4	Bedele	Mute	12	3	8	3	2	0	0	0	2	0	24	6
5	Gechi	Haro	14	2	8	3	2	0	1	0	3	1	27	7
	Total		**78**	**34**	**52**	**44**	**12**	**0**	**9**	**0**	**12**	**3**	**154**	**90**

Farmers' perception on the technology attributes

The respondents who replied that the machine has good winnowing capacity are in the range of 53% to 88 % for the four crop varieties (Table 4). This shows that most of the farmers have positively perceived towards its cleaning capacity. Similiarly, respondent farmers in the range of 53% to 71 % perceived that the machine has good cleaning efficiency. The winnower was also shown its own strength and drawbacks at the farmers' field. Farmers liked the machine for its low grain loss while winnowing or cleaning the seed and easy to operate and labor saving. However, they perceived it negatively in its manual operation that takes more time to clean large farm produces. The machine needs to be modified to engine driven to upgrade its winnowing capacity and minimize the human labor consumption.

Table 4. Farmers' Perception on improved winnower for Maize, Wheat, Tef & Sorghum crops

Attributes used for acceptance degree	scale measurement	participants' reaction per Crop Variety (No=45)							
		Wheat		Teff		Maize		Sorghum	
		Column		Column		Column		Column	
		Fr	%	Fr	%	Fr	%	Fr	%
Winnowing capacity (kg/hr)	Poor	-	-	-	-	-	-	-	-
	Medium	20	44	21	47	5	12	16	36.4
	Good	25	56	24	53	40	88	29	63.6
Cleaning efficiency %	Poor	-	-	-	-	-	-	-	-
	Medium	14	36	20	44	13	29	21	47
	Good	29	64	25	56	32	71	24	53
Grain loss (%)	Poor	-	-	-	-	-	-	-	-
	Medium	7	16	8	17.7	6	13	11	24.4
	Good	37	82	37	82.3	39	87	34	75.6

Conclusions and Recommendations

The improved crop winnower was evaluated and demonstrated on farmers' field against the local winnowing practice mainly Gundo for maize, wheat, and tef seeds in terms of the machine clearing efficiency, clearing capacity and the grain loss percentage. The machine has showed average time taken (man-hour) 22.67, 68, 67.33, 47.33 for maize wheat and teff respectively**.** Moreover, the machine had winnowing capacity (kg/man-hour) of 460.80, 144.60 and 129.60 and cleaning efficiency of 97.22, 90.89, and 83.56 for maize, whaet and tef respectively. The machine can perform the winnowing activity in a better way than the traditional methods with relatively less percentage of the product loss. It was also liked by the participants for its low grain loss during cleaning the seed and easy to operate and labor saving. Therefore, based on the study result, the machine was recommended for further popularization to the small size cereal crop producing farmers. As the demonstrated winnower is manually operated and more appropriate for small scale farmers, further modifications are needed to upgrade it to engine driven to improve its capacity to satisfy the need of medium scale crop producing farmers.

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Participatory Demonstration and Evaluation of Family Level Rain Water Harvesting Technologies in East Shoa Zone of Oromia, Ethiopia

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Abstract

*Participatory Demonstration and Evaluation of Family Level Rain Water Harvesting activity was carried out for two year (2016/17-2017/18) in Lume Woreda (Ejersa Joro, Ejersa, Korma Fatole and Muda Senkele) areas. One FREG was established per PA and a total of 4 farmers (one at each site) were selected to host the experiment. Four plastic lined trapezoidal water harvesting structures made of silt trap were constructed at each site. Introductory training related to water harvesting structures, harvested water utilization and its management was given to FREG members. The input cost for 11m x 11m pound excavation includes 6719 Birr for geo membrane plastic sheet (14m*14m), 400 irr for gricultural inputs (seed, fertilizer etc) & 2000 for labor cost. The marginal rate of return goes to 11,431 birr simply by growing brassica & by producing local blocket. The result of the study revealed that constructing water harvesting structure in dry and moisture stress area is the most important in improving farmers' income & the livelihood than those farmers dependent on rain fed farming. When the structures are compared in terms of water storage and its income generation options, it is 100% better than those which have no water harvesting structures. None host farmers who have got the opportunity to visit the structures were very much surprised, the benefit from harvested water and stayed on pond for longer period (more than four month and half) than they expected. Therefore, popularizing this technology in areas with similar agro ecology & moisture stressed environments are very crucial and utilization of harvested water and management of the pond, and on control of seepage, evaporation loss and siltation minimization.*

Key words: FREG, Supplementary irrigation, Revenue, Water Harvesting, Revenue

Introduction

The Arid and semi-arid lands of Sub Saharan Africa are characterized by erratic rainfall with high annual variability, annual potential evaporation exceeding the rainfall amounts, high amounts of runoff due to low infiltration and recurrent soil moisture deficits limiting crop production (Ben-Asher and Berliner, 1994). Even under normal rainfall conditions, households rarely produce sufficient food for their needs. Moreover, a combination of population growth and a lack of out-migration and off-farm opportunities have pushed people to more marginal land where rainfall is often unreliable. Consequently, the food insecure household is growing annually in the country. This is especially the case in the more semi-arid lowland areas (the problem persists in all areas), where agricultural productivity tends to be the lowest. In these areas, unless supplemented by irrigation to reach crops to production or fully involved in irrigation, the agricultural production is not as such compelling to reduce the food gaps on citizens (Goshu, 2007).

Larger water storage structures have not been widely implemented in Ethiopia (where adequate data set is not available), as they have often proved to be too expensive in construction and maintenance. Instead, small earthen reservoirs are proved to be promising answer to the problem of storing water (Rami, 2003). Sufficient investment in water harvesting needs to be not only a higher priority for the semiarid regions but also for the entire country (Kidane, 2001). Farm ponds and reservoirs provide a logical source of such water, for they may be designed and adjusted to fit the individual land use plan (Taffa, 2002).

Rainwater harvesting (RWH) can improve the livelihood of rural population by ensuring optimal crop production in areas where shortage of rainfall is a limiting factor. Rainwater harvesting (RWH) systems, successfully tested for higher crop productivity in smallholder farming of the semi-arid world, are suggested by several researchers and developmental organizations as potential measures of supplemental moisture/water supply (Hatibu and Mahoo ,1999;Critchley and Reij 1989). For instance, marginal land with annual rainfall as low as 300 mm can be made productive if controlled and limited water is made available by RWH techniques (Ngigi, 2003). The problem of moisture stress is common especially in mid rift valley of Oromia region, particularly in Lume district. Therefore, the problems related to food security and recurrent famine need urgent solutions to find viable and urgent management options, which would increase the productivity of agricultural activities and meet the food requirements of the rapidly growing population. The major problems in the study area are crop failure at vegetative stage or could not provide expected yield, uneven distribution of rainfall or erratic rainfall and etc. Because of the problem mentioned above some farmers were not secured their food. Thus, appropriate management of rain water harvesting (RWH) is very crucial to get the benefit out of this valuable resource. Hence, rainwater harvesting is a useful mechanism to overcome the recurrent erratic rainfall and dry spell conditions which often result in crop failures in Lume District. There is a need to effectively promote promising RWH technologies and systems; to incorporate and integrate land users' knowledge and innovations; and to build capacity of the land-users to assimilate, adopt and adapt various technologies. Therefore, to tackle the problem of poverty and increase agricultural productivity in Lume district, the proposed research bases upon on awareness creation and implementation of successful method of "run off rain water harvesting" which can be effectively used by resource poor farming households, to overcome the hardships of nature.

Materials and methods

The activity was carried out in four major moisture stress and shortage of rainfall areas in Lume (at Ejersa, Ejersa Joro, Kurma Fatole and Muda Senkele) Wereda for two year (2016/17-2017/18). Plastic lined trapezoidal water harvesting structures were made of 11m * 11m of top width and 3m*3m bottom width as well as with a depth of 2.5m. A total of 10-15 labor was used to excavate the structure and a construction material used were Geo membrane plastic sheet (PVC for pond lining), excavation tool, meter tape, pegs, sand and cement. A silt trap which filters the runoff water was constructed nearest to pond with lined cement and early matured horticultural crops (paper, head cabbage and tomato and etc) were used.

Table 1: The materials used for construction of the pond structure

No	Material used	Purpose
1	Geo membrane plastic sheet (14m*14m)	for lining the pond
2	Peg and meter tape	For lay out
3	Axe, akafa, jamba, digging tool	Excavated tool
4	Sand, cement and bricks	For construction of silt trap
5	Labor	Excavating the pond

The activity was conducted in East Shoa zone of Oromia. Lume district which is drought sensitive area was selected for the study area. The area is characterized by porous type of soil and very high rate of evaporation. Plastic lined trapezoidal underground ponds were constructed considering demand and loss of water. Nature of the soil in the area, volume of water to be stored, catchment area, and capacity of the households to manage the structure were the major criteria to decide the site. Attempts were also being given to siltation control methods since it affects both quality and quantity of water and reduced the capacity of pond. During design spillway and freeboard were considered to prevent surplus flood water and protect the bank from overtopping under high intensity rain fall respectively. From the district representative four kebeles were selected. From each kebele one household (HH) was selected to implement the project. Three parties were involved in selection of the PA's based on severity of moisture deficit and access. These were the research center, district agriculture and natural resource office staffs and PA leaders. The selected farmers were organized under Farmers Research Extension Group (FREG) to increase group learning.The selected HHs were expected to express their willingness and commitment to undertake the activity in their backyards.

Discussion were made using PRA with each group of organized farmers to identify priorities. After priority was identified data were collected on the amount and frequency of water use. For further sharing of information field days were organized by inviting farmers and relevant stakeholders. The activity was regularly visited for follow up. Training was conducted both in the beginning (introductory) and at the mid on importance of water harvesting and harvested water utilization. Moreover, field days were organized at the one site where more than 70 surrounding farmers attended and provided their feedback on the structure.

Implementation process

Farmers and DAs participation*:* As discussed earlier four farmers; one at each location were involved in the activity. With the idea of implementing family level water harvesting structure in their back yards by sharing common understanding with in farmers, discussion and training was held with participant farmers and DAs. The pond was fenced and multiple crops were planted on one farmer's farmland with supplementary irrigation and demonstrated to the FREG member for awareness creation. The participant farmers, in general, played the role of information sharing to other farmers, providing feedback on the structures, recording and provided information and took an active part all the way from construction of the structure.

Introductory training*:* the hosting farmers together with the respective members of the Farmers Research Extension Group (FREG), experts from woreda agricultural office of irrigation and natural resource and DAs were given an introductory training on water harvesting and on ways of implementing the activity in demonstration in respective locations. The participants visited the constructed structures which were built in the area.

Field day: Field day was organized for surrounding FREG and non FREG member farmers one months after rainfall recedes and harvested water in the constructed pond. A total of 60 farmers, 4 DAs and 3 experts were respectively participated on the experiment. The host farmers and the researchers explained the whole process and discussions were held in response to the queries from the farmers. Issues such as water shortage and crop failure due to moisture stress problems and interest to construct the pond by private and also in group about the importance of harvesting water in the area and its utilization were raised.

Selection of catchments area

The catchment were selected considering that the catchment area were collected sufficient runoff water. The runoff water collected from the catchment area should be easily diverted to the pond. The catchment area should be located sufficiently away from pollution sources. The catchment must generate as little sediment as possible.

Pond Constructed

Plastic lined trapezoidal underground pond was constructed considering demand. Four ponds were constructed at each kebeles based on the criteria of selection like severity of moisture deficit and access to the infrastructure. The pond which was constructed is trapezoidal 11m*11m top and 3m*3m bottom with depth of 2.5m respectively.

Estimation Volume of stored water in the Pond

V=P*C*A/1000 in m^3

Where; V=volume of water in the pond, m^3, P=Total Rainfall, mm; C=R/P=runoff coefficient A=catchment area, m^2; R=runoff, mm; C or Run off coefficient value

Estimation of Volume of stored water in the Pond

Length of rain period was recorded from June to the end of August. Duration of water stayed in the pond. The water was stayed on the pond from two month to five month. The total rain fall recorded was 650mm, the catchment area of the site was 1000m^2 and runoff coefficient, C was taken from table of plastic line covered is 0.85. The total volume runoff estimated from the area where V (volume of water stored) = 650*0.85*1000/1000 = 552.5 m^3

Table 2 runoff coefficient value

S.N.	**Type of catchments**	**P-Values for difference rain fall amount**		
		250-500 mm	**500-1000mm**	**1000-1500mm**
1	Roof	0.8-0.9	0.8-0.9	0.8-0.9
2	Concrete floor	0.75-0.85	0.75-0.9	0.75-0.9
3	Stone Riprap	0.70-0.80	0.75-0.85	0.75-0.85
4	Compacted soil	0.15-0.30	0.25-0.40	0.35-0.55
5	Cement clay	0.40-0.55	0.95-0.60	0.50-0.65
6	Plastic covered	0.85-0.95	0.85-0.92	0.85-0.92
7	Scattered vegetation cover	0.08-0.15	0.15-0.30	0.30-0.50
8	Good vegetation cover	0.06-0.10	0.10-0.25	0.25-0.45
9	Stone riprap with pointing	0.70-0.80	0.70-0.85	0.75-0.85

Results and discussions

FREG Establishment

Four Kebles were selected from the study district. The selected farmers were organized under Farmers Research Extension Group (FREG). Four Farmers Research Extension Group (FREG) were established, one at each kebeles. One FREG comprised of 10 farmers and hence a total of 40 farmers participated in the project from this 40% of them were women and 60% of them were men household farmers.

Table 3: Farmers Research Extension Group established at each sites

District	Peasant association (PA)	FREG Established	Number of FREG		
			Men	Women	Total
Lume	Ejersa Joro	1	6	4	10
	Ejersa	1	6	4	10
	Korma Fatole	1	6	4	10
	Muda Senkele	1	6	4	10
Total		**4**	**24**	**16**	**40**

Training and Field Days

Training to the farmers and SMS were given on water harvesting management and water utilization and accordingly around 60 farmers and experts participated. Mini field day was prepared on water harvesting and 60 farmers and experts participated.

Evaluation and Feedback of the Farmers

In Ejersa and Ejersa Joro, the farmers were excited to observe water stayed on the pond for more than four months even if the harvested water used as supplementary irrigation for maize crop. The host farmers explained the whole process from the construction to the time of harvested water as well as for which purpose was used. Moreover, more technical matters viz direction of the future utilization and management of harvested water and pond, how and when to use the water, why and in what position should the silt trap be constructed, how the geo membrane plastic sheet and the overflow of water should be removed were explained to the field day participant by the researcher. Farmers recognized the technology as an alternative means to store water and income generation. Farmers have raised the issue of size, whether the pond can be constructed to carry more volume of water, and it was explained that by increasing the dimensions (size), it can serve the stored water for different purpose not only for supplemental irrigation and also home garden vegetation, home consumption and livestock use. In general, the farmers were convinced by the technology and some of them made a decision to construct the pond by their own in the following year by private and group.

