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Preface

Realizing the key role that it plays in the national economy, the Ethiopian government has given due emphasis to the agricultural sector development. The Agricultural and Rural Development Policy and Strategy of the country which was designed nearly a decade and half ago,has highly emphasized the important role of agriculture as a means of ensuring rapid economic growth, enhancing benefits to the people, eliminating food aid dependency, and promoting the development of amarket-oriented economy. Guided by this national policy and strategy, different consecutive national plans, programs and projects focusing on the development of the agriculture sector has been implemented and is being implemented throughout the country. Among such programs, the Agricultural Growth Program (AGP-II) is one and perhaps the biggest World Bank and other donors supported project launched to support agriculture research and development.

The AGP-II project which is currently under implementation is providing financial supports to the agricultural research and extension both at national and regional levels. The project has four components of which the research component is one. The aim of the research component is to adapt or generate agricultural technologies, undertake pre-extension demonstration of proven technologies, produce source technologies that would serve as a base for large scale technology multiplication and enhance capacity of the research systems to improve technology supply.

Being one of the implementing institutions, the Oromia Agricultural Research Institute (IQQO) is conducting various technology adaptation and generation, pre-extension demonstrations, source technology multiplication and capacity building activities. Of the total technology adaptation/generation and pre-extension demonstrations conducted in 2016/17 cropping seasons 23 technology adaptation/generation and 14 pre-extension demonstration activities have been completed and their results are by now ready for use.This workshop is organized with the purpose of reviewing research findings related to pre-extension demonstration of improved agricultural technologies. The workshop involves researchers from different disciplines, research directors and other relevant stakeholders.

Asefa Ta'a (PhD)

Deputy Director General

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Pre-extension Demonstration of Improved Bread Wheat Technologies in Ginnir District of Bale Zone

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Abstract

Participatory on-farm demonstration of bread wheat varieties were carried out with the objectives of evaluating and selecting the best performed improved bread wheat technologies under farmers' condition and to build farmers' knowledge and skill of wheat production and management packages in Ginnir district of Bale Zone in 2016/17 production season. A total of ten (10) participant farmers were selected from two wheat growing potential Kebeles of Ginnir district to carry out the demonstration activity. One FRG/FREG having 20 member farmers was established at each Kebele. Two improved bread wheat varieties (Bika and Ogolcho) were compared (demonstrated) with one standard check (Dhakaba) on plot size of 32 m x 32 m (1024 m^2) by using each farmer's field as replication. All recommended agronomic practices were equally applied to all the plots and the fields were closely supervised and managed well. Participatory training was given for a total of 176 participants on important agronomic practices and disease control measures. At maturity stage of the crop, the varieties were jointly evaluated with a team composed of researchers, farmers, development agents and experts. Tillering capacity, disease tolerance, spike length, seeds per spike, plant height, seed color and size, early maturing, adaptability to their locality, uniformity, crop stand and overall yield were the selection criteria identified by the participants for selecting the best performing variety/ies. Agronomic data and yield data were collected and analyzed using descriptive statistics in order to evaluate the performance of the varieties. With regard to yield, 54.5 qt ha^{-1}, 47.5 qt $ha^{-1}$and 40 qt ha^{-1}were obtained from Ogolcho, Bika and Dhakaba, respectively. Besides; Ogolcho has 36.25 % and 14.74% yield advantage over Bika and Dhakaba, respectively. Whereas, Bika has 18.75% yield advantage over Dhakaba. Thus, Ogolcho ranked first followed by Bika and both varieties were recommended to scale up/out in Ginnir district and other similar agro-ecologies of Bale zone.

Key words: *Farmers' preferences, Farmers Research Extension Group (FREG),*

Introduction

Agriculture is a dominant sector in Ethiopia. It contributes 41.6 % to the gross domestic product (GDP), employs nearly 85 % of the total labor force and generates over 70% of the country's export (foreign currency) earnings and 80% of raw materials supply for agro-industries (UNDP Ethiopia, 2012). Though smallholder farmers differ in individual characteristics, farm size, resource distribution for on-farm activities, their use of external

inputs and hired labour; smallholder farms are predominant, account for more than 90 percent of agricultural production and over 95 percent of the total area under cultivation (CSA, 2016).

Ethiopia is the largest producer of wheat in Sub-Saharan Africa. Recently, wheat in general has become one of the most important cereal crops (strategic crop) in terms of production and food security in Ethiopia (Tolesa, 2014). Two wheat species are dominantly grown in the country. These two economically important wheat species are bread wheat *(Triticum aestivum* L.) and durum wheat (*T. turgidum* var. *durum*). Bread wheat is of recent introduction; durum wheat is indigenous to the Ethiopia, which is considered as 'the secondary center of diversity for tetrapod wheat'. Wheat is one of the major cereal crops grown within the range of 1500 to 2800 m.a.s.l in Bale, Arsi, West Arsi and Shoa zones of Oromia National Regional State (SARC Profile, 2015). During 2015/16 cropping season 1,664,564.62 ha of land was covered by wheat (bread and durum) and over 42,192,572.23 quintals was harvested with the average yield of 25.35 qt/ha at national level. Similarly, the land covered by wheat production in Bale zone in 2015/16 Meher production season was 143,971.78 hectare and the average yield of wheat produced from the zone was 28.97 qt/ha (CSA, 2016).