Farmers' reaction/perception

Through the conducting period of the activity/project the farmers' reaction/perception before the starting of the project and at the end was different. Before the starting of the project the farmers in the selected areas of the project, even if the area was moisture stress, uneven rain fall distribution and long dry spell occur the farmers who live in the area of crop production depends on only by rainfall on which the amount of the water that fall were small that does not satisfy the crop water need throughout the growing season that were the main challenges that face the farmers during the summer time and the farmers' in the area do not have any awareness/ knowledge of harvesting the runoff water during the rainfall period until the project/activity started. After the activity/project were started the farmers' perception on harvesting the runoff water were increased.

Table 4. Farmer's perception on the technology

No	Information gathered from farmers	Feed backs from the farmers (%)	
		Accepted (%)	Not Accepted (%)
1	Cost of the technology	87.5	12.5
2	beneficiary	93.75	6.25
3	on income generation	97.5	2.5
4	used for supplementary irrigation	82.5	17.5
5	domestic use	43.75	56.25
6	water harvesting structure(pond)	85	15
7	information on availability of material	12.5	87.5
8	willingness and capacity to construct the pond	90	10
9	options create on availability of water on the area	96.25	3.75
10	knowledge gained on management and utilization on project	98.75	1.25
11	awareness created on farmers	98.75	1.25

The attitudes of the farmers' on back yard family level water harvesting structures awareness were improved. To know the farmers' reaction/perception on water harvesting pond the data/information gathered were like cost of the technology, benefit before and after introduced the technology, supplemental irrigation when long dry spell of rainfall and also income gained from harvested water etc. the result indicated in the above table more than 95% of the farmers were accepted the technology based on cost, income generation, gained knowledge on supplemental irrigation for crop production by using the harvested water when long dry spell of rainfall occur. The farmers' willingness and capacity to construct the pond and share the knowledge and skill gained from the project to each other 90% of the farmers were accepted.

Farmers' participation and Change in level of awareness

Farmers' participation, the cchange in level of awareness, knowledge and skill of participating farmers were 100% increased and changed. The participation of the farmers in this project were increased from year to year. The willingness of not only the members of the farmers research extension group that of non FREG which were not in the group had great wish to participate and conduct/construct such kind of structure in their back yards. Demonstration of family level water harvesting structure from the start of site selection and pond construction to the end of utilization and management of harvested water of farmers' participation were throughout at each the process level. All the trial farmers were participated in lining the geo membrane platic sheet on the ground, silt trap construction, layout and pond excavation, during training on harvested water utilization and pond maintenance, and on mini field day played active role of participation during demonstration. The level of awareness created in the farmers' were changed and increased not only by taken training and also in actively participating in demonstration process. The skill and the knowledge of the farmers' before demonstration were low as compared with after demonstration. Not only the trail farmers level of awareness were increased both the FREG and non FREG members of level of awareness, skill and knowledge on water harvesting were very low and which improved up to 98.78% of level of awareness reached through demonstration and training.

Estimation of Financial Cost

Table 4: Summary of overall economic analysis of the technology

Description	Total ETB
Costs	
Labor cost	2000
geo membrane plastic sheet(11m*11m)	6719
Input costs	400
Total Cost	**9119**
Revenues	
Maize (produced supplementary irrigation)	10800
Local mud blocket (4000 Blockets)	8000
Tomato	300
Head cabbage	250
Ethiopian kale	700
Brassica carinata (Goman zer)	500
Total revenue	20,550
Profit (Total Revenue-Total cost)	11,431

The above table shows the cost of expenditure involved in the construction of family level back yards plastic lined pond of water harvesting structure. If the farmers have the potential privately to excavate the pond with labor cost, it was around two thousand birr (2000), but if not have the capacity to excavate the pond and made on its own otherwise by forming group to excavate on each of the members of the group step by step the labor cost would be zero and the expenditure would be reduced as seen in column three of above table. 1meter square of geo membrane plastic sheet at the time of market price was around 39birr. Total cost spends for construction of the pond (11m*11m) the geo membrane plastic sheet needed around 14m*14m its cost was recorded 6719 Birr. Agricultural inputs (seed, fertilizer etc) were recorded around 400 birr.

Revenue

The benefit of harvested water was the crucial importance in improving farmers' livelihood and income generation. As seen in table above the revenue which was gained from the constructed pond as serves as supplementary irrigation of maize crop when there is no rainfall and when the crop needs water were used. By using supplementary irrigation the harvested water for the maize it minimized loss of crop failure and have got around 12 quintal which was 900 birr per quintal at the time of harvested and from the total around ten thousand eight hundred birr (10800) were recorded and sold to the market. Farmers also used the harvested water for other purpose for instance, locally made blocket which either used for building of house or sold to local market. The price of one locally made bloket was 2 birr and the farmers were made around four thousand birr (4000) locally mud bloket. Totally, the farmers got around eight thousand birr (8000). Home garden vegetables also was planted in the backyards which were planted tomato, head cabbage, cabbage (Ethiopian Kale)and also other like Gomanzar (Brassica carinata). A total of not considering that the farmer was used for home consumption and only sold from home garden and other was around one thousand seven hundred fifty birr (1750). This indicate that if properly constructed water harvesting structure in where there is shortage of rain fall and moisture stress exists it is crucial on livelihood improvement. As suggested by Awulachew *et al.* (2005), increased productivity of staple grains is an important element contributing to the achievement of food security in Ethiopia. “To meet future increased food demand in SSA, current farming systems need to be more efficient in both farm water and nutrient management. (Barron & Okwach, 2005).

Profit

The profit that farmers got from construction of pond on his back yards would be seen in two ways one when the farmer have the potential to labor cost and the other was when the farmers excavate the pond by its own which totally reduces the labor cost and the profit which the farmer got would be different and increases as well as the profit of the product rather than sold from home garden which was used for home consumption was another benefit.

Conclusions and recommendations

Therefore, the issue of water is put as top priority in the regional agricultural policy and strategy in order to attain food security. The major constraint to successful crop production in the area is water stress and this is the common denominator to all areas in the world. Therefore, the first step to improve crop production in the area is to develop water-harvesting techniques and then use the limited water efficiently. Water-harvesting technology (WHT) were introduced to counter the effects of the adverse natural conditions and enhance food production through intensive backyard gardening using the water collected in the structures. The technology was contributed to the improvement of House Holds livelihood in different ways, depending on the capacity House Holds to utilize them effectively. There was remarkable improvement in the level of farmers’ awareness on utilization of WHT. The numbers of farmers requesting the technologies were grown year to year.

The FREG farmers’ understanding about the purpose and importance of the FREG approach/activity has improved. The FREG farmers in the four locations are aware of the physical family level water harvesting in the backyards and utilization of water harvested as well as the management of the constructed pond. Surrounding non FREG farmers got the opportunity to observe and learn the potentials of the water harvesting on improving livelihood income generation and on consumption of harvested water for different purpose. Ensuring active involvement of the respective woreda agricultural offices is critical in sustaining the activity.

It was recognized that farmers had lack of knowledge on water harvesting. Organizing Training to fill such gaps coupled with an on farm visit to the site of pond constructed FREG farmers’ field had helped the farmers to gain knowledge on water harvesting, its utilization, management and maintenance of the pond. The future research direction should focus on estimation of sediment yield that comes with the runoff from the catchment to the pond and design the silt trap based on the coming sediment yield. And also continuous training on the importance of water harvesting should be providing to the farmers. Scaling up of this technology in moisture deficit area is necessary.

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Pre-extension Demonstration-cum-Evaluation of Coffee Huller in E. Wollega Zone

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Abstract

The research was carried out for a year (2016/17 & 2017/18) in two AGP-II beneficiary woredas viz. Wayu Tuka and Gida Ayana, with the specific objectives of creating awareness on coffee huller technology among farmers and evaluating performance of the machine through FREG approach. A total of 60 farmers were included & sex was considered when FREG was estalished. In the course of implementing the project, farmers received two days training that focused mainly on awareness creation on characteristics of the technology, merit of the machine compared to farmers practice, procedures to be followed in implementing the technology evaluation. Following the two days training, successful technology demonstrations were carried out during which farmers evaluated the technology on their farm and verified that the technology worked well under their circumstances.The introduced technology saved on average 9.7 hours per quintal for hulling activity, compared to the hulling time that could be taken to following the traditional methods. About 94% of the farmers said that there is difference in labour requirement between the traditional and the new coffee huller. However, the rest (6%) said that there is no difference in labour requirement between the two methods. Therefore, based on the encouraging results obtained in the pre-extension demonstration, the technology was recommended for wider popularization and pre scaling out.

Key words: Coffee, Coffee hulling, Demonstration, FREG

Introduction

Coffee in Ethiopia forms an integral part of the national economy accounting on average for about 4 % of GDP, 10% of agricultural production, and about 37 % of the total export earnings over the past decade (MoA, 2014). Recent estimates show that more than 16% of the Ethiopian population, representing 15 million people, is dependent on coffee for at least a significant part of their livelihood, adding 7 million people directly involved in coffee cultivation and 8 million in the processing, trading, transport, and other coffee related businesses (Girma et al., 2008). According to EAFCA (2010), Ethiopia is the fifth largest global producer of Arabica coffee bean in the world, and the largest coffee producer in Africa. In 2011, for instance it produced about 270 000 million tons of coffee. In the same year, annual coffee export from Ethiopia is around 200,000 tons valued 500 million (ITC, 2011).

The Ethiopia's zones of Kaffa, Sidama, Harar, Jimma, Ilubabor, East and West Wallaga, are producing a large proportion of the Arabica coffee in their forests and plantation fields of their fertile and beautiful region. So, as it is mentioned above, East Wallaga is one of the Zones of Ethiopia where coffee grows well. Its natural climate becomes suitable for the plantation of coffee in most parts of its districts. In East Wollega the area under coffee production covered 137,102 ha more than 95% of which is cultivated mainly by small scale farmers in home gardens and semi-forest and forest coffee production systems (EWZANRDO, 2017; FDRE, 2003). Be that as it may, these small holder farmers are not benefiting from coffee production as a result of poor harvest and post-harvest practices. Hulling is an operation that is part of the post-harvest processing of coffee which if not adequately managed, results in poor quality of the product (Agrisystems, 2001). There are active hullers in Leka Dulacha and Guto Gida. However the proximity of these facilities to remote poor farmers is inadequate and the farmers in the study area are still hulling the coffee bean either by the method of beating by hand in a tool locally known as Moye or milling it by local cereal milestone. The process is arduous, time intensive, and often results in high level of drudgery and product losses due to breakage. As indicated in the study conducted by Dagnachewu (2017), removing husks from dry coffee like this affects the final quality of coffee and deteriorates flavor, fragrance and other attributes of coffee as well.

Taking these problems in to account Bako Agricultural Engineering Research Center (BAERC) has designed and developed a machine with hulling capacity of 2.5-3 qt h^{-1} and can give quick-solution for the problem aforementioned. The technology does not only make coffee-hulling operation easier faster, and efficient, but also saves the time, reduces back pain and palm blister. However, farmers in the area are lacking awareness and information regarding the existence, result and importance of the technology over the existing local coffee hulling methods. This being the case the present research was initiated and carried out to create awareness among farmers on coffee huller technology, evaluate the performance of the machine, and to assess farmers' and other stakeholders' feedback for further technology improvement

Methodology

Description of the study area

The present research was carried out in Oromia Region, Western Ethiopia, East Wollega Zone in Wayu Tuka and Gida Ayana districts. These woredas are some of the beneficiaries of the second national agricultural growth program (AGP) that targeted supporting agricultural productivity and commercialization focusing on high agricultural potential areas to address some of the key constraints to agricultural growth. The two woredas were chosen for their wider area coverage of coffee production than the rest five AGP-II beneficiary districts administrated under this zone

Wayu Tuka

Wayu Tuka in which the research was conducted is a woreda located about 320 km west of Addis Ababa and some 10km east of Nekemte town, the capital of east Wollega zone. Astronomically, the woreda lies between 8°56' to 9°07' N latitude and 36°32' to 36°48'E longitude with 1183.44 square km area coverage. Low land and mid land agro ecological zones characterize the woreda's climate. The woreda minimum annual temperature is 14^{o}c degree centigrade whereas the maximum temperature reached as high as 26 degree cent grade with the mean annual rainfall ranges from 800-2000mm. The main rainy season in the woreda is from March to half of September. The soil of the area is characterized by is reddish brown Nitosols with sub surface layer of accumulated Kalonitic clay in the order Oxisol, low Cation exchange capacity, low base saturation and low pH values. The woreda has a total of 10 kebeles in which mixed agriculture is commonly practiced. The major crops cultivated in the woreda include both rain-fed and irrigated crops namely Maize, coffee, Millet, Teff, Fruits, Vegetables and root crops like Anchote, sweet potato and Irish potato (WAO, 2014).

Gida Ayana

Gida Ayana is located 120 km from Nekemte- the zonal capital and 450 km from Addis Ababa to the west. The size of the woreda has an area of 183,063.73 hectare of land which lies between two agro-climate zone of Weiyena Dega, covering 51 percent of the total land and Kolla with a total coverage of 49 percent. Annual crops take the leading land use type covering 27,410 ha following, grazing land 26,340 ha, mixed land use 20,000 ha, perennial crops 8,000 ha, roads and social institutions 4,223 ha, plantation forest 4,050 ha, and natural forest 2,196 are among the many land use types in the woreda in order of importance (CASCAPE PRA study report document, 2012).

The altitude of the woreda ranges between 1380 meters above sea level in the low lands bordering Hunger river and 1,750 m a s l at the high land and the major soil type are 26% clay, 17% sandy, and 58% silts (Gida Ayana district annual report document, 2012). In case of rainfall pattern the woreda is predominantly uni-modal and it receives rain from mid-march through end of September. The dry season extends from January to mid march. It has a total of 21 rural kebeles, populated by 27,496 households of which 88.2 % is male and 11.9% is female (project based on 2007 census result BoFED, 2010). Both livestock raring and crop cultivation are practiced. Cereals, pulses and different types of oil seed crops and horticultures are grown well from the lowlands to the midlands of the district (GAoANR, 2012). According to development corridor that the region pursues, the research area was set under production of coffee and associated crops which are more of market value agricultural products in terms of their price and demand.

Site and farmer selection

Meeting and Discussion were held with the management of Woreda Office of Agricultural and Natural Resource Development by which the nature and purpose of the activity was explained and the representative research sites (kebeles) within the districts were identified. Accordingly Gute Badiya, Gidda Abalo, Konaji and Ejere kebeles were chosen for the intended activity from Wayu Tuka and Gidda Ayana districts respectively. From each selected kebele and village, fifteen farmers that include both sexes and different age groups were selected based on the willing to participate and explain the details of the technology demonstrated, to other neighboring farmers. The selection was done through consultation between project staff, extension agent and local leaders.