Even though, most agro-ecologies of West Arsi and Bale Zones are the potential areas for wheat production, the yield obtained by farming community was below the potential. This is due to lack of improved wheat varieties with associated packages, low crop management practices, diseases and insect problems and low use of recommended full packages. Therefore keeping this fact in view, in the last few years, efforts have been made to release varieties like Bika, Ogolcho and Dhakaba for mid agro- ecology of the Zones. Yet, farmers in the mid land agro-ecology of Bale Zone have limited access to those improved wheat verities with recommended agronomic practices. Thus, undertaking participatory demonstration, evaluation and validation of improved bread wheat technologies with the participation of farmers and other stakeholders is important to familiarize the farming communities with the varieties which in turn will facilitate the adoption process and bridge the productivity gap.

Material and Methods

Description of the study area

The research was carried out in Ginnir district of Bale Zone. Ginnir district is among the eighteen (18) rural districts of Bale zone, which is located at 560 km southeast of Finfinne/Addis Ababa and 130 km from Robe town. It is one of the largest districts of Bale zone with a total land area of 2351 km^2 (235,100 hectares). It is divided into twenty eight (27) rural *Kebeles* and three (3) towns. More than 95% of the population is engaged in agriculture. Farming system of the district is characterized by mixed crop-livestock farming. The major crops grown by farmers in the district are wheat (bread, durum and emmer), barley (food and malt), field pea, faba bean, lentil, chickpea, haricot bean, linseed, maize, hot pepper, potato, fenugreek, black cumin, coriander, garlic, onion, cabbage, banana, sugar cane, orange and papaya. Domestic animals like cattle, equines, sheep, goats, camel and chickens are important livestock species reared by farmers in the district (Gdanro, 2016).

The agro-ecological zones of the district are highland (0.96%), midland (61.17%) and lowland (37.87%). The altitude ranges from 1203 m to 2204 m.a.s.l. The mean annual temperature of the district is 22^oc. The maximum and minimum temperatures are 29^oc and 15^oc, respectively. The mean annual rain fall is 650mm where as 900mm and 400mm maximum and minimum annual rain fall recorded in the district, respectively. The dominant soil type is loamy clay 26%, vertisols 48 % and sandy soil 18%. Ginnir district is bounded by Gololcha district in the North, Goro district in the South, by Sawena and Rayitu districts in East and Gassara district in the West. The administrative center of the district is Gassara town (Gdanro, 2016).

Site and farmers' selection

Site selection

As a target area, Ginnir district was selected for the implementation of the activity from AGP-II beneficiary districts due to its potentiality for bread wheat production and the high demand for the crop. Selection of potential Kebeles was carried out in collaboration with DAs and experts. Accordingly, Walta'i Atota and Aqasha Kebeles were selected as demonstration sites of the varieties based on accessibility and potentiality for the crop.

Farmers (FRGs/FREGs) selection

Selection of FRGs/FREGs members was based on farmers' willingness to be held as member, accessibility for supervision of activities (vicinity), good history of compatibility with groups and genuineness and transparency to share innovations to other farmers. Consequently, one FRG/FREG having 20 members with the composition of resource rich, medium and poor category of farmers including men, women and youth farmers was established at each kebele. Gender and youth balance in each FRG/FREG unit was strictly considered (at least 40%).

After establishment of the FRGs/FREGs, a theoretical training session was arranged to farmers, DAs, and experts at Ginnir town. Multidisciplinary team of researchers from SARC delivered training to a total of 56 participants: - 40 FRGs/FREGs members, 6 DAs, 2 supervisors and 8 experts on the following topics: participatory agricultural research and promotion through FRGs/FREGs, suitable agro-ecologies and weather condition for wheat production, wheat production and management packages, agronomic practices, economic and nutritive importance of bread wheat, post-harvest managements and storage of the crop.

Selecting participant farmers

Having suitable and sufficient land to accommodate the demonstration activity, willingness to contribute the land, vicinity to roads so as to facilitate the chance of being visited by many farmers, initiatives to implement this activity in high-quality, good in field management and willingness to explain the technologies to others were criteria used to select the hosting farmers. Then, three to four representative hosting farmers from each FRG/FREG were selected at each kebele with the help of group members and DAs. Thus, a total of ten (10) hosting farmers were selected for this purpose. Farmers (FRG/FREG members and other follower farmers) were encouraged to participate in the physical activities from the beginning up to the end of the demonstration activity.

Implementation design

Two improved bread wheat varieties (Bika and Ogolcho) and one standard check (Dhakaba) were used for the demonstration process by using each farmer's field as replication *i.e.* the demonstration activity was replicated on three farmers per kebele. The varieties were planted on farmers' land with simple plot design (32 m X 32 m) in 2016/17 main cropping (*Meher*)

season with full recommended management packages. Row planting method was employed and spacing of 20 cm between rows was used for the demonstration trial. The recommended seed rate of 150 kg/ha was used by drilling in the prepared rows. Shallow planting of 5 cm depth was used in the presence of sufficient soil moisture. The recommended rates of 100 kg/ha UREA and 100 kg/ha DAP were used to conduct the experiment. All DAP was applied at planting time while, UREA/*Nitrogen* applied in split of: 1/3 at planting and 2/3 at tillering stage of the crop. The trials were weeded two times; first at one month after sowing and second at two months after sowing of improved bread wheat varieties. Farm operations (land preparation-ploughing four to five times using oxen plough) were carried out by hosting farmers, whereas activities such as land leveling, planting, first and second weeding, agro-chemical spray, harvesting, threshing were handled by SARC.

Technology demonstration and evaluation techniques

FRGs/FREGs members and other follower farmers were encouraged to participate on different extension/promotional events organized at each demonstration site. These were mechanisms used to enhance farmer-to-farmer learning and information exchange such as trainings, field visits/tours, experience sharing, field days, etc.

Training

Training (both theoretical and practical) is very important for awareness creation and to bring improvement on the job after filling the gap on knowledge, skill and attitude (KSA). Hence, stakeholders such as zone and district level Agriculture and Natural Resource Office, Unions, private service providers, Arsi-Bale Plant Health Clinic office, zone and district level agricultural inputs regulations and quarantine experts were invited and participated during consultation meeting and training.

Monitoring and evaluation, field visit and field day

Field visit 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.

Farmers' preferences and selection criteria

The varieties were demonstrated, evaluated at crop maturity stage and validated by farmers, agricultural experts, development agents, researchers and other stakeholders based on the following selection criteria. The criteria were tillering capacity, disease tolerance, spike length, seeds per spike, plant height, seed color and size, early maturing, adaptability to their locality, uniformity, and crop stand, marketable and overall yield. Each selection and evaluation criteria were rated using the following rating scale; 1= Very poor, 2= Poor, 3= Fair, 4= Good and 5= Very Good

Data collected

Both qualitative and quantitative data were collected using appropriate data collection methods such as focused group discussion (FGD), direct field observation and measurements. Agronomic data and grain yield per plot were recorded. Total number of farmers participated on extension/promotional events such as training, field visits and mini field days were recorded by gender composition. Feedback assessment on farmers' preference to the demonstrated varieties (likes and dislikes, which is the base for plant breeding process) and farmers' perception towards the performance of the technologies were also identified.

Data analysis

The collected data was analyzed using SPSS and descriptive statistics such as mean, frequencies distribution and percentages. Besides, pair wise ranking matrix was used to evaluate and select best performing varieties and rank the varieties in order of their importance.

Results and Discussions

Inputs used and yield harvested

Demonstrations of improved bread wheat varieties (Bika and Ogolcho) with one standard check (Dhakaba) were conducted at Ginnir district of Bale zone in the 2016/17 cropping season. The varieties were demonstrated to the farmers with full recommended management practices. SARC was the source of all inputs (seed, fertilizers and agro-chemicals) required for trial implementation.

Table 1: Lists of demonstrated varieties on hosting farmers' field at Ginnir district in 2016/17

Variety	Locations/ Districts	No. of trial farmer	Plot size (m)	Seed/ farmer (kg)	Total seed distribute (qt)	Fertilizers for one farmer (kg)		Total Area (ha)	Harvested seed (qt)
						UREA	NPS		
Ogolcho	Ginnir	6	32X32	16	0.96	11	11	0.64	35.0
Bika	Ginnir	4	32X32	16	0.64	11	11	0.43	20.5
Total		10			1.6			1.07	54

Training on capacity building

Participatory training was given by multidisciplinary team of SARC researchers (Breeder, Agronomist, Weed Scientist, Pathologist, Entomologist, Economist and Extensionist) in Ginnir district (Ginnir towns) to a total of 176 participants: - 156 farmers (40 FRGs/FREGs members and 116 follower farmers), 8 DAs and Supervisors, 12 experts and 7 researchers. The theme of the training were included the availability of improved wheat technologies for mid altitude areas of Bale zone and utilization, bread wheat (both in quantity and quality) production and management packages, major wheat diseases and their control measures, agro-chemicals utilizations/applications and safety precautions, the importance of crop rotation to break cereal based mono-cropping practices in mid altitude areas of Bale zone through pulse crops (commodity) integration and on creating strong linkage among relevant actors through multi-stakeholder approach to tackle the problem in joint action through taking emergent, medium and long term actions/measures.

Field day organized

Mini field day was jointly organized in collaboration with other stakeholders (zone and district level agriculture development offices and participant farmers) in Ginnir district to create awareness about the importance and availability of the new improved wheat technologies. About **152** participants (120 farmers, 12 DAs, 4 Supervisors, 12 experts and 4 researchers) were participated on this event including FRGs/FREGs members and follower farmers.

Yield performance of the varieties

The overall mean yield of Ogolcho and Bika varieties on farmers' field were 54.5 qt/ha and 47.5 qt/ha, respectively while the average yield of standard check (Dhakaba) was 40qt/ha.

Table 2: Yield advantages of the varieties over the standard check

District	Mean yield of standard Check (qt/ha)	Mean yield of improved bread wheat varieties (qt/ha) and yield advantage over the check			
Ginnir	Dhakaba	Ogolcho	%	Bika	%
	40	54.5	36.25	47.5	18.75

Result in the table 2 reveals that the hosting farmers had obtained more than 10% yield advantage from both improved bread wheat varieties over the standard check (Dhakaba). This figure was competent with the potential yield of the varieties at research field since package approach was employed during demonstration activity.