Mode of implementation

This pre-extension demonstration was carried out through the participatory fashion. Prior to performing the intended on-farm showcases, the farmers were grouped into four farmers research groups (FREGs). The group consists of 40% women and they assigned the leader and secretary to work closely with researchers. After the establishment of FREGs, training was given to the farmers on the FREG concept, coffee hulling technology and finally the technology was delivered to the farmers from BAERC and follow ups and essential advices from respective researchers has been taken place. Mini field days were also organized to provide the opportunity for other farmers to witness the benefits of demonstrated machine. During demonstration, field day and participatory monitoring, FREG members, development agents, experts and other inviting farmers were evaluated the performance of the improved machine versus local practices for its merit.

Data collection and analysis

The data entail farmers attended demonstration; participated in training; became aware of the availability and importance of the technology and their perception in relation to demonstrated technologies were collected employing checklist developed for this purpose through group discussion and personal interview. Finally those collected data were analyzed with simple descriptive statistics of frequency and percentage.

Results and Discussions

Farmers' awareness creation

A multidisciplinary team of researchers drawn from Socio Economics, Agricultural Extension, & Machinery Case Teams has given two day training for a total of 73 farmers and extension workers (Table 1). In this way they all became aware of the existence and of the benefits emerging from the machine. The provision of training was not only for awareness creation but for also develops and improve the technical know-how of how to use the machine.

Table 2. Type and numbers of trainees

District	kebele	Participants								
		Farmers			Development agents			SMS		
		Male	Female	Total	Male	Female	Total	Male	Female	Total
Wayu Tuka	Gidda abalo	13	2	15	1	0	1	2	0	2
	Gute badiya	12	3	15	1	1	2			
Gidda Ayana	Ejere	12	3	15	3	0	3	3	0	3
	Konaji	12	3	15	2	0	2			

Source: Own data (2010)

Moreover, to help and create awareness on the technology, farmers' field day was successfully conducted under the project and a total of 60 farmers, 20 extension workers, and 8 other stakeholders attended the activity. Evaluation after the field day showed that the technology was rated very good versus traditional practices in terms of its performance.

Difference in performance between traditional and demonstrated technology

Table 2 presents comparison of the demonstrated machine and traditional method with regard to average time spent in coffee hulling activities. As estimated by the farmers, the average time required to hull one quintal of dry coffee bean was 10.3 hours. Similarly, during demonstration the average time required to hull one quintal of coffee was 0.3 hour. The result is not comply with the recommended on station result. This was may be due to improper application and unskillfulness to operate with the machine. All of the farmers (n=60) perceived that the introduced technologies saved their time in general

Table 2 Average time spent to hull one quintal of dry coffee

Activity	Average* time spent (hours)		Difference
	Traditional	Introduced	
Hulling coffee	10.3	0.3	9.7

Source: Own data (2010); * the sum of time estimated by farmers divided by number of farmers

As shown in table 2, farmers who used the introduced technologies on average saved 9.7 hours per quintal for hulling activity, compared to the hulling time that could be taken to perform this activity under the traditional methods. Labour requirement: About 94% of the farmers (n=16) said that there is difference in labour requirement between the traditional and the showcased coffee huller. However, the rest (6%) said that there is no difference in labour requirement between the two methods

Work load: Farmers were asked to give their general views on whether there is workload difference when using the traditional and the demonstrated coffee hulling technology. Of the interviewed farmers (n=32), majority (78%) of them replied that there is workload difference when using the traditional and the demonstrated coffee huller. However, 34% of the farmers did not realize whether there is work load difference or not while 3% of them said there is no difference.

Conclusions and recommendations

From the current pre-extension demonstration of coffee huller machine, participant farmers, experts and DA of the targeted area evaluated the machine and got first hand observation and information on the actual performance and benefit of that technology. Similarly, surrounding non-FREG farmers got the opportunity to observe and learn the potential of the demonstrated technology. The result of evaluation showed that the technology saves the time in average 9.07 hours. In conclusion, demonstrated coffee huller has better performance than the existing conventional method in terms of reducing work load, time and labor cost. Therefore further popularization and pre scaling up activities should be done by the research centers and office of agriculture and natural resource developments for its mentioned merits.

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Pre–Extension Demonstration of Roof Top Rain Water Harvesting based Drip Irrigation System for hot Pepper Production in selected districts of Harari Regional State

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Abstract

Agriculture is only possible when there is availability of water. Water harvesting can reduce the risk substantially by facilitating early planting, by taking maximum advantage of the rainfall, thereby insuring crop against rainfall irregularities. Therefore, the aim of this study was; demonstration and awareness creation on drip irrigation technology using roof top rain water harvesting through pepper production at household level. The study was carried out for two year in Harari Regional state of Erere Waldiya district in Erer Dodota kebele and Sofi district of Kile kebele. Two kebeles (PAs) were selected for the implementation of the activity based on willingness, availability of corrugated iron houses, accessible of site/parcel of lands. From each PA 15 farmers were grouped in the form of Farmers Research & Extension Group (FREG) with consideration of gender balances. Among them, two trial farmers were selected for implementation of intended work. Where 28 farmers were participated in conducting the field works like; land preparation, drip system layout and water harvesting structures installation on selected trial farmers accordingly. Economic evaluation or cost benefit analysis of drip irrigation method for hot pepper production using roof top rain water harvesting was done. Accordingly, yield performance hot pepper under drip irrigation method showed 95.9 and 108.4 kg were harvested from a total area of 10 m^2 from Kile and Erer dodota, respectively. Thereafter the system NPW (net present worth) and BCR (benefit cost ratio) for 10 years life span of drip system computed as 59062.3 Birr and 8.3 respectively. As a result, it can said that drip irrigation system is feasible though its initial investment is high. Based on those criteria, the FREGs evaluation showed that, drip irrigation method was preferred by farmers and ranked first in both PAs due to its better water saving methods, operation simplicity, labour & level of acceptance of the technology reaches, 92.11% to 89.47% at Erer dodota and Kile, respectively.Therefore Farmers should either get subsidy from government, loan from financial and credit institutions or organize in to cooperatives to pool money so that they can afford the heavy investment cost of drip sets.

Key words*:* Rooftop rain water harvesting, drip irrigation demonstration, pepper, partial budget analysis,

Introduction

A major reason for the low and erratic rate of growth in agricultural production is the highly uncertain and unpredictable rainfall, combined with low soil fertility (FAO 2003). Even in years of ‘average’ rainfall, a shortfall during critical periods of crop growth often leads to widespread crop failure. Therefore, water storage is absolutely crucial for stabilizing and increasing crop yields (FAO 2003). Agriculture is only possible when there is availability of water. By water harvesting during rainy seasons, water availability can be formed. Water harvesting can reduce the risk substantially by facilitating early planting by takingmaximum advantage of the rainfall, thereby insuring the crop against rainfall irregularities.Thus, rainwater harvesting, utilization and management has a special significance in solving the food security and poverty alleviation issues in the country in general and the Oromia region in particular. Efficient collection and storage of rainwater is critical in food insecure areas with increasing pressure on land. Capturing of more rainfall and the efficient storage and use of the water is even becoming a national necessity against combating drought and famine (OFS, 2002).

Pepper is extensively used as spice and diet in Ethiopia. Irrigation is essential in arid and semi-arid regions to provide adequate moisture for production of pepper. Today, many hectares of peppers are grown with irrigation in the semi-arid regions of the world. The total world production of this crop has been estimated to be 14 to15 million tons a year (Weiss, 2002). Della Costa and Gianquinto (2002) reported that continuous water stress significantly reduced total fresh weight of pepper fruits. Moreover, Antony and Singand (2004) found that the total pepper yield was less at lower levels of irrigation. Therefore the aim of this study was; demonstration and awareness creation on drip irrigation technology using roof top rain water harvesting through pepper production at farmer level in drought prone area of Erer Waldiya and Sofi district in Harari Region state

Materials and Methods

Description of study area

The study was conducted in Harari Regional state of Erer Waldiya district in Erer Dodota Kebele and Kile Kebele of Sofi district. Both sites were situated at 42^0 10' 50" to $42^0$15' 50" East latitude and 9^0 $19^{'}$ 10" to 9^0 13' 20" northern longitude respectively. The sites receive a mean annual rainfall of 400 mm. It has erratic and uneven in distribution, with mean minimum and maximum temperatures of 25 ^{0}C and 35 ^{0}C respectively. The major soil types which occur in both midland and lowlands of the Erer Waldiya and Sofi districts are Luvisols (Sandy soil) 90% and nitisols (clay) 10% (AGP-II, 2016). The soil types in the experimental sites are sandy loam and sandy clay loam respectively. Major crops grown in the study area are sorghum, maize, pulse or oil crop, and chat. In addition, sugar cane, mango, tomatoes and pepper are the commonly cultivated vegetable crops, in the vicinity of the sites, under traditional irrigation method like wild flooding, basin and furrow irrigation

Farmer Selection

Farmers' selection was conducted through collaboration of woreda agricultural and rural development experts and development agent. Model farmers were selected based on their willingness/interest, availability of corrugated iron houses, accessible of site/parcel of land, ability to risk taker and ability to allot land for the intended purpose. Two PAs were selected from two district of Harari Region for the implementation of the activity based on the above criteria. The selected farmers were grouped in form of Farmers Research Group (FREG) with the member of 15 farmers per PA with consideration of gender issues (women, men and youth). One FREG at Kile Kebele and another FREG in Erer Dodota) which contain a total of 30 farmers was formed. Among them two trial farmers were selected, where 28 farmers were participated during conducting the field work.

Implementation of drip irrigation system

Irrigation system design, field layout and water application method

Irrigation water was obtained from rooftop rain water harvested during rainy season for the experiment which was then stored plastic tank (storage) near the experimental plots. Water storing tank were placed at appropriate place around the houses from which to collect the roof rainwater. Water collecting gutter (*ashanda)* and down pipes were prepared and installed in appropriate manner to collect the roof rain water and store in the tanks. Two storage tanks were installed at appropriate place around the houses for collecting storing rainwater. At each location the tanks were designed to have a storage capacity of 3000 litter and 5000 litter. The plot having an area of 10 x 10 m^2 was prepared in each location. Drip system consisted of water storing tank, main lines; sub main lines, lateral lines, emitters and regular filter.

The sub main line was connected to the mainline. The drip lateral lines arranged in each plot received equal amount of irrigation water from the sub main line. The spacing between each emitter was 0.4 m and, between each lateral was 0.7 m which matches with the intra- and inter-row spacing of the test crop. The required amount of irrigation water was applied by drip irrigation system from temporary and permanent water storing tanks in Kile and Erer Dodota respectively. At Kile PA rain water in the reservoir was fetched into elevated temporary water storing tank (barrel). This barrel was installed at a height of 1.30 m at appropriate pressure head to supply required amount of water for each plot at Kile PA, but at Erer Dodota the stored water was directly supplied from main storage/tank and distributed through main line to each laterals.

Irrigation water was obtained rain harvested from corrugated house of trial farmers during rainy season. The harvested water was which was then stored plastic tank near the experimental plots. Total areas of the house of selected farmers were 7 m x 10 m = 70 m^2 and mean monthly rain fall/effective rain fall of cropping season were used. Meteorological data was collected from nearest station to determine weather condition and crop water requirement. Mean monthly rainfall during cropping season of July, August and September determined from loc-clim and estimated by CROPWAT software. Total volume of water was calculated as:

Volume of rainwater collected (m^3) = A (m^2) *average annual rainfall (m) in depth (1)

where, A is the effective area of the roof.

Water collecting gutters (*ashanda)* having 40 m and 15 m of down pipe were prepared for both selected house and installed in appropriate manner to collect the roof top rain water and store in the tanks. Agronomic parameters like plant height, number of main branch and fruit per plant, fruit weight per plant, total fresh fruit of plot were collected.

Supplementary irrigation and irrigation duration

Irrigation water supplied through supplementary irrigation as per recommended irrigation water requirement of pepper. Irrigation water requirement was determined as:

Net Irrigation requirement (I_n) = CWR-ER- ΔSW (2)

Gross irrigation requirement $I_g = \frac{I_n}{E_a}$ (3)

where: CWR= Crop water requirement, E_a = Field application efficiency taken as (90%), ER = Effective rainfall (mm) and

Economic evaluation of drip irrigation system

In order to find out the economic viability of investment in drip irrigation in pepper cultivation, both net present value (NPV) and benefit-cost ratio (BCR) were estimated using discounted cash flow technique (Singh, 2008) for the life period of the drip set. The life period of drip set was taken to be 10 years as indicated in Michael (2008). The cost of cultivation and income generated using drip method of irrigation was assumed constant during the entire life period of drip set. The cultivation technology of pepper was also assumed to remain constant during the entire life period of drip set. The opportunity cost of capital as per the Ministry of Finance and Economic Development of the Federal Democratic Republic of Ethiopia Guideline (MOFED, 1998) was indicated to be 10-12% and in this financial analysis 11% discount rate was used for financial projection. In this study economic evaluation drip irrigation for initial investment, installation and maintenance cost and operation cost were computed for 100 m^2 and then, the total cost found converted to cost of hectare base. The yield obtained from experimental plot (average) in t/ha multiplied by 20 birr (local market price) to get the gross benefits. Then, by taking into account the income stream for the whole life period (10 years) of investment made on drip irrigation systems, Net Present Worth (NPW) and Benefit–Cost Ratio (BCR) was estimated using discounted cash flow technique as follows (Singh, 2008).

$$NPW = R_1 + \frac{R_2}{(1+r)} + \frac{R_3}{(1+r)^2} \ldots + \frac{R_n}{(1+r)^{n-1}} \ldots\ldots\ldots\ldots \qquad (4)$$

where NPW is net present worth R_1, R_2, R_3,….R_n are the net returns in period 1,2,3,…..n years respectively; n is the life span of drip irrigation system (n years) and r is the discount rate in percentage. BCR can be calculated as follows (Singh, 2008):

$$BCR = \frac{\sum_1^n \frac{B_i}{(1+r)^n}}{\sum_1^n \frac{C_i}{(1+r)^n}} \qquad (5)$$

where: BCR is benefit cost ration; B_i is income in n years and C_i cost in n year.

Data to be collected

Climatic data (Rainfall, minimum and maximum temperatures) from nearby meteorological station. Soil samples will be collected from the study area to determine selected soil physical and soil texture, moisture content, date of irrigation and fertilizer application mount of irrigation water applied every costs and benefits. Number fruit per plant, plant height, weight of fruit per plot total tomato yield at each harvest, total cost of production. Farmer's perception/feed back towards this technology analyzed.