Participatory evaluation and farmers' preference

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). The target beneficiaries of improved agricultural technologies are strongly inclined to their likes and dislikes (preferences). These preferences will cause them to give up less favored good crops/varieties for more favored ones. Therefore, before

venturing/undertaking into breeding process, there is a need to consult intended beneficiaries to assess which qualities of a particular crop/variety they desire. Based on this, the breeding team (breeding program) can assess and evaluate which qualities are realistic (depending on many factors/criteria), and present their results to the beneficiaries. This will not only be resource saving in terms of preferred variety promotion/dissemination, but also time saving and fast adoption (Dan, 2012). Thus, a total of 62 participants (40 FRGs/FREGs member farmers, 6 DAs, 2 Supervisors, 8 experts and 6 researchers) were participated on the process at maturity stage of the crop.

First, the evaluators were grouped in to small manageable group (one group had 10 members including one group leader and one secretary). At each kebele and 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.

Table 3: Pair wise ranking matrix result to rank the varieties

No	Variety	Ogolcho	Bika	Dhakaba
1	Ogolcho			
2	Bika	1		
3	Dhakaba	1	2	

All participant farmers were very interested with the stands of the demonstrated varieties and good awareness was created among stakeholders about improved bread wheat technologies. Based on farmers' assessment and evaluation, Ogolcho ranked first followed by Bika. The two varieties need early planting using the first rain shower to overcome the moisture stress problem in the mid altitude areas of Bale zone. Revolving seed and farmer-to-farmers seed exchange mechanisms were designed to access seed for FRG/FREG members and other interested farmers in the study area.

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

Varieties	Rank	Reasons
Ogolcho	1st	Good tillering capacity, disease tolerance, spike length, seeds per spike, plant height, seed color and size, early maturing, adaptability, uniformity, crop stand, marketable and overall yield
Bika	2nd	Has medium tillering capacity, disease tolerance, spike length, seeds per spike, plant height, early maturing, adaptability to their locality, crop stand, marketable and overall yield
Dhakaba	3rd	Though early maturing, it is susceptible to diseases (YR,SR), has medium tillering capacity, crop stand and poor yield

Conclusion and Recommendations

In general, earliness of the varieties, spike length, tillering capacity, seed per spike, drought tolerance, disease tolerance, uniformity, crop stand, seed quality (marketability) and yield were the best selection criteria identified by the evaluators. The overall harvested mean yield of Ogolcho, Bika and Dhakaba was 54.5 qt/ha, 47.5 qt/ha and 40 qt/ha, respectively. Agronomic data result shows that Ogalcho and Bika varieties were selected as compared to the standard check (Dhakaba) variety.

Effective and efficient delivery of technical advices and support to farmers is highly required to improve wheat production and productivity, and bring the targeted impact. Strengthening the pre-extension demonstration, participatory evaluation and validations of newly released/registered wheat technologies under farmers' condition is important to make our research demand-driven and enhance wheat production and productivity. Farmers' preferences should be considered and taken into consideration in breeding program in order to save resources in terms of preferred variety promotion/dissemination, time and make technology adoption faster.

Based on farmers assessment, both varieties were selected (ranked Ogolcho 1st and Bika 2nd) and recommended for pre-scaling up activity on wider plot (at least 0.25 ha per trial farmer) in Ginnir district and similar agro-ecologies of Bale zone. Thus, popularization of the varieties should be made on different extension events and during field day that organized by SARC and even by ANR Offices in the cropping season in order to create high demand for these demonstrated improved bread wheat varieties. Strengthening the linkage among stakeholders is paramount to achieve the desired goal.

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Pre-extension Demonstration of Improved Bread Wheat Technologies in AGP-II Districts of East and Horro Guduru Wollega Zones, Western Oromia

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Abstract

This activity was conducted in Jardaga Jarte, Jimma Rare, Guduru and Jimma Geneti dstricts of western Oromia with the objective of demonstrating the recently released bread wheat varieties, Buluq and Liban, to the farming community in these districts. These districts were purposively selected based on potentiality for bread wheat production. Two potential kebele from each district were selected on the basis of accessibility and potentiality. One FRG/FREG was established at each kebele and trained on wheat production and management packages. Three varieties of bread wheat, Danda'a (as standard check); Buluq and Liban (as a new variety) were planted on 20 m x 10 m adjacent plots on 32 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 of the crop, the varieties were jointly evaluated with a team composed of researchers, farmers, development agents and experts. Tillering capacity, disease tolerance, seeds per spike, plant height, crop stand, overall yield, seed size, lodging resistant, early maturity, spike length, seed color, threshability were the common identified selection criteria across all locations for selecting the best performing variety/ies. Danda'a beat in yield both Liban and Buluq while Liban has met the set criteria and impressing the farmers; especially in threshability and resistant to stem rest. With regard to yield, 50.5qt ha^{-1}, 41.2qt/ha and 34.75 qt ha^{-1} were obtained from Danda'a, Liban and Buluq, respectively. Liban variety is recommended for pre-scaling up in the next season. Besides; Danda'a has 31.19 % and 18.32% yield advantage than Buluq and Liban, respectively.

Keywords: *Bread wheat; FRG/FREG unit; Participatory evaluation; Buluq, Liban, Danda'a*

Introduction

Wheat is a major crop in Ethiopian high lands, primarily as mid-altitude and highland rain fed crops. It the fourth most important cereal next to tef, maize and sorghum 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). At national level, during 2015/16 cropping season 1,664,564.62 ha of land was covered by wheat (bread and durum) and over 42,192,572.23 quintals was harvested with the average yield of 25.35 quintals per hectare (CSA, 2016). It is a staple food crop in all high land areas of western Oromia.

In developing countries like Ethiopia it is believed to cover up to about 25 % calorie requirements of the population (Kebede *et al*., 2013). Despite its greater economic and nutritional contribution to our population, the national average does not exceed 2.2t ha^{-1}. Shortage 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).

It was reported that in 1950's Ethiopia was the next exporter of wheat, but in 2011, 1,049,000 ton was imported. Technological and natural factors (disease, weed and insects), grain quality, lack of varieties for specific growing conditions and lack of improved seed supply for the best variety are among the constraints that lowered the productivity (EAAPP, 2014). More than 60 different bread wheat varieties have been released and/or registered in Ethiopia to satisfy the growing production demands of the farmers in the country (Variety Registration Book, 2014).

However, released bread wheat varieties specifically Kubsa, Galama, Abola, Simba, Millenium, Pavon-76 and Digalu are losing their genetic potential due to wheat rusts disease epidemics, especially stem rust (Amare *et.al*, 2015). In 2013-2014, for instance, stem rust of wheat occurred at epidemic level breaking resistance of Digelu variety (EAAPP, 2014). Recently, Danda'a, to our dismay was also attacked by wheat rust diseases, despairing bread wheat producers.

To tackle such a challenge, BARC has been conducting intensive research work on the crop and has recently released two wheat varieties that have better disease tolerance than the previous varieties. It is, thus an urgent task to demonstrate these improved varieties.Therefore, this project was initiated with objectives of demonstrating improved bread wheat technologies so as familiarize the farming communities with the new varieties which in turn will facilitate the adoption process and bridge the productivity gap.

Materials and Methods

Site and FRGs/FREGs Selection

This activity was conducted in purposively selected districts of Horro Gudru wollega zone. Selection of the districts was based on potentiality for bread wheat production, accessibility for supervision and compatibility with the AGP-II criteria. Accordingly, Jimma Geneti, Jardega Jarte, Guduru and Jimma Rare were selected based on the aforementioned criteria.

Two potential kebeles from each district were selected based on accessibility and potentiality for bread wheat production. In each Kebele two FRG/FREG units comprising of 12-15 farmers were established. Gender and youth balance in each FRG/FREG unit was strictly considered (at least 40%). In each FRG/FREG unit four trial/hosting farmers were selected with the rest being participant farmers. Development agents and experts were collaborating in site and farmer selection.

The FRG/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. Moreover, the trial/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 FRGs/FREGs a theoretical training session was arranged to farmers, DAs, and experts. Multidisciplinary team of researcher from Bako Agricultural

Research Center (BARC) delivered training to a total of 148 participants:- FRGs/FREGs members (120), DAs and supervisors (16) and experts (12) on the following topics: participatory agricultural research and promotion through FRGs/FREGs, suitable agro-ecologies and weather condition for wheat production, wheat production and management packages, agronomic practices, economic and nutritive importance of bread wheat, post-harvest managements and storage facilities of wheat.

Implementation Design of the activity

The plots were properly ploughed and made ready for planting ahead of the planting date. Three bread wheat varieties Liban, Buluq and Danda'a (as a standard check) were planted on adjacent plots of 10 m x20 m each. All the necessary recommended agronomic practices were equally applied for all of the plots. For bread wheat, the spacing of 20 cm between rows was used. The recommended seed rate of 150kg ha^{-1} was used by drilling in the prepared rows. Shallow planting of 2-4 cm depth was employed in the presence of ample soil moisture. The recommended fertilizer rate of UREA 100 kg ha^{-1} and DAP/NPS 100 kg ha^{-1} were applied. All DAP/NPS was applied at sowing/planting time while 1/3 of UREA was used at sowing and 2/3 at tillering /stems elongation stage of the crop.

Joint monitoring and evaluation, demonstration sites were supervised at a monthly interval to check the status and to identify gaps. At maturity stage, participatory variety evaluation platform was arranged that attended by the FRG/FREG members, the trial farmers, neighboring/follower farmers, researchers from BARC and other stakeholders.

Data collected

Appropriate data collection methods (direct field observation/measurements, focused group discussion, and knowledge test) were employed to collect both qualitative and quantitative data. The types of data collected include yield data, change in level of knowledge and skill of farmers, farmers' perception towards the performance of the technologies, farmers' preferences and their variety selection criteria, total number of farmers participated on extension/promotional events such as training, field visits and field days, and stakeholder's participations and role in technology demonstration and evaluation.

Data analysis

The data was analyzed using descriptive statistics such as mean, frequencies distribution, and percentages were used. Besides, pair wise ranking matrix techniques was administered and used to evaluate and select best performing varieties and rank the varieties in order of their importance according to real situation of the area.

Result and Discussion

Participatory Variety Evaluation and Selection

The target beneficiaries of improved agricultural technologies are strongly inclined to their likes and dislikes (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). Thus, a total of 152 participants from 4 districts 120 farmers, 16 DAs and supervisors and12 experts) and 4 researchers were participated on the process at maturity stage of the crop. Consequently, at maturity the varieties were evaluated based on the farmers' selection criteria. During the assessment, the farmers were assisted to list their own evaluation criteria, which then be ordered using pair-wise ranking technique.

First, the evaluators were grouped in to small manageable group (one group had 10 members including one group leader and one secretary). At each district, Kebele and 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. Each variety was evaluated against the criteria ordered based on the weight attached to each parameter. At the end of the evaluation process, result of

the evaluation was displayed to the evaluators, and discussion (FGD) was made on the way ahead. The variety/ies selected, accordingly, will be proposed for further pre-scaling up.