Data analysis

Agronomic, yield and social data (farmers' perception) were collected. The collected data were analyzed by using simple descriptive (MS-Excels).

Demonstration of the technology, capacity building and knowledge sharing

Before starting demonstration and to the farmers water harvesting accessory: like (gutters, down pipe, water storage tank) and drip system was arranged. For effective implementation of the trials, training was provided for the farmers, development agents and experts on the importance drip technology for stakeholder's participation in agricultural research evaluation process, advantage of drip irrigation system for pepper production, installation of drip irrigation, pepper production and irrigation water management. Moreover, mini field visits were organized and given for all member farmers, 5 DA and 3 SMS to create awareness and experience sharing among farmers and other stakeholders in the area. The performance pepper, and drip irrigation technology was demonstrated to the participants, and awareness was created on improved pepper variety, and drip irrigation technology in the area. Moreover additional training was conducted on advantage benefits of rain water harvesting; by using drip irrigation on vegetable production was given.

Results and Discussions

System design, field layout and water applied

Irrigation water was obtained from rooftop rain water harvested during rainy season for supplementary irrigation which was then collected plastic tank (storage tank) installed near the experimental plots. Mean monthly rain fall/effective rain fall of cropping season data were collected from Meteorological data was collected from Harar station to determine weather condition and crop water requirement. Mean monthly effective rainfall during cropping season of July, August and September were 92, 72.8 and 51.2 mm respectively. Total area of the house of selected farmers were 7 m x 10 m = 70 m^2. Total volume of water was calculated from depth of rainfall (m) multiplied area of corrugated selected farmers as 70 m^2 *0.092 m= 6.44, 70 m^2 * 0.0728 m= 5.094 m^3 and 70 m^2 * 0.0512 m= 3.584 m^3 for July, August and September respectively. Total water collecting having 40 m gutters (*ashanda*) m and 15 m down pipe used.

Table 1: Total drip set and other materials used

Materials description	Location	
	Kile	Erer dodota
Filter in (pieces)	1	1
Main line (m)	1.5	0.5
Sub mains (m)	10	10
Laterals for 10.5 length * 14 rows (m)	147	147
Plastic tank/ Roto (m^3)	3	5
Galvanized sheet/ gutter 0.8 mm thick (m)	20	20
Galvanized sheet/ down pipe 0.8 mm thick (m)	6	9

The storage plastic tank (storage tank*))* having a cap1acity of 3 and 5 m^3 at Kile and Erer dodota were used respectively. The system components of drip irrigation system include:

Filters: used to remove particles from irrigation water that may clog the drip emitters
Main lines: used to convey water from barrel or tank to the two sub- mains
Sub mains: used distribute water to the laterals or experimental plot
Laterals: provide water to emitters through which water droplets irrigate

Total plot area of 10 x 10 m^2 and the spacing between each emitter was 0.4 m and, between each lateral was 0.7 m which match with the intra- and inter-row spacing of the test crop. CROPWAT software was used to determine crop water requirement (CWR). FAO, 2002 described indicative values of total growing season and crop water requirement for pepper ranges 600-900 mm for 120 -150 growing period. Accordingly CWR estimated in cropping season of July, August and

September were 50.8, 55.5 and 62.0 mm respectively, with supplementary irrigation interval of 1- 2 days based on soil moisture content.

Agronomic parameters and Fresh yield data

The overall agronomic parameters and Fresh yield performance of pepper under drip irrigation were 9.59 and 10.84 ton/ha total fresh yield at obtained at Kile and Erer dodota respectively. The higher yield obtained at Erere dodota. The yield difference may occur due to soil fertility of the experimental site.

Table 2: Pepper performance under drip irrigation

Agronomic parameters and yield component		
	Kile PA	Erer dodota PA
Flowering date	-	-
Plant height (cm)	60	68.33
Number of main n branch /plant	7	8.0
Number of fruit /plant	40	53.0
Mean weight of fruit per plant (kg)	0.35	0.35
Total fresh yield recorded (ton /ha)	9.59	10.84

The yield obtained, slightly higher when compared to national average i.e. the yields recorded were 64.20 and 54.50 q/ha, respectively (CSA, 2006, 2007). But national average yield hot pepper of CSA, recorded in 2004 and 2005 were agreed or negligible difference with this study as average yields 92.57 q/ha and 92.56 q/ha, respectively. The result of (Takele, 2009) on hot pepper variety (mareco fana variety) performance under drip irrigation using different irrigation water application levels were 85.7, 128.0 and 165.7 q/ha, produced by reducing I_{50}, I_{75} and I_{100} ETc (crop water requirement) respectively, under the normal planting method.

Farmers' perception on drip irrigation technology through rain water harvesting

All FREG members and neighboring farmers, development agents, experts and researchers were closely evaluate the performances of the hot pepper (marako fana variety) under drip irrigation through rain water harvesting system based on their own criteria. The most important criteria used in evaluating hot pepper production under drip irrigation through rain water harvesting, were water saving of drip irrigation method, operation simplicity, labor, maintenance, and total fresh yield obtained were used as evaluation criteria by FREGs in study area on the basis of native knowledge and irrigation practices. Based on those criteria, the FREGs evaluation showed that, drip irrigation method was preferred by farmers and ranked first in both PAs due to its better water saving methods operation simplicity, labor, maintenance than their traditional irrigation practice for hot pepper production. Moreover total fresh yield of improved hot pepper (marako fana variety) obtained slightly higher as compared to locally produced hot pepper variety.

Table 3: Farmer's perception on hot pepper production under drip irrigation method

Activity title	Site or Pas	Numbers of farmers participated	Frequencies of farmers accept the technology	Acceptance of technology (%)
Drip irrigation method under rain water harvesting system, water saving, operation simplicity, labor, maintenance, and total fresh yield obtained	Kile	38	34	89.47%
	Erer Dodota	38	35	92.11%

Economic evaluation of drip irrigation system

The economic feasibility of drip irrigation method in pepper production under roof top rain water harvested was examined using two indicators, viz., Net Present worth (NPW) and Benefit-Cost Ratio (BCR). The NPW is suitable for absolute measure of value of an inflow–outflow system. NPW is well accepted for sound reasons. The BCR is a direct indicator of benefit (gain) or loss from a project. However, it does not tell us about the total income from the project alternatives; thus not suitable to compare different sized projects and mutually exclusive projects (Ali, 2010). The result of economic viability of pepper (marako fana variety) production using and drip technology under supplementary irrigation described as follow. The analysis results showed that investment in drip irrigation system for supplementary irrigation was economically viable for pepper production. The NPW and BCR for 10 years life span of drip system computed were 59062.3 birr and 8.3, respectively. According to Singh (2008) BCR greater than 1 and NPW greater than zero is economically viable. This result show investment on drip irrigation or even under supplementary is feasible though initially investment is high. Farmers should either get subsidy from government, loan from financial and credit institutions or organize in to cooperatives to pool money so that they can afford the heavy investment cost of drip sets

Table 4: Economic analysis of drip irrigation system under pepper production

Year	Y	U.P	Y x U. P	AOC	AMIC	TC	GB	NI	DF	DB	DC	NPW	CBR
						200000	0	-200000	1	0	200000	-200000	0.0
1	9590	20	191800	3050.7	20000	23050.7	191800	168749.3	0.9	172620	20745.6	151874.4	8.3
2	9590	20	191800	3050.7	20000	23050.7	191800	168749.3	0.81	155358	18671.1	136686.9	8.3
3	9590	20	191800	3050.7	20000	23050.7	191800	168749.3	0.73	140014	16827.0	123187.0	8.3
4	9590	20	191800	3050.7	20000	23050.7	191800	168749.3	0.66	126588	15213.5	111374.5	8.3
5	9590	20	191800	3050.7	20000	23050.7	191800	168749.3	0.59	113162	13599.9	99562.1	8.3
6	9590	20	191800	3050.7	20000	23050.7	191800	168749.3	0.53	101654	12216.9	89437.1	8.3
7	9590	20	191800	3050.7	20000	23050.7	191800	168749.3	0.48	92064	11064.3	80999.7	8.3
8	9590	20	191800	3050.7	20000	23050.7	191800	168749.3	0.43	82474	9911.8	72562.2	8.3
9	9590	20	191800	3050.7	20000	23050.7	191800	168749.3	0.39	74802	8989.8	65812.2	8.3
10	9590	20	191800	3050.7	20000	23050.7	191800	168749.3	0.35	67130	8067.7	59062.3	8.3

Note: Y: yield in (kg/ha), U.P: unit price of pepper in (Birr/kg), TC: Total cost, AOP: Annual operation cost (Birr/ha), AMC: Annual maintenance and installation cost, TC: Total cost in (Birr/ha NI: Net Income in (Birr), GB: Gross benefits in (Birr/ha), DF: Discount factor/rate (r =11.00%), DB= Discount benefit in (Birr/ha), DC; Discount cost Birr/ha NPW : Net present worth (Birr/ha). CBR: Cost benefit ratio and the Initial investment cost assumed or estimated as 200000 ETB.

Conclusions and Recommendations

Most Ethiopian farmers depend on rain-fed agriculture. However, rainfall is very erratic, and drought occurs very frequently in most of the eastern party of Ethiopia or Oromia Region especially in East Hararghe Zone the same for Harar Region. Due to this problem, a huge activity of rainwater harvesting and utilization for irrigation sustaining vegetable production at household levels had been inefficient. Hence the aim of this study was demonstrating hot pepper production through drip irrigation technology using roof top rain water harvesting under farmers condition. Two FREG which contain 30 farmers were established, from those two model farmers house were selected for construction and implementation of the experiment during the implementation of the activity practical training was given on awareness creation about drip technology and skill development on land preparation, transplanting, drip installation and operation. Hot pepper performance under drip irrigation method was 9.59 and 10.84 ton/ha was at obtained at Kile and Erer dodota, respectively.

Based on those criteria, the FREGs evaluation showed that, drip irrigation method was preferred by farmers and ranked first in both PAs due to its better water saving methods, operation simplicity, labour & level of acceptance of the technology reaches, 92.11% to 89.47% at Erer dodota and Kile, respectively.

Therefore based on farmer's idea and importance of this technology the following recommendation drawn:

- More popularization is necessary
- Capacity building (training) could be required
- More Effort is required on availability, distribution and demonstration of the technology made on
- Future study could require on drip irrigation technology in different crop and area for more water productivity and busting crop production

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NATURAL RESOURCE MANAGEMENT

Pre-Extension Demonstration of Soil Test Based Crop Response Phosprous Recommendation on Teff at Omo Nada district, Western 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. To this end, on-farm pre-extension demonstration of Soil Test Based Crop Response Phosphorus Recommendation on Teff was conducted at Omo Nada district during 2017cropping season. The aim of the study was to demonstrate soil test based crop response calibrated P (STBCRP) at Omo Nada for teff. Composite soil samples before planting were collected and analyzed in order to calculate phosphorus rate. The results revealed that the soil reaction pH (H_2O) were strongly acidic ranging from 4.45 to 4.89, very low available P (Olsen method) from 1.16–3.28ppm. The maximum mean grain yield (940 kg ha^{-1}) was recorded from the application of STBCRP and 23 kg ha^{-1}N, whereas the lowest (350 kg ha^{-1}) was recorded from the farmer's practice. The study also showed that nitrogen determined 23 kg ha^{-1}N, P-critical level (4.5 ppm) and P- requirement factor (15.12) were determined for the area. Thus, farmers in the Omo Nada area might be advised to use soil test based crop response phosphorus recommendation to increase the productivity of Tef.

Keywords: Soil test based crop response calibrated P (STBCRP), Tef (*Eragrostis tef*)

Introduction

Teff(*Eragrostis tef* L) is an ancient crop in Ethiopia, and the country is considered to be center of both origin and diversity for the species (Vavilov, 1951). Teff is grown in almost all regions of Ethiopia since it is the preferred grain for local consumption, highly valued by farmers and consumers and fetches the highest grain price compared with other cereals (Ketema, 1997).Ecologically, Teff can be grown in a wide range of environments, and is presently cultivated under diverse agro-climatic conditions. It can be grown from sea level up to 2800 m.a.s.l. (Seyfu, 1993). The ability of Teff to perform well on both waterlogged vertisoils in the highlands as well as in low moisture stress areas in the semi-arid regions throughout the country. ThusTeff is preferred over other grain crops such as maize, wheat, sorghum and barley (Hailu, 2001).

Some of the factors contributing to low yield of teff are lack of high yielding cultivars, lodging, weed, water logging, low moisture and low soil fertility conditions (Fufa, 1998).Soil test based fertilizer recommendation plays a vital role in ensuring balanced nutrition to crops. It is widely believed that economic optimum fertilizer application can only be achieved by developing appropriate fertilizer recommendation that takes into consideration the nutrient status of individual field. Currently there is no site specific fertilizer recommendation for the different soil-crop climatic condition. To come up with solution, soil test based crop response phosphorus recommendation and verification trail were made at Omo Nada district and resulted in optimum N-fertilizer, p-critical level and p-requirment factor were completed. Pre extension demonstration activity should be conducted before further popularization in order to evaluate and create awareness in the community. Therefore the objectives were to evaluate soil test based crop response calibrated Phosphorus recommendation on Teff and to create awareness on site specific crop response fertilizer recommendation

Materials and Methods

The demonstration activity was conducted on farmers' fields at Omo Nada district. Three PAs per district were selected based on their willingness, initial soil test value and purposively from previous verification trials. One FREG per PA and two host/test farmers per FREG were organized. Under each FREG, 20 farmers among which (40%) female farmers were organized and trained. Training and meetings were conducted with FREG members, development agents (DA), and other stake holders. Composite soil samples were collected from each site and analyzed. Phosphorus recommendation was applied according to the formula P (kg/ha) = (P critical – P initial)*Prf. Phosphorus recommendation was compared with farmers practice. Teff variety (Guduru) was used as a test crop. Plot size 50m x 50m for STBCR phosphorus recommendation and 10m x10m for farmer's practices was used to compare visually during training. The entire rate of phosphorus was applied at planting while, urea applied at 30-35 days after emergency.

Results and Discussions

Soil reaction (pH) and available phosphorous

The pH (H_2O) of the soil samples collected before planting was ranged from (4.45 to 4.89) (Table 1). According, to criteria established for acidity level by FAO, (2008).the soils fulfill to be strongly acidic in reaction Continuous cultivation and long-term application of inorganic fertilizers lowers soil pH and aggravate the losses of basic cations from highly weathered soils (Mokwunye et al.,1996). Therefore, it is essential to maintain the reaction of the soil around pH 7 to have conducive soil environment for all biological and chemical process. Available phosphorous (by Olsen method) collected before planting were ranged from 1.16–3.28 ppm (Table 1). The available p contents of the soil were very low (Olsen et al., 1954). The low contents of available p observed in the soil of the study areas are in agreement with the result reported by (Mesfin, 1998, Yihenew, 2002; Dagne, 2016) who reported that the Ethiopian agricultural soils particularly the Nitisoils and other acid soils have low available p content due to their inherently low p content, high p fixation capacity, crop harvest and soil erosion.