Table 1: Rank of the varieties based on farmers' selection criteria

No	Varieties	Rank	Reasons
1	Danda'a	**3rd**	Good tillering capacity, relatively tolerant to disease (Yellow rust, Stem rust), crop stand, attractive seed color and hard seed for market, very good yield and very difficult to trash
2	Liban	**1st**	High tillering, seeds/spike, disease tolerant (Yellow rust, stem rust), early maturing, good plant height, good crop stand, good yield, easy to trash and small seed size compared with others
3	Bulluq	**2nd**	Medium tillering capacity, soft seed for market, little bit late than Liban, medium crop stand, good yield, medium seed size, medium to trash and relatively susceptible to disease

Table 2: Pair wise ranking matrix result to rank variety traits in order of importance

No	Parameters	Disease tolerance	Seed color	Tillering	Seeds/ spike	Spike length	Overall yield	Crop stand	E.M
1	Disease tolerance		7	6	6	4	4	3	1
2	Seed color			6	7	4	5	4	1
3	Tillering				8	4	6	5	1
4	Seeds/spike					4	7	6	1
5	Spike length						8	7	1
6	Overall yield							8	1
7	Crop stand								1
8	Early Maturing								

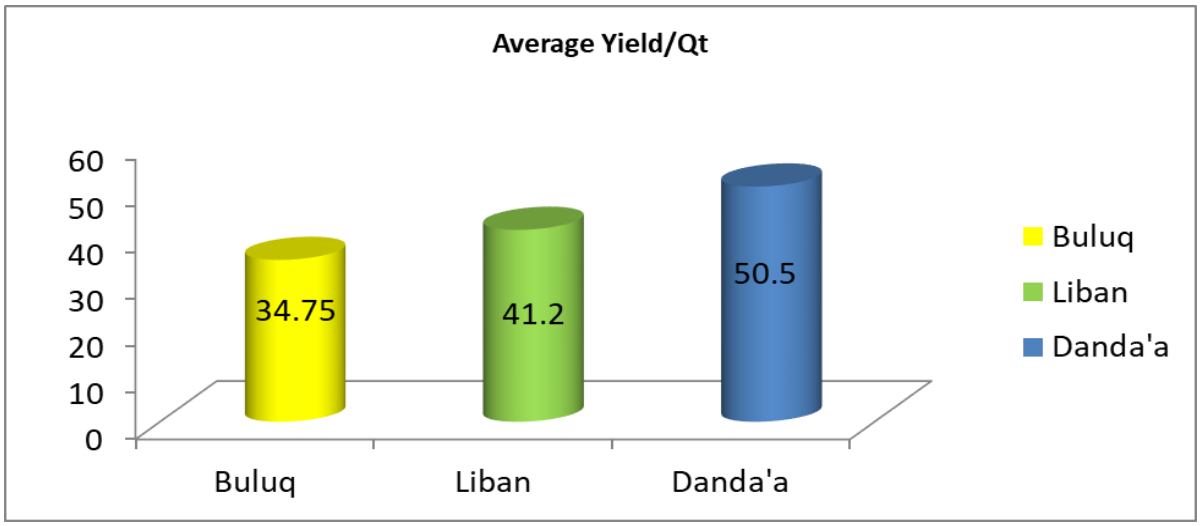
Table 3: Summary of matrix ranking and rank of variety traits (Input for Breeders)

No	Variety Traits	Frequency	Rank
1	Wheat rust (yellow and stem rust)	7 times	1st
2	Seed colour, hardness and softness	0	0
3	Tillering capacity (fertile tillers)	1 time	7th
4	Seeds per spike (≥60)	6 times	2nd
5	Spike length	2 times	6th
6	Overall yield	5 times	3rd
7	Crop stand	4 times	4th
8	Early maturing	3 times	5th
	Total	**28**	

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 and site specific varying weather conditions (for instance, ice rain, rainfall intensity i.e. flooding or shortage). The overall harvested mean yield of Buluq, Liban and Danda'a was 34.75 qt/ha, 41.25 qt/ha and 50.5 qt/ha the, respectively.

Figure 1. On-farm yield performance of the varieties



Yield advantage %= Yield of new variety (qt/ha) - Yield of standard check (qt/ha) X 100
Yield of standard check (qt/ha)

Yield advantage % for Buluq=34.75 qt/ha – 50.5 qt/ha X 100 = -31.19 %
50.5 qt/ha

Yield advantage % for Liban= 41.25 qt/ha – 50.5 qt/ha X 100 = -18.32 %
50.5 qt/ha

Lessons Learned

On-farm demonstration is bidirectional process where farmers and researchers learn from each other. During the study, farmers had first hand observation on the actual performance of new released varieties. Farmers got familiar with and access to improved bread wheat technologies demonstrated to them, had better knowledge and/or skill on wheat production and management, each FRG/FREG got improved bread wheat variety of their own preference which is adaptable to their local socioeconomic, cultural and ecological circumstances, research team exposed to collective variety evaluation and feedback for future research work to improve production and productivity of the varieties and linkage among research team, experts, DAs, farmers and other stakeholders were strengthened for dissemination of the technologies.