Table 1: Initial soil fertility status (Ava.p, and PH) before planting at Omo Nada district in 2017 cropping season.

Sites	Ava.p (ppm)	pH(H_2O)
Site 1	3.286	4.89
Site 2	1.209	4.71
Site 3	2.129	4.71
Site 4	1.175	4.45
Site 5	2.925	4.65
Site 6	1.161	4.72

Ava.p =available p

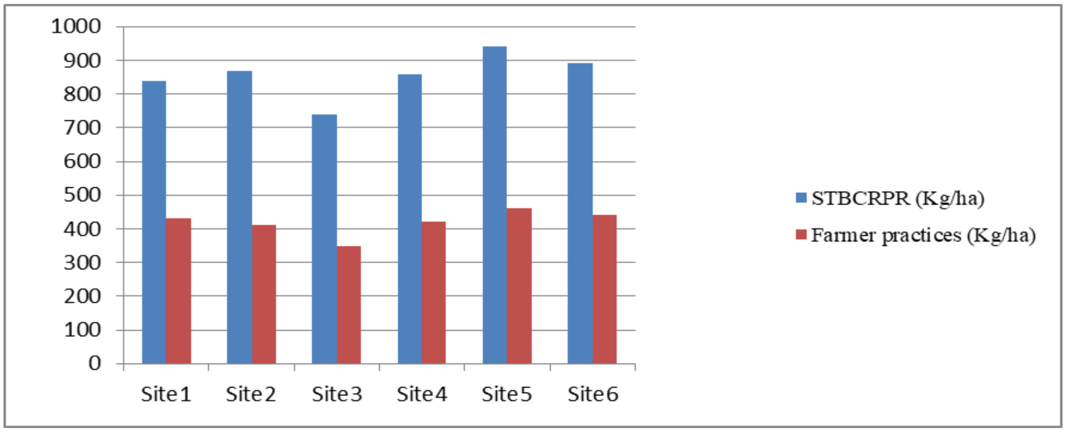
Teff grain yield at Omo Nada district in 2017 cropping season

The maximum teff grain yield (940 kg/ha) was recorded from the application of STBCRPR (soil test based crop response phosphorous recommendation whereas the lowest (350 kg/ha),was recorded from farmer's practices (Table 2). STBCRPR is maximum in all sites and ranged from 940 to 740 kg/ha, while farmer’s practices ranged from 460 to 350 kg/ha.

Table 2: Teff grain yield at Omo Nada district in 2017 cropping season

STBCRPR=soil test based crop response phosphorous recommendation

Sites	STBCRPR (kg/ha)	Farmer practices (kg/ha)
Site 1	840	430
Site 2	870	410
Site 3	740	350
Site 4	860	420
Site 5	940	460
Site 6	890	440



Graph 1: Graphical representation of Teff grain yield at Omo Nada district in 2017 cropping season.

Conclusions and Recommendations

STBCRPR was superior to both farmers’ practices and control. Hence ,STBCRPR is selected for the recommendation on teff at Chora district. The farmer’s of the area should be advised to use STBCRPR. Therefore further awareness should be created for farmers. To sustain and/or improve the current soil fertility status of the study sites, integrated soil fertility management practices (soil conservation, lime application, crop rotation) can improve the current situation

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Pre-Extension Demonstration of Soil test based crop response phosphorus fertilizer recommendation on teff crop in Wera Jarso district of North Shewa Zone, Oromia

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Abstract

*Unbalanced application of plant nutrients may aggravate the depletion of other important nutrient which limit crop productivity in Ethiopia in general and in the study area in particular. In view of this, a field experiment of participatory evaluation and demonstration of soil test based phosphorus recommendation on improved maize (BH-661) was conducted in Wayu Tuka district on farmer's field during 2017/18 main cropping season. The aims of the study were to demonstrate and evaluate the technology to farming community through Farmers Research & Extension Group and create awareness among farmers about the technology generated. The treatments were soil test based recommended rate of phosphorus (RR), No fertilizer/Control (C) and Farmers practice (Blanket recommendation). Available phosphorus in the soil was tested and phosphorus recommendation rate was given according to P in kg/ha = (P critical – P initial)*P requirement factor. The determined value was 4.2 ppm and 9.6 were P critical and P requirement factor, respectively whereas 46 kg ha^{-1} of N and P was used as blanket recommended rates (farmer practise). The results of soil samples analysis revealed that the soil reaction pH (H_2O) were strongly acidic ranged from 4.63 to 5.29 and very low available P ranged from 1.73 to 2.17 for all sites except site one which is rated as low with p value 4.7ppm. The effects of treatments were significantly influenced grain yield of maize in all demonstration sites except site 4. The highest grain yield (12020.8 kg ha^{-1}), plant height (2.763 m) and other growth and yield components of the crop were recorded at the application of soil test based phosphorus recommended rate. Besides, most participant farmers ranked soil test based P recommended plot first while visiting and evaluating crop on field. Therefore, it can be concluded that soil test based recommended rate of phosphorus was chosen as the best and led to the maximum yield and yield components of maize compared to control and farmer practiced.*

Key words: Blanket recommendation, Control, Farmers Research Group, soil test based phosphorus recommendation, Wayu Tuka

Introduction

Teff [(Eragrostis teff (Zucc.)Trotter] is a cereal crop extensively cultivated in Ethiopia with annual land coverage of about 3.01 million hectares (CSA, 2015). 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; the seeds are not attacked by storage pests; and the seeds are gluten-free, and hence considered as a healthy food (Kebebew *et al.*,2011).Doris (2002) reported that teff contains 11% protein and is an excellent source of essential amino acids, especially lysine, the amino acid that is most often deficient in grain foods. He also noted that teff is nearly gluten-free, and is gaining popularity in the whole food and health food industry in the USA as an alternative grain for persons with gluten sensitivity. It contains

11% total carbohydrates,24% dietary fiber,10% thiamine,2% riboflavin, 4% niacin, 8% calcium and 20% iron and is free from saturated fat, sugar and cholesterol (Purcell Mountain Farms,2008).

Fertilizer use in sub Saharan Africa countries is low, partly because farmers do not recognize adequate profit opportunity with acceptable risk. Unfortunately, most countries have blanket fertilizer use recommendations that too often fail to consider farmers' profit potential. Farmers who are financially well off can afford to apply fertilizers on all their farmland to maximize profit per hectare. Smallholders often have some financial ability to use fertilizer, but need high returns on their small investment. The high returns will often reduce the financial constraint, enabling them to invest more in fertilizer use in following seasons. Nutrient mining due to sub optimal fertilizer use in one hand and unbalanced fertilizer uses on other have favored the emergence of multi nutrient deficiency in Ethiopian soils (Wassie *et al*.,2011); that in part may contributed to fertilizer factor productivity decline experienced over recent past.

According to CSA (2015), teff covers cultivated land of 3.02 million hectares with average annual production of 47.5 million hectares and an average yield of 1.58t ha^{-1}. From the above figure, one can concluded that there is low teff yield in Ethiopia. The low yield is mainly due to low soil fertility status which is the result of continuous cropping, overgrazing soil erosion and complete removal of filed crops' residues without any soil amelioration (Seyfu Ketema, 1993). In addition, according to Habtamu et al., 2000 suggestion, extra use of NP for Teff grain yield production was not economical because of its genetic potential and increasing of fertilizer cost from year to year.

So exercising soil test based application of plant nutrient helps to realize higher response ratio and benefit: cost ratio because nutrients are applied in proportion to the magnitude of the deficiency of a particular nutrient. However, even though N optimum and p-fertilizer rate for teff crop was determined for Wera-Jarso district using soil test based site specific crop response to fertilizer p calibration study, farming community of the district have no such experience and exposure to shift from accustomed practice to modern approach. Therefore, this pre-extension demonstration was designed to create awareness and to ignite farming community interest to ward new approach for economic teff production having the following objectives.

Materials and methods

Description of the study area

Wera Jarso district is found in North Showa zone of Oromia region on 185 km distance from the capital city of Oromia, Finfine (Addis Ababa) to North West direction at 38^{0} 27'-38^{0} 43'E and 9^{0}47'-10^{0}11'Nlongitude and latitude. The district has an altitude ranging from 500-2606ma.s.l, and receives an annual rain fall ranging from750 to 850mm. The annual average temperature range from 21-28^{0}C while soil of the area is dominantly characterized by vertisol.

FREG Establishment

One Farmers Research and Extension Group (FREG) comprising of 15 members was established in five selected PA's of the district based up on their interest and willingness. A total of five (5) FREG was established in different five (5) kebeles (PAs) comprising a total of 75 members, among those male are 51 and 24 are female. The FREG members were selected based on willingness, accessibility for supervision of activities and considering age and gender issues. Besides, the hosting farmers were also selected based on availability and accessibility of land as well as willingness of farmer to provide land and perform the duty according to the recommendation provided.

Experimental procedure to select the experimental site,

27 composite soil samples were collected from different farmer's field of the district by using zigzag method. Soil chemical analysis was done for available phosphorus using Olsen method, and then thirteen (13) farmers' fields with initial phosphorus concentration categories below critical p-concentration for the district were selected. Phosphorus fertilizer rate was calculated by using the formula:

Phosphorus fertilizer rate (kg/ha)= (Pc-Pi)*Pf;

Where; **Pc**- critical phosphorus **10ppm** for Wera Jarso; **Pi**-Initial available Phosphorus; **Pf**-phosphorus requirement factor**16.33ppm** for the District.

Experimental layout

The pre-extension demonstration of soil test based fertilizer recommendation was conducted on improved (kora) and local (Bora) teff variety having 4 treatments (Improved variety + P-recommended rate, Local variety+ P-recommended rate, Blanket recommendation + Improved variety, Control (No fertilizer)+Improved variety) in Wera-Jarso district in 2017 on thirteen (13) farmers'field on 10m x 20m (200m^2) experimental plot size for each treatment considering farmers as replication

Field day

Mini-field days and field visit were organized for with active participation of farmers, DA'S, agricultural experts and others farmer's closest to the experimental field. Participants observed different experimental site and appreciate for the undertaken activities. The participants reflect their feedback that the soil test based phosphorus recommendation on improved teff variety performed the best followed by soil test based phosphorus recommendation on local teff variety and farmer's practice was ranked least.

Partial Budget Analysis

Partial budget analysis was done to identify the economic feasibility of the treatments. To identify its economic feasibility, partial budget, dominance, marginal and sensitivity analyses were used. For this the average open market price (Birr kg-1) of teff, urea (N) and DAP (P) fertilizers were used for analysis. For a treatment to be selected as option to farmers, the minimum acceptable rate of return (MARR) should be 100% (CIMMYT, 1988), which is suggested to be realistic. This enables to make farmer recommendations from marginal analysis.

Results and discussions

The finding of soil test based crop response phosphorus calibration study was demonstrated along with blanket recommendation and control on farmers' holding farm lands using FREG groups. Improved teff variety (Kora) and local teff variety was used as a test crop.

Yield of Teff as Influenced by different treatments

The experiment conducted on farm land at Wera-Jarso district shows that teff grain yield was highly increased with the application of 92N Kg/ha and site specific fertilizer recommendation, which gives 461.36Kg/ha and 379.55Kg/ha yield advantage using improved variety (Kora) and local variety of teff over the blanket fertilizer recommendation. As in contrary to Habtamu et al., (2000) that stated as with extra use of NP the teff grain yield was not economical (fertilizer cost is increasing and the economic return is not comparable with the cost of fertilizer that incur to the house hold income), the use of 92Kg/ha N and site specific fertilizer recommendation increased Teff grain yield from 1325Kg/ha to 1786.4Kg.

The optimum N which is 92 Kg/ha N and soil test based P-fertilizer recommendation rate was influenced teff grain yield and the mean maximum grain yield was 1786.4Kg/ha for improved variety and 1704.5Kg/ha for local variety with a 34.82% and 28.65% grain yield advantage over the blanket recommendation, respectively. Similarly, according to Gidena (2016) teff grain yield was highly increased with application of 46 Kg/ha N and site specific phosphorus fertilizer recommendation.

Table1: Descriptive statistics of soil test based "P" fertilizer recommendation on mean grain yield of Teff.

Treatment	Grain yield(Kg/ha)		Average	% yield increment
	Minimum	Maximum		
Improved variety + P-recommended rate	1275	2375	1786.4^{a}	STBPR gave 34.82% and 28.65% yield increament over farmers practice when applied for improved and local variety, respectively.
Local variety+ P-recommended rate	1135	2300	1704.5^{a}	
Blanket recommendation + Improved variety	1000	1875	1325^{b}	
Control (No fertilizer)+Improved variety	300	850	575^{c}	

Partial budget analysis

During this partial budget analysis, farm gate price of 22/21 Birr per kg of teff as well as 12.8 and 8.92 Birr per kg of DAP and Urea (Table2), respectively were used during the study time, 2017 (2009/2010). In similar the actual market price of 27Birr/23Birr for improved and local seed rate was used respectively in the analysis. Accordingly, the marginal rate of return found to be economically feasible and beneficial for teff production at Wera-Jarso district were both soil test based with improved variety (Kora) in soil test based with local variety (Bora) having MRR value 534.9% and 470.5%, respectively.

Table 2: Partial Budget Analysis for teff crop in Wera Jarso district2017/18(2009/10).

Fertilizer rate	Variable Input DAP, Urea & Seed rate ($Kgha^{-1}$)	Unit price (ETB)	TVC	Output ($Kgha^{-1}$)	Unit price (ETB)	Gross Income	Net Income	MRR(%)
Control (Without fertilizer)+ Improved variety	0	12.8&8.92	736	575	22	12650	11914	-
Farmers practice/blanket recommended rate +Improved variety	100,100 &32	12.8 & 8.92	3036	1325	22	29150	26114	467.7

Soil test based+ Improved variety(Kora)	178.9,130&32	12.8 & 8.92	4313.5	1786.4	22	39300.8	**34987.3**	534.9
Soil test based+ local variety(Bora)	178.9,130&32	12.8 & 8.92	4185.5	1704.5	21	35796.6	31609	470.5

Conclussions and recommendations

In Ethiopia, fertilizers recognized as one of the most important inputs for maintaining soil fertility and maximizing agricultural production and productivity of the country. However, there is no adequate site-specific fertilizer recommendation for different crops.. Therefore, this activity was carried out in Wera Jarso district of North Shewa Zone, Oromia to address the need for fertilization rates that are specific to teff crop. That means, significant differences observed between different treatments signify the need of soil test based site specific crop fertilizer response calibration study in the area. Hence statistical and partial budget analysis provided promising result that encourages the use of site specific fertilizer recommendation for sustainable soil fertility, production and productivity improvement without harming the environment. Accordingly, farmer perception and preference as well as interest developed toward the technology were promising. So based on this conclusion the following recommendation was forwarded. Optimum nitrogen rate (92 kg N/ha), critical P (Pc) concentrations 10 ppm and P (Pf) requirement factors 16.33 ppm for teff crop that have been verified and demonstrated were recommended for the area while further scaling up will be the pre-request to popularize the technology. Extrapolation of the recommended Optimum nitrogen rate (92 kg ha^{-1}N), critical P (Pc) concentrations (10 ppm) and P (Pf) requirement factors (16.33 pmm) to the area having similar agro-ecology and soil will be advisable. Oromia Bureau of Agricultural and Natural Resource and Research Centers may use these recommendations for advisory services to end users. Because of dynamic nature of the soil and varietal improvement of the crop, updating the experiment at certain interval will be recommended.

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Participatory Evaluation and Demonstration of Soil Test Based Phosphorus Recommendation on Maize at Wayu Tuka District of East Wollega Zone

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Abstract

*Unbalanced application of plant nutrients may aggravate the depletion of other important nutrient which limit crop productivity in Ethiopia in general and in the study area in particular. In view of this, a field experiment of participatory evaluation and demonstration of soil test based phosphorus recommendation on improved maize (BH-661) grown during 2017/18 main cropping season was conducted in Wayu Tuka district on farmer's field. The aims of the study were to demonstrate and evaluate the technology to farming community through Farmers Research Group and create awareness among farmers about the technology generated. The treatments were soil test based recommended rate of phosphorus (RR), No fertilizer/Control (C) and Farmers practice (Blanket recommendation). Available phosphorus in the soil was tested and phosphorus recommendation rate was given according to P in kg/ha = (P critical – P initial)*P requirement factor. The determined value was 4.2 ppm and 9.6 were P critical and P requirement factor, respectively whereas 46 kg ha^{-1} of N and P was used as blanket recommended rates (farmer practise). The results of soil samples analysis revealed that the soil reaction pH (H_2O) were strongly acidic ranged from 4.63 to 5.29 and very low available P ranged from 1.73 to 2.17 for all sites except site one which is rated as low with p value 4.7ppm. The effects of treatments were significantly influenced grain yield of maize in all demonstration sites except site 4. The highest grain yield (12020.8 kg ha^{-1}), plant height (2.763 m) and other growth and yield components of the crop were recorded at the application of soil test based phosphorus recommended rate. Besides, most participant farmers ranked first soil test based P recommended plot while visiting and evaluating crop on field. Therefore, it can be concluded that soil test based recommended rate of phosphorus was chosen as the best and led to the maximum yield and yield components of maize compared to control and farmer practiced.*

Key words: *Blanket recommendation, Control, Farmers Research Group, soil test based phosphorus recommendation and Wayu Tuka*

Introduction

Cereals are the most widely grown crops and comprise about 86.68% of total grain production in Ethiopia (CSA, 2016). The dominant cereal crops in Ethiopian agriculture are maize, teff, sorghum, barley and wheat. At the national level, maize productivity is about 3.387 tons ha^{-1} and currently ranks 1st compared to the other cereals in the total national production (CSA, 2016). In Oromia region, among the total land size of 5,796,737.00 ha planted by all cereals, maize covered 4,077,899.00 ha. It is the first major crop in the region. The regional productivity of maize is about 3.51 tons ha^{-1}(CSA, 2016).

The maize variety, HB 661 is the most widely grown in Wayu Tuka district of Eastern Wollega Zone. The zone's mean productivity of maize is about 4.40 tons ha^{-1} and ranks 1st compared to the other cereals production in the zone (CSA, 2016). According to reports of Wayu Tuka

District Agricultural Development Office 2018/19 (WTDADO, 2018), the district’s mean productivity of maize is decreases from year to year. This decrease maize productivity mainly due to the low soil fertility status which is the results of continuous cropping, soil erosion, leaching due to high rainfall and complete removal of field crops residues (Sayfu Ketama, 1993). Nitrogen, Phosphorus and potassium are the three major nutrient elements required in large quantities for normal growth and development of crops.

Some nutrient elements such as potassium are not being used as a commercial fertilizer for agricultural crop production under Ethiopian conditions. This is merely because of the generalization that Ethiopian soils are believed to contain enough or sufficient quantity of the K nutrient. Nevertheless, some reports indicated that elements like K, S, Ca, Mg and micronutrients particularly Cu, Mn, B, Mo and Zn are becoming depleted and deficiency symptoms are being observed on major crops (Abiyne *et al.,* 2001; Asgelil *et al.,* 2007). As indicated by Abayneh *et al.* (2001), the soils of some of the regional and federal agricultural research centers such as Areka and Pawe were found to be deficient in K status. This is particularly apparent in soils and/or areas where agricultural crop production makes use of the application of N and P fertilizers on a continuous basis. Sound soil test based crop response fertilizer is essential for successful fertilizer program and crop production. It is essential that the results of soil tests could be calibrated or correlated against crop responses from applications of plant nutrients in question as it is the ultimate measure of a fertilization program. An accurate soil test interpretation requires knowledge of the relationship between the amount of a nutrient extracted by a given soil test and the amount of plant nutrients that should be added to achieve optimum yield for each crop (Sonon and Zhang, 2008). Calibrations are specific for each crop type and they may differ by soil type, climate, and the crop variety. Demonstration is very important to expose this technology to farming community through farmers’ research group. Therefore, soil test based phosphorus calibration study was conducted at Wayu Tuka district on Maize. The study area was selected purposively by the potential of maize production. Wayu Tuka is the major maize producing area of East Wollega Zones. Soil test based fertilizer recommendation could not be achieved without farmers’ involvement. They have to carry out the experiment, analyze the difference and choose the best. Therefore, this experiment was conducted to evaluate the technology to farming community through FREG and create awareness among farmers about the technology generated.

Materials and methods

Description of the Study Area

The study was conducted in Wayu Tuka district that is located in East Wollega Zone of the Oromia Regional state, Ethiopia (Figure 1). Gute town, which is the capital of the district, is situated at about 316 km distance from of Addis Ababa in western direction. It is among the highly potential districts prioritized by the AGP. Geographically it is located between 36°40’0’’ and 36°50’0’’ Easting and 8°50’0’’ and 9°10’ 0’’ Northing.

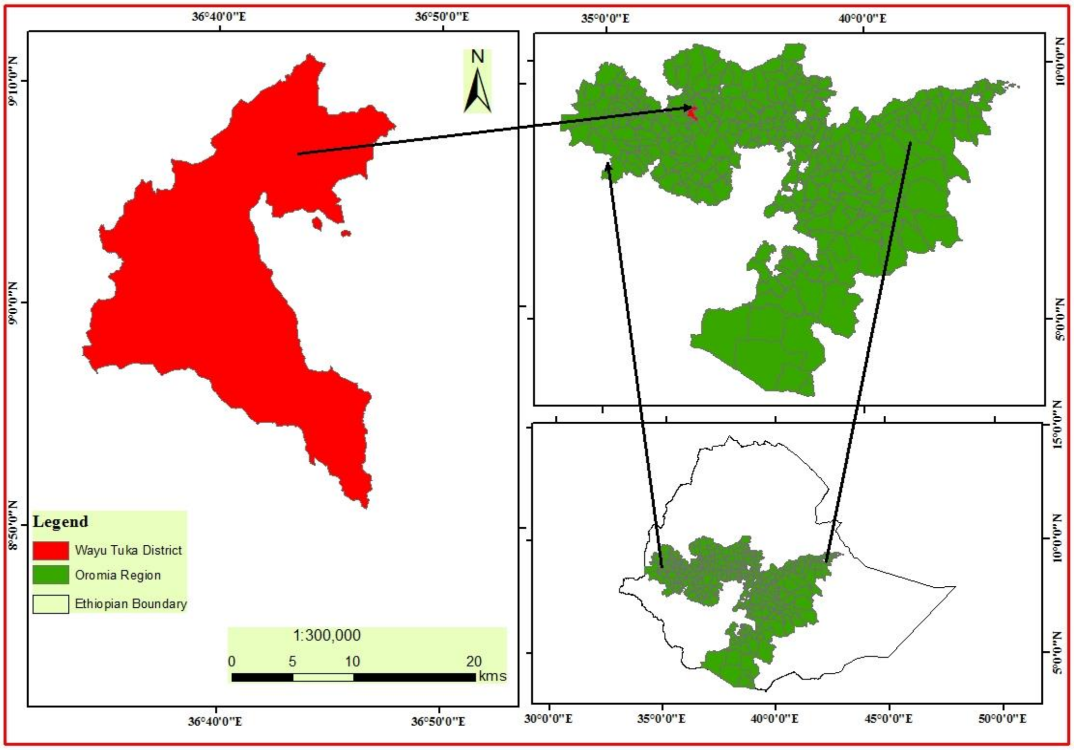

Figure 1. Location Map of Wayu Tuka district
Source: Ethio Maping Agency

Agro climate, soil type and topography of study area

The agro-climatic zone of wayu tuqa district is highland (*baddaa*) (0.26%), midland (*Badda daree*) (46.74%) and lowland (*gammmoojjii*) (53%) (Negara and Getachew, 2014). According to the ten years (2005 - 2014) weather data recorded at the Nekemte Meteorological Station, the average annual rainfall of the study area is 2204.1 mm and the monthly mean minimum and maximum temperatures ranges between 11.90 to 14.30 and 20.30 to 27.00^{o}C with unimodal rainfall pattern. The area received mean maximum rainfall (403.40 mm in the year during the month of August. While the average annual minimum and maximum temperatures of the district are 13.1 and 23.5^{o}C, respectively (Figure 2).

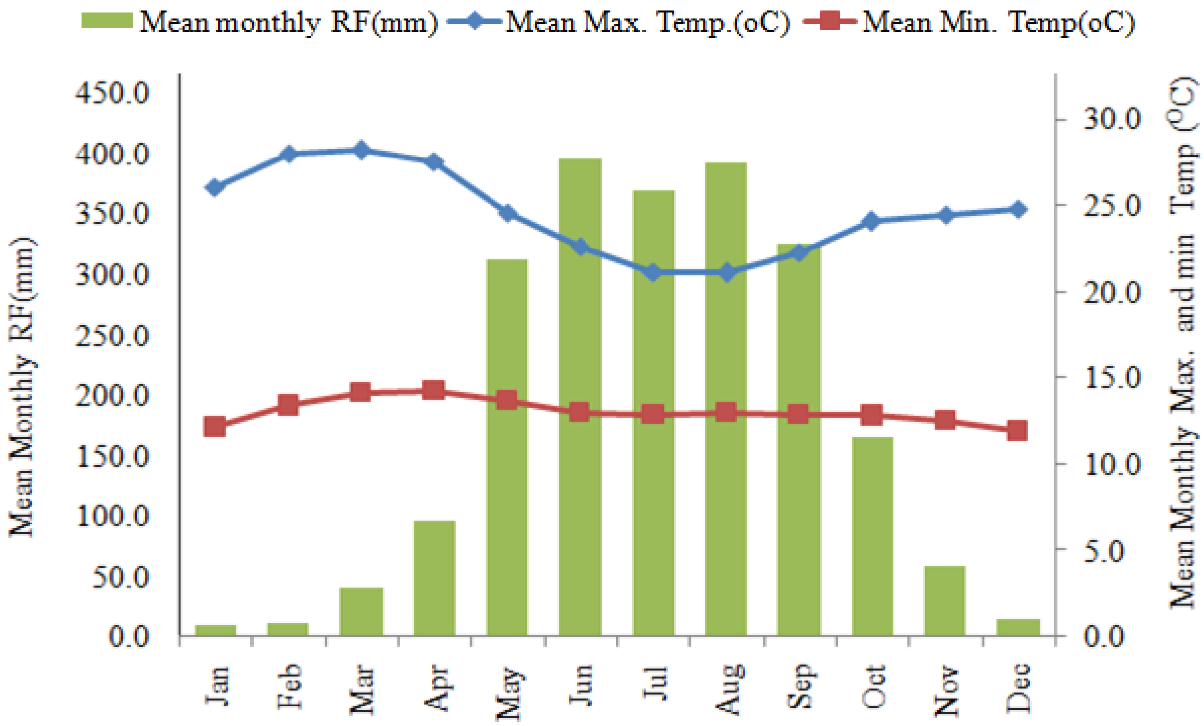

Figure 2. Mean monthly rainfall (mm) and Mean monthly minimum and maximum temperatures (oC) of the study area (2005 – 2014)

Source: National Meteorological Agency; Nekemt Station.

According to FAO (2014) classification, the dominant soil type in Wayu Tuka district is Nitisols. The soils are acidic and deficient in N and P which are the common problems associated with soil fertility. The district is topographically characterized by mountainous and gentle sloping landscapes.

Farming system of the area

Subsistence farming is the main livelihood of the community. Mixed crop-livestock farming system is the predominant in the agricultural production of Wayu Tuka district. The major crops commonly grown in the district are coffee (*Coffee arabica*), wheat (*Triticum aestivum* L.), teff (*Eragrostis tef*), barley (*Hordeum vulgaris*), maize (*Zea mays*), potato (*Solanum tubersoum*) and hot pepper (*Capsicum annum*) (Achalu *et al.*, 2012b). Cattle, sheep and goat are the most common livestock reared by the farmers of the district (CSA, 2016).

Sites and Farmers' field selection

As a target area, Wayu Tuka district was selected for the implementation of the experiment due to its potentiality for maize production, accessibility for supervision and compatibility with AGP II criteria. The study was conducted on farmers' fields across the district. Potential farmers' field were selected in a collaboration with DAs and experts. Five farmers' field as site 1, 2, 3, 4, and 5 were selected as demonstration site based on willingness to provide land, vicinity to roads, initiative to implement the activity and willingness to explain the technology.

FREGs/FREGs selection and training

Three farmers research group was established with farmers of five, ten and ten member groups purposively based on will of actors. Emphasis was given to gender and wealth. Gender and youth balance in each FREGs unit was strictly considered. The groups were trained theoretically and practically on the concept of FREG and the activities they are going to perform. The training was provided to 25 famers, 5 experts and 5 Das, a total of 35 participants. All actors were came up with ground rules and regulations.