Conclusions and recommendations

Based on the evaluators, tillering capacity, disease tolerance, seeds per spike, plant height, crop stand, overall yield, seed size, lodging resistant, early maturity, spike length, seed color, threshability were the common identified election criteria across all locations for selecting the best performing variety/ies. 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 and site specific varying weather conditions (for instance, ice rain, rainfall intensity i.e. flooding or shortage). The overall harvested mean yield of Buluq, Liban and Danda'a was 34.75 qt ha^{-1}, 41.25 qt ha^{-1} and 50.5 qt ha^{-1}, respectively. Though Danda'a was better in yield but when compared with other traits Liban was selected first then by Buluq and lastly Danda'a. Of the three varieties the lowest gap was observed with Danda'a whereas the largest gap was observed with Buluq. Danda'a is nearly as productive as its on-station performance as compared to the other two varieties.

Technical advice and support to smallholder farmers is highly required to improve bread wheat production and productivity, to attain food self sufficiency and bring the required impact. Now days, farmers' group are seen as the smallest unit of the farmers. Hence,

establishing and strengthening FRGs/FREGs is one of the extension approaches, which make the farmer to be central to agricultural research, technology promotion and dissemination. Bread wheat variety (Liban) was selected and recommended for pre-scaling up activity on wider plot (at least 0.25ha per trial farmer) for popularization. Strengthening the linkage among stakeholders is paramount to achieve the desired goal.

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Pre-extension Demonstration of Improved Durum Wheat Technologies in Bale and West Arsi Zones, Southeastern Oromia, Ethiopia

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Abstract

Recently released durum wheat varieties (Dirre and Toltu) were demonstrated against one standard check (Bakkalcha) with participation of farmers and other stakeholders in 2016/17 cropping season in order to enhance the farmers to select the best performing variety/ies. The demonstration activity was carried out in Adaba and Dodola districts of West Arsi zone and Sinana, Gassara, Agarfa and Ginnir districts of Bale zone. These districts were AGP II beneficiary and purposively selected based on their potential for durum wheat production and two Kebeles from each district were selected on the basis of accessibility and potentiality. One FRG/FREG having 20 member farmers was established at each Kebele and trained on durum wheat production and management packages. Two improved varieties (Dirre and Toltu) and one standard check (Bakkalcha) were planted on adjacent plot size of 32 m x32 m (1024 m^2) on 43 farmers' fields. All recommended agronomic practices were equally applied to all the plots and the fields were closely supervised and were managed well. Participatory training was given for a total of 384 participants (300 farmers, 48 DAs and Supervisors, 36 experts and 12 researchers) on durum wheat production and post-harvest handling practices. Field day also organized in representative potential Kebeles on which a total of 470 participants (357 farmers and 113 experts) were attended on the event to show the field performance of the varieties. At maturity stage of the crop, the varieties were jointly evaluated with a team composed of researchers, farmers, development agents and experts. Tillering capacity (fertile tillers), disease tolerance for rusts, spike length, fertile spikelets, seeds per spike, plant height, lodging resistant, crop stand, seed color and size (marketable), threshability and overall yield were the common identified selection criteria across all locations for selecting the best performing variety/ies. Agronomic data and yield data were collected and analyzed using descriptive statistics in order to evaluate the performance of the varieties. With regard to mean yield, 64qt/ha, 55.5 qt^{-1} ha and 50.9 qt ha^{-1} were obtained from Dirre, Toltu and Bakkalcha, respectively. The maximum yield of Sannate (69 qt ha^{-1}) was recorded in Agarfa district where as the minimum yield was recorded in Ginnir district (58 qt ha^{-1}). Besides, the combined analysis showed that Dirre has 15.32% and 25.74 % yield advantage over Toltu and Bakkalcha, respectively. Whereas Toltu has 9.04% yield advantage over Bakkalcha. Since, Dirre was selected by the farmers, it is recommended to be scaled up/out in all demonstration sites and similar agro-ecologies of the study zones.

Key Words: *Durum wheat, Farmers' preferences, FREG approach, Dirre, Toltu, Bakkalcha*

Introduction

Wheat is one of the major cereal crops grown within the range of 1500 to 2800 m.a.s.l in Bale, Arsi, West Arsi and Shoa zones of Oromia National Regional State (SARC Profile, 2015). During 2015/16 cropping season 1,664,564.62ha of land was covered by wheat (bread and durum) and over 42,192,572.23quintals was harvested with the average yield of 25.35 qt/ha at national level. Similarly, the land covered by wheat production in West Arsi and Bale zones in 2015/16 Meher production season was120,067.9 and 143,971.78 hectares respectively. Whereas, the average yield of wheat produced from the two zones was 32.97 qt/ha and 28.97 qt/ha respectively (CSA, 2016).

Durum wheat is produced for food and industrial purposes and used as raw materials for pasta and macaroni industries. However, due to low volumes and poor quality of national durum wheat production, pasta industries are importing huge amount of wheat and pasta every year costing about 30 million USD or >600 million Eth. Birr (Ethiopian Revenue and Customs Authority, 2013). To improve the situation, effort has been made by Sinana Agricultural Research Centre (SARC) in collaboration with Ethio-Italian Development Cooperation-Agricultural Value-chain Projects in Oromia (AVCPO) in supporting the research work and promoting durum wheat technologies as viable business opportunities for farmers through involvement of farmers' cooperatives and unions by linking with agro-industries since 2011/12. The project was emphasized on capacity building (both skill and physical) for research centers, farmers' cooperatives and unions, durum wheat technology generation, multiplication, popularization and dissemination, seed and grain production with primary cooperatives and marketing through unions as institutional innovation and interventions (Seifuddin, 2014).