Experimental procedures and management

The experiment was laid out in simple observation plot (10 m by 10 m with the spacing of 75 cm*30 cm). The experiment was replicated three times. Phosphorus addition was based on initial phosphorus content of the soil for soil test based recommendation plot whereas 100 kg/ha Urea and 100 kg DAP used for blanket recommendation and no fertilizer application for control one. Composite soil samples with the depth of 0-20 cm was collected from each selected farmers' fields. Available phosphorus in the soil was tested in our soil laboratory (NSRC) using Olsen *et al*. (1954) method. Phosphorus recommendation rate was given according to P requirement in kg/ha = (P critical – P initial)*P requirement factor. Full doze of P was applied at planting while, full doze of Urea was applied 35 days after planting. Whereas 4.2 ppm and 9.6 were P critical and P requirement factor respectively. This recommendation was compared with blanket recommendation and farmers practice. Therefore, the treatments were: Recommended rate (RR), Control (C) and Blanket recommendation (BR).

Pre plant soil sampling and analysis

Soil sample was taken from top soil at depth 0-20 cm in zigzag method using soil sampling auger. Ten sub-samples were taken from each site to have one composite soil sample. Then bagged and labeled one kg of composite soil samples for each site and totally five composite soil samples were taken to center soil laboratory for farther soil chemical analysis. The submitted composite soil samples were air dried, prepared and analyzed for the following chemical properties.

Soil pH was measured potentiometrically using a pH meter with glass electrode in the supernatant suspension of 1:2.5 soils to water ratio (Barauah and Barthakulh, 1997). Since Olsen, method is most widely used for P extraction under both acidic and basic pH ranges in Ethiopia; available phosphorus was determined by using Olsen *et al*. (1954) method. The soil exchangeable acidity was measured by saturating the soil samples with potassium chloride solution and titrating with sodium hydroxide as described by Mclean (1965).

Field day

Field days are the core extension activities in promoting technologies, stimulating knowledge and experience sharing, farmer-to-farmer extension and adoption of new technologies. It is a method of motivating people to adopt a new technology by showing what has already achieved in a field conditions and used to take feedback from them. Thus field day was conducted at maturity stage in the presence of Zone and district agricultural experts, Zone finance head and accountants, and all members of FREG and while visiting several explanation was given including for issues raised at each demonstration site.

Farmers' preferences and selection criteria

Farmers and other stakeholders evaluated the technology and give different feedbacks and comments at the crop maturity stage during field day. A brief orientation was given to the evaluators to evaluate the technology based on the criteria of cob length, cob number, and the performance of maize crops within the treatments.

Agronomic parameters collected

Plant population, plant height, number of cobs harvested, cop length, Kernels per cop and grain yield were collected.

Data management and analysis

Data recorded were subject to analysis of variance (General Linear Model (GLM) procedure) using SAS software (SAS Institute, 2004) to test treatments effect on yield and yield component parameters. Means of treatment effects were separated using the Duncan's Multiple Range Test (DMRT) comparison at $p \leq 0.05$.

Results and discussions

Selected Soil Properties of Experimental Site

Soil reaction (pH): According to Chude *et al.,(*2005) soil reaction range, soil pH of the experimental sites before planting were very strongly acidic for site 1, 2, 3 and 5 while site 4 is strongly acidic (Table 1). Therefore, in relation to soil reaction, the soil is not suitable for the growth of most crops. Because acidic soil fix phosphorus and make it unavailable to plants.

Available phosphorus: According to Cottenie (1980) rating, phosphorus level of all experimental sites were very low (Table 1). Tekalign and Haque (1987) and Dawit *et al.* (2002) reported that availability of P in most soils of Ethiopia decline by the impacts of fixation as a result of low pH. For optimum crop production, the soil test based phosphorus calibration is important. Therefore, application of adequate phosphorus is mandatory to optimize crop yield on such soil.

Exchangeable acidity (EA): The soil analysis results showed that the concentration of exchangeable acidity before planting were 4.7, 32.8, 25.9, 3.8 and 5.3 cmol (+) kg^{-1} for site 1, 2, 3, 4 and 5 respectively. Thus, according to Daryl D (1983) rating, the exchangeable acidity of soil of the experimental sites were low for site 1 and 5, very high for site 2 and 3 and very low for site 4 (Table 1).

Relation Analysis among selected Soil Properties

Relation analysis revealed that soil exchangeable acidity was negatively related with soil pH while, soil available phosphorus was positively related with soil pH with having coefficient of determination (r^2) 0.004 and 0.101 respectively (figure 3). This implies that, as soil became acidity soil availability to plant decreases.

Table 3. Values and rates for selected soil chemical properties before planting

Soil properties	VALUE	RATING	REFERENCES
SITE 1			
pH(H_2O)	5.04	Very Strongly Acidic	Chude *et al.*,2005
EA (cmol(+) kg^{-1})	4.7	Low	Daryl D, 1983
Av.P (ppm)	1.78	Very low	Cottenie, 1980
SITE 2			
pH(H_2O)	4.63	Very Strongly Acidic	Chude *et al.*,2005
EA (cmol(+) kg^{-1})	32.8	Very high	Daryl D, 1983
Av.P (ppm)	1.75	Very low	Cottenie, 1980
SITE 3			
pH(H_2O)	4.94	Very Strongly Acidic	Chude *et al.*,2005
EA (cmol(+) kg^{-1})	25.9	Very high	Daryl D, 1983
Av.P (ppm)	3.61	Very low	Cottenie, 1980
SITE 4			
pH(H_2O)	5.29	Strongly Acidic	Chude *et al.*,2005
EA (cmol(+) kg^{-1})	3.8	Very low	Daryl D, 1983
Av.P (ppm)	2.17.	Very low	Cottenie, 1980
SITE 5			
pH(H_2O)	4.8	Very Strongly Acidic	Chude *et al.*,2005
EA (cmol(+) kg^{-1})	5.3	Low	Daryl D, 1983
Av.P (ppm)	1.73	Very low	Cottenie, 1980

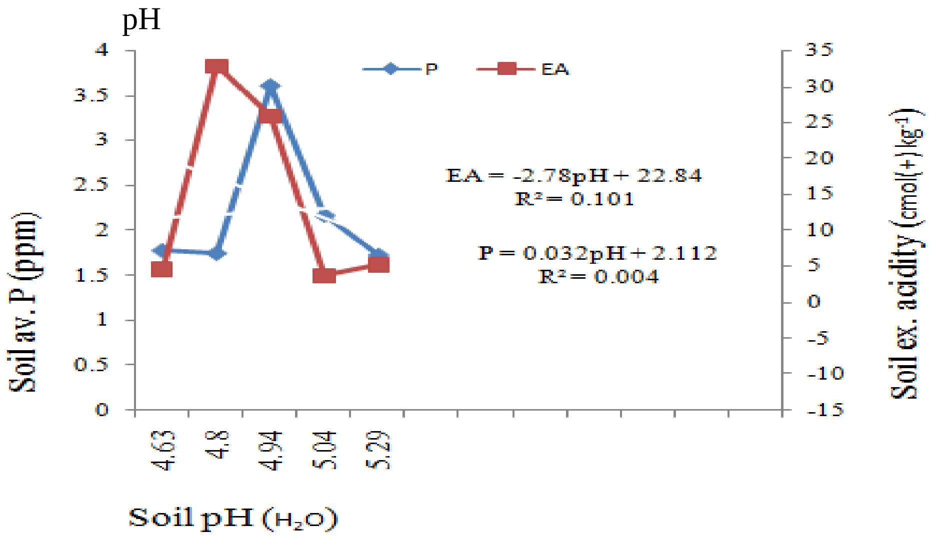

Figure 3. Correlation/relation of Soil available P and exchangeable acidity with soil

Participatory Evaluation and Farmers' perception

Farmers have good and broad experience on their environment in relation to crop production. Therefore, it is important to consult them to asses which treatment they desire. During the field day, farmers were oriented briefly on how to integrate the researchers' criteria to their own criteria to select the best. Most of participant farmers were very interested with the performance of maize stand on soil test based P recommended plots depending on cob length, cob number, and the performance of maize crops. Therefore, according to farmer observation and evaluation, maize on soil test based P recommended plot was ranked first.

Yield and Yield component of Maize as Affected by Treatments

Plant height: Plant height was significantly affected by different Phosphorus rates at site 2, 3, 4 and 5. However, it was not significantly influenced at site 1 (Table 2). Plant height ranges from 2.76 to 1.07 m. The highest plant height was recorded at recommended rate application of phosphorus. Mean maximum height was recorded for plant grown on plots treated with the recommended rate of phosphorus where as the shortest was recorded for plant grown without application of phosphorus (Control). Phosphorus application at RR rate increased mean plant height by 59, 36.2, 18.48 and 76.42% at site 2, 3, 4 and 5, respectively as compared to control (Table 2). The result is consistence with the findings of Sudhir (2012), who get higher and significant maize height at fertilizer application of soil test based crop response.

Cob length: Analysis of variance revealed that plant height was significantly affected by phosphorus rates at site 2, 3, 4 and 5. However, it is not significant at site 1. The increased cop length due to the application of recommended rate of phosphorus was not statistically significant compared to farmer practise at site 2, 3 and 5 while it is significant at site 1 and 4. Cob length of the crop ranges from 0.12 to 0.17 m. The mean maximum was recorded at phosphorus application rate of recommended rate while the shortest was at control. Phosphorus application at recommended rate significantly increased mean plant cob length by 66.67, 46.15, 8.6 and 56.1 % at site 2, 3, 4 and 5, respectively as compared to control. While Phosphorus application at blanket recommendation rate significantly increased mean plant cob length by 50, 53.85, and 48.92 at site 2, 3 and 5, respectively as compared to control (Table 2).

The increased length of cob in soil test based crop recommendation was might be due to the increased physiological processes leading to higher growth and increased transport of photosynthesis to sinks. Similar results were reported by Arun Kumar *et al*. (2007).

Kernels per cob: The treatment effects showed significant ($p \leq 0.01$) influence on kernels per cop at site 2 and 5 and significant ($p \leq 0.05$) at site 3 and 4. Phosphorus application at recommended rate significantly increased mean plant kernels per cob by about 45.64, 45.13, 17.59 and 63.26% at site 2, 3, 4 and 5, respectively as compared to control. Relatively the maximum mean kernels per cob recorded at recommended rate application of phosphorus at all site except site 3 while the lowest were at control plot (Table 2). Similar results were reported by Arun Kumar *et al.*(2007).

Grain yield: As it is observed from ANOVA, the applied phosphorus showed significant ($p \leq 0.01$) effect on grain yield of maize at all sites except site 4. Sharma *et al.* (1989) revealed that soil test recommendation gave significantly higher yield than that of the state department recommendation and the method adopted by farmers. Reddy *et al*. (2000) also conducted soil test crop response correlation studies in maize in Karimnagar district of Andhra Pradesh. Multiple regressions were worked out for predicting maize yield through soil and fertilizer nutrients and their interactions.

Table 4. Effects of Studied treatments on yield and yield components of maize

	Site 1			
Treatment	Growth, Yield and yield related traits of maize			
	PH (m)	CL (m)	KPC (No)	GY (kg ha^{-1})
(Phosphorus)				
C	2.060	0.205	580.200	9843.8^{b}
RR	2.763	0.213	715.33	12020.8 ^{a}
FP	2.393	0.205	633.17	11093.8^{ab}
Significance	**ns**	**ns**	**Ns**	***
LSD (5%)	2.78	0.0121	175.4	2095.5
CV(%)	13.87	2.55	12	8.4
	Site 2			
C	1.230^{b}	0.12^{b}	467.92^{b}	2271^{b}
RR	1.96^{a}	0.20^{a}	681.5^{a}	7073^{a}
FP	1.91^{a}	0.18^{a}	44.47^{a}	5594^{a}
Significance	**	**	***	***
LSD (5%)	2.78	0.05	87.0	1759
CV(%)	12.92	13.47	6.41	15.58
	Site 3			
C	1.16^{c}	0.13^{b}	426.3b	2541.7^{c}
RR	1.58^{b}	0.19^{a}	618.72a	9479.2^{a}
FP	2.0^{a}	0.20^{a}	635.97a	6666.7^{b}
Significance	***	**	**	***
LSD (5%)	0.28	0.04	137.75	2533.9
CV(%)	7.86	11.39	10.86	17.94
Site 4				
C	1.84^{c}	0.198^{b}	625.39^{b}	8458
RR	2.18^{b}	0.215^{a}	697.89^{a}	10438
FP	2.33^{a}	0.213^{b}	881.5^{a}	8896
Significance	***	**ns**	**	**Ns**
LSD (5%)	0.11	0.016	54.1	7024.4
CV(%)	2.3	3.4	3.57	36.04
Site 5				
C	1.077^{b}	0.139^{b}	426.3^{b}	3406^{b}
RR	1.903^{a}	0.217^{a}	696.0^{a}	9698^{a}
FP	2.013^{a}	0.207^{a}	690.2^{a}	7885^{a}
Significance	***	***	***	***
LSD (5%)	0.375	0.018	84.5	2917.3
CV (%)	9.93	4.32	6.17	18.39

Comparison of means among application levels showed that the highest mean grain yield (12020.8 kg ha^{-1}) was recorded at the recommended rate of P at site 1. While the lowest (2271 kg ha^{-1}) was recorded from control plot of the 2nd site. At site 1, 2, 3, 4 and 5 mean grain yield advantage of 2177, 4802, 6937.5, 1980 and 6292 kg ha^{-1} respectively were gained due to recommended rate application of phosphorus as compared to the grain yield obtained from blanket recommendation. While mean grain yield advantage of 927, 1479, 2812.5, 3542 and 1813 kg ha^{-1} respectively were gained when compare with control

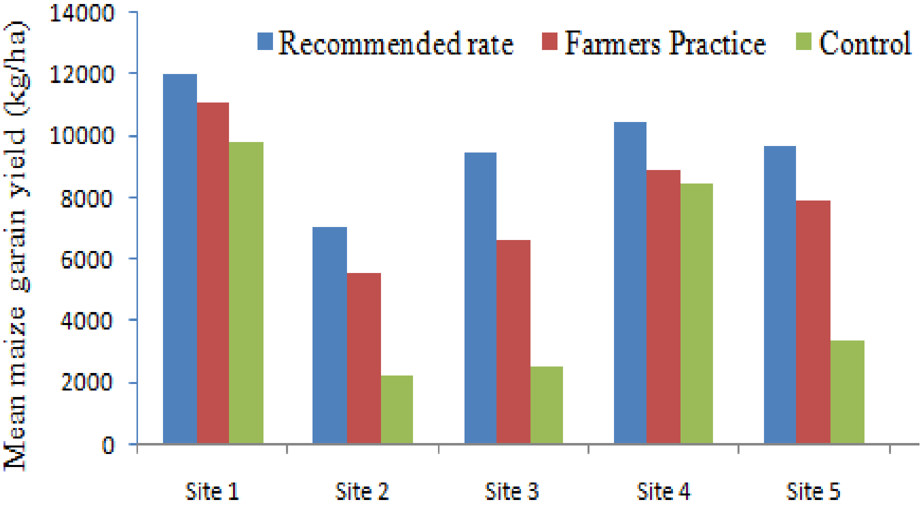

Figure 4. Maize grain yields of all studied sites

Table 5. Mean minimum, maximum and mean of maize grain yields (kg ha^{-1})

Variable	Min.	Max.	Mean
RR	7073	12020.8	9742
FP	5594	11093.8	8227
C	2271	9843.8	53.04

Conclusions and recommendations

Demonstration is very important tool to expose the technology to farming community through farmers' research group. They have to carry out the experiment, analyze the difference and choose the best. Based on both farmers assessment and agronomic data analyzed, soil test based recommended rate of phosphorus was chosen as the best and led to the maximum yield and yield components of maize as compared to control and blanket recommendation in all demonstration sites. Exercising soil test based fertilizer recommendation for production and strengthening the linkage among stakeholders were paramount to achieve the desired goal and improve the income of small-scale farmers. Therefore, Soil test based response fertilizer recommendation was selected and recommended for pre scaling up activity on wider plot for popularization.

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Pre-Extension Demonstration of Integration of both Mechanical and Biological Soil and Water Conservation Practices in Kofele District, West Arsi Zone, Oromia

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Abstract

Soil erosion is one of the major challenges of Ethiopia deteriorating the productivity of land. Soil and water conservation (SWC) is the only practice to reverse the threat and protect the land. Over the last three decades, different soil and water conservation activities have been undertaken. However, soil erosion still persists and become major threats of Ethiopian farmers. Despite the massive mobilization of resources for SWC, only very few farmers have been practicing integrated soil and water conservation measures for restoration of degraded agricultural land. In addition, there is lack of information among farmers on the impact of SWC on soil fertility improvement and soil nutrient content dynamics. This study was conducted in Kofele district, which is one of AGP district, in West Arsi Zones of Oromia. The study was aimed to demonstrate the impact of integrated Soil and water conservation measures in restoring degraded agricultural land. Dasho and Elephant grasses were planted on graded soil bund as an integration measures at four farmers field. Farmer's field visit was arranged two times in two years to share practical experiences among the farmers and DA. It was also identified that soil nutrient contents in terms of total nitrogen, available phosphorous, available potassium and soil organic carbon content showed an increasing trend since establishment (2016). On the other hand, this kind of soil and water conservation practices on agricultural land showed promising way of carbon sequestration as the climate change mitigation strategy. The study recommended the use of integrated soil and water conservation measures as strategy of rehabilitating degraded agricultural land as apart of integrated water shed management.

Keywords: *Soil and water conservation, Soil erosion, Soil nutrient, Pre-extension, demonstration*

Introduction

Agriculture is the major source of livelihood in Ethiopia. However, land degradation in the form of soil erosion has hampered agricultural productivity and economic growth of the nation (Haileslassie *et al.*, 2005; Balana *et al.*, 2010). Land degradation, low agricultural productivity and poverty are critical and closely related problems in the Ethiopian highlands (Yitbarek *et al.*, 2012). Investments in soil and water conservation (SWC) practices enhance crop production, food security and household income (Adgo *et al.*, 2013). Recognizing these connections, the government of Ethiopia is promoting SWC technologies for improving agricultural productivity, household food security and rural livelihoods. Particularly in the Ethiopian highlands, different SWC technologies have been promoted among farmers to control soil erosion problem. The traditional physical SWC measures, such as soil bund and terraces, have been practiced in a few areas for several hundred years for which awareness and experience have been confined in that particular area. The structures having certain technical designs and specifications have been introduced to many new areas, assuming that land users can adopt it sooner or later. Recently, pilot projects, campaign work, food for work programs (grain and edible oil support), etc. were initiated and are ongoing by both government and non-governmental organizations. However, most of these SWC technologies, especially construction of SWC practices on agricultural land, has got less acceptance in different parts of the country (Tesfaye *et al.*, 2013; Teshome et al., 2014), largely because investments by farmers in SWC are influenced by the ecological, economic and social impacts of the SWC technologies. The actual and long term financial profitability to farm households critically influences the process of accepting and replicating such structures (De Graaff *et al.*, 2008). Poverty and a long time span to get return from soil conservation activities reduced adoption of SWC technologies in East Shewa. In the northwestern Ethiopian highlands, labour shortage, problems with fitness of the SWC technologies to the requirements of farmers and land tenure insecurity discouraged farmers from adopting SWC measures such as soil and stone bunds, *fanya juu*, etc. (Bewket, 2007).

Therefore, it is important to improve farmers' level of understanding on the effect of soil and water conservation technologies in controlling soil erosion and maintaining soil nutrient content on agricultural land. On the other hand, participatory evaluations of these technologies are also equally crucial to improve farmers' level of adoption of SWC technologies. Despite the massive mobilization of resources for SWC, only very few farmers have been practicing integrated soil and water conservation measures for restoration of degraded agricultural lands. In addition, there is lack of information on the impact of SWC on soil fertility improvement and soil nutrient content dynamics. Therefore, the aim of this research was to demonstrate and improve farmers' practical level of awareness/understanding on SWC technologies and to evaluate the impact of integrated soil and water conservation on soil nutrient change.

Materials and methods

The soil and water conservation measures were established at four different Sites/farmers in Kofele district on an area of 30m x 50m at each farmer. A total of four FREG (one FREG under each site) was established and one host farmers. Animal forages such as *Elephant and Dansho grass* were used as an integration measure with soil bund. Farmers' field visit was done to improve farmers' level of understanding on SWC technologies. Composite Soil samples were collected from each site every year since establishment and analyzed to evaluate soil nutrient dynamics.

Result and discussions

Farmers training and Field visit

Farmers training and field visit were arranged for all FREG members, DA and Experts of the district to create awareness on the contribution of integrated SWC practices in controlling soil erosion, improving soil fertility and as additional source of feed for livestock. A total of 80 farmers grouped in eight FREG, 9DA, and 9 Experts participated in field visit and training from 2016-2017 (Table 1).

Table 1. Training and field visit participants from 2016-2017

Years	No. of FREG	No. farmers organized as FREG			DA			Experts			Total
		M	**F**	**Total**	**M**	**F**	**Total**	**M**	**F**	**Total**	
2016	1	7	3	10	4	1	**5**	3	2	**5**	10
	1	8	2	10							
	1	7	3	10							
	1	8	2	10							
2017	1	6	4	10	3	1	**4**	3	1	**4**	8
	1	9	1	10							
	1	7	3	10							
	1	8	2	10							
Ground total	**8**	**60**	**20**	**80**	7	2	**9**	6	3	**9**	**18**

Farmers, DA and Experts' perception

Farmers' perception on integrated soil and water conservation was assessed using prepared check list. Accordingly, 100% of the participants understand that integrated soil and water conservation is highly valuable in terms of controlling soil erosion, improving soil fertility and increasing land productivity. Development agents (DA) and experts, who participated on this field visit, were also asked to say on their perception on the technology demonstrated. They have suggested that most of soil and water conservation practices conducted through campaign were not successful particularly on agricultural land due to farmers' lack of awareness on the contribution of soil and water conservation measures.

In addition, even though different physical conservation structures are constructed every year, farmers are not interested to integrate the structures with the biological ones as they perceive that trees or grasses may reduce the land size and can compute for nutrient. Therefore, to change farmers' negative perception on integrated soil and water conservation, such demonstration activities are very important. They have also planned to maintain such conservation structures and grasses for further demonstration and scaling up it to different PA in the district. Change in total Nitrogen, available phosphorous, potassium and SOC from 2016-2018 wereassessed every year. Accordingly, Total N, available phosphorous, potassium and soil organic carbon showed an increasing trend at all sites since 2016 (Table 2).

Soil nutrient content is highly significantly different at $p<0.05$ between and within experimental sites across the years (Table 2). Major soil nutrient contents also showed an increasing trend since 2016 (baseline) indicating that integrated SWC measures interventions have a positive effect on improving soil nutrient content. On the other hand, SOC content of the soil showed an increasing trend since establishment of integrated SWC indicating that it is a promising way of carbon sequestration on agricultural land. In addition, Soil nutrient status in 2016 (baseline) is also smaller and highly significantly different from the soil nutrient status after intervention. EC (electrical conductivity) and soil pH are not significantly different ($p>0.05$) across the year and sites.

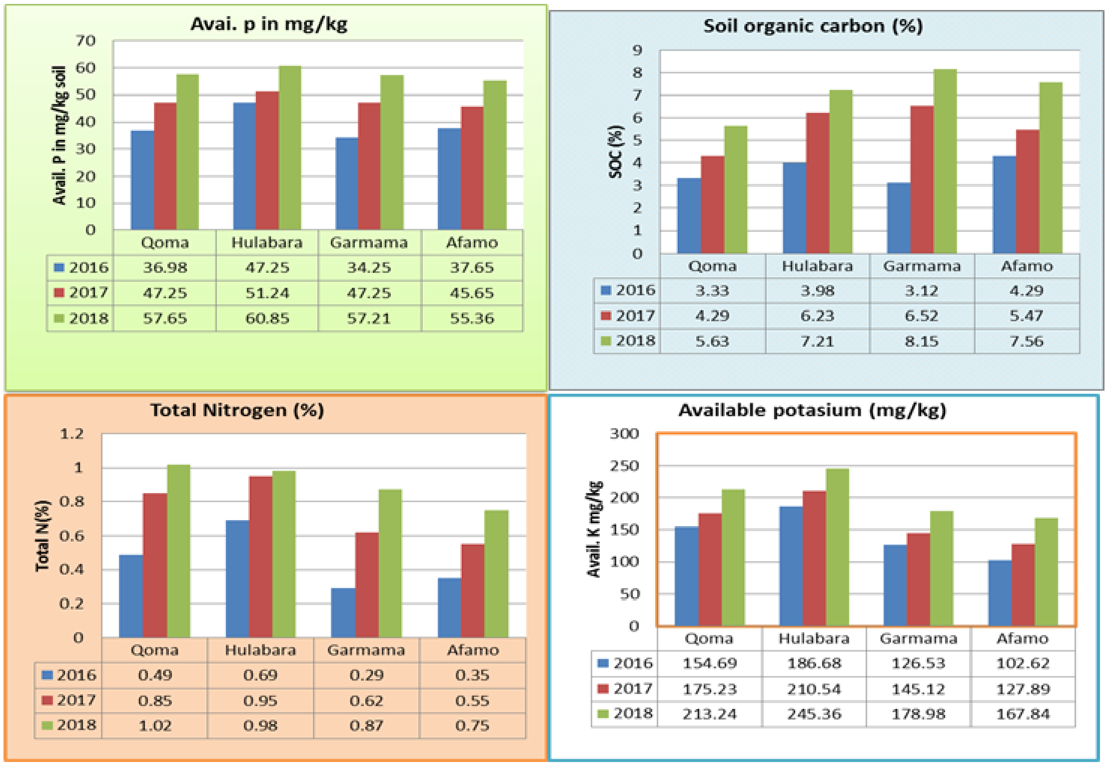

Figure1: Change in total Nitrogen, available phosphorous, potassium and SOC from 2016-2018

Table 2: Mean comparison of soil nutrient content at different site across the years

District	Years	Sites	Total N (%)	Avail. P in ppm	Avail. K in mg/kgsoil	EC in mmhos/cm	Soil pH	SOC (%)	C/N
Kofele	2016	Hulabara	0.63^{de}	44.95^{cde}	172.05^{cd}	0.35^{a}	5.19^{ab}	8.19^{c}	13.00^{ed}
		Afamo	0.51^{ef}	40.62^{def}	148.00^{d}	0.22^{b}	4.99^{b}	6.53^{cd}	12.80^{cde}
		Qoma	0.44^{f}	34.73^{f}	138.38^{d}	0.21^{b}	5.10^{ab}	5.83^{d}	13.25^{cde}
		Garmama	0.42^{f}	38.20^{ef}	142.29^{d}	0.27^{ab}	5.35^{ab}	6.45^{cd}	15.35^{abcde}
	2017	Hulabara	0.90^{ab}	51.77^{bc}	198.82^{bc}	0.36^{a}	5.11^{ab}	10.67^{b}	11.85^{e}
		Afamo	0.67^{cde}	47.37^{cd}	155.16^{d}	0.20^{b}	5.7^{ab}	9.89^{b}	14.76^{abcd}
		Qoma	0.84^{abc}	47.90^{cd}	170.94^{cd}	0.24^{ab}	5.79^{ab}	13.23^{d}	15.75^{abcd}
		Garmama	0.69^{cd}	49.28^{c}	167.98^{cd}	0.26^{ab}	5.57^{ab}	8.31^{c}	12.04^{cde}
	2018	Hulabara	0.76^{bcd}	64.15^{a}	254.86^{a}	0.28^{ab}	5.33^{ab}	12.70^{ab}	16.71^{abc}
		Afamo	0.77^{abcd}	62.62^{a}	170.94^{cd}	0.27^{ab}	5.84^{a}	11.69^{ab}	15.18^{abcd}
		Qoma	0.94^{a}	59.18^{ab}	229.55^{ab}	0.26^{ab}	5.80^{ab}	10.08^{b}	10.72^{e}
		Garmama	0.83^{abc}	57.60^{ab}	198.24^{bc}	0.27^{ab}	5.57^{ab}	9.94^{abc}	11.97^{e}
	CV (%)		14.61	9.87	12.19	26.73	8.97	13.07	15.06
	$LSD_{0.05}$		0.17	8.30	36.75	0.12	0.82	2.30	3.83
	p-value		0.00	0.00	0.02	0.25	0.34	0.00	0.01

Similarly, Eshatu (2004) reported that SWC practices significantly increased organic carbon, total nitrogen and soil-organic matter in the soil. Other studies also indicated that there is a positive contribution of SWC measures to the reduction of soil erosion, conservation of soil moisture, and soil nutrient content (Asefa *et al.* 2003; Vancampenhout *et al*. 2006; Mekuria et al. 2011; Gebreegziabher *et al*. 2009). Many other cases studies also indicated that integration of biological with physical measures improved effectiveness of the structure and soil fertility (Zougmore et al., 2002 and Adimassu et al., 2012).

Conclusions and Recommendations

Major soil nutrients such as total nitrogen, phosphorous, potassium and SOC contents showed an increasing trend since establishments of integrated soil and water conservation measures at all sites. In addition to providing forage to the livestock and controlling soil erosion, integrated soil and water conservation can improve soil fertility and increase soil organic carbon pool. Based on this study, the following recommendations were given:

- Integrated SWC activities should be scaled up particularly on agricultural land as means to control soil erosion problem, improving soil fertility and as a source of feed for livestock
- Integrated soil and water conservation is a promising way of carbon sequestration on agricultural land. Therefore, this should be considered in the implementation of climate smart agriculture as strategy to mitigate climate change

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