Commercial durum wheat varieties under production including Bakalcha, Tate, Ilanni, Oda, Leliso, Yerer and Ude are losing their potential to resist disease and their protein quality decreasing from time to time. To overcome the problem, efforts have been made by SARC through developing and releasing the new varieties of durum wheat (i.e. Dirre and Toltu) with full recommended packages that have relatively better resistance towards wheat rust diseases (yellow rust and stem rust) and good in protein quality. Dirre has 44-68 qt ha^{-1} yield potential,

28.8% yield advantage over standard checks (Yerer), 17.1% over Bakalcha and 25.2% over local check (Ingiliz) (Crop Variety Registration, 2014).

However, these varieties were not seen under farmers' condition until recent time. The top down approach to variety selection and seed production in Sub-Saharan African countries resulted in small adopters of varieties mostly not suited to their climatic conditions and socio-economic circumstances (Foti *et al.*, 2008). In contrast, participatory technology evaluation on farmers' management condition may have many 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, undertaking participatory demonstration, evaluation and validation of recently released durum wheat varieties (Dirre and Toltu) and associated technologies with the participation of farmers and other stakeholders in the study area is important to familiarize the farming communities with the varieties, to select the best performing variety/ies with farmers' participation which in turn will facilitate the adoption process and bridge the productivity gap. Therefore, this research work was conducted to address such pressing needs.

Material and methods

Description of the study area

The research 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 of the ONRS and located in southeastern Oromia. The districts were selected purposively based on their potentiality to wheat production and beneficiaries of AGP-II project.

Site and farmers' selection

Site selection

Purposive sampling methods were employed to select six representative districts from the two zones based on being AGP-II beneficiary districts. For this study, four districts (Sinana, Agarfa, Gassara and Ginnir) from Bale zone and two districts (Adaba and Dodola) from West Arsi zone were selected due to their potential for durum wheat production and the high demand for the crop. From each district, two representative Kebele were also selected purposefully as demonstration sites of the varieties based on their accessibility and potentiality.

Farmers (FRGs/FREGs) selection

Now days, group approach (as institutional intervention) is more efficient than dealing with individuals especially in our context where the majority of farmers are smallholders and clear socio-economic differences are existing. It enhances the development, popularization, dissemination and adoption of improved agricultural technologies meant for our farmers.

Thus, selection of FRGs/FREGs members was based on farmers' willingness to be held as member, accessibility for supervision of activities (vicinity), good history of compatibility with groups and genuineness and transparency to share innovations to other farmers. Consequently, one FRG/FREG having 20 members with the composition of resource rich, medium and poor category of farmers including men, women and youth farmers was established at each Kebele. Gender and youth balance in each FRG/FREG unit was strictly considered (at least 40%).

After establishment of the FRGs/FREGs, a theoretical training session was arranged to farmers, DAs, and experts at Dodola, Robe and Ginnir towns. Multidisciplinary team of researchers from SARC delivered the training on the following topics: participatory agricultural research and promotion through FRGs/FREGs, suitable agro-ecologies and weather condition for durum wheat production, wheat production (with required quality and quantity) and management packages, agronomic practices, economic and nutritive importance of durum wheat, post-harvest managements and storage of the crop.

Table 1: List of new FRGs/FREGs established for the demonstration activity

FRGs/FREGs	District and Kebeles	Members by Gender				
		Adult (Male)	Adult (Female)	Youth (Male	Youth (Female)	Total
2	Sinana (Hawusho and Gamora)	20	15	4	1	40
2	Agarfa (Ali and Sabaja)	22	14	2	2	40
2	Gassara (Nake Nagawo and Ba/Guranda)	23	16	1	0	40
2	Adaba (Washa and Ejersa)	24	16	0	0	40
2	Ginnir (Walta'i Atota and Aqasha)	21	15	3	1	40
2	Dodola (Katta Baranda and Kachama Chare)	23	15	1	1	40
12	Total	133	91	11	5	240

Selecting participant farmers

Having suitable and sufficient land to accommodate the demonstration activity, willingness to contribute the land, vicinity to roads so as to facilitate the chance of being visited by many farmers, initiatives to implement this activity in high-quality, good in field management and willingness to explain the technologies to others were criteria used to select the hosting farmers. Then, three to four representative hosting farmers from each FRG/FREG were selected at each kebele with the help of group members and DAs. Thus, a total of forty three (43) hosting farmers were selected for the purpose. Farmers (FRG/FREG members and other follower farmers) were encouraged to participate in the physical activities from the beginning up to the end of the demonstration activity.

Implementation design

Two improved durum wheat varieties (Dirre and Toltu) and one standard check (Bakkalcha) were planted on selected farmers' land with simple plot design (32 m X 32 m) in 2016/17 main cropping (Meher) season with full recommended management practices. The demonstration activity was replicated on at least on three farmers per Kebele. Row planting method was employed and spacing of 20 cm between rows was used for the demonstration trial. The recommended seed rate of 150 kg ha^{-1} was used by drilling in the prepared rows. Shallow planting of 5 cm depth was used in the presence of sufficient soil moisture. The recommended rates of 110 kg ha^{-1} UREA and 100 kg ha^{-1} DAP were used to conduct the

experiment. All DAP was applied at planting while, UREA or *Nitrogen* was applied at split of*:* 1/3 at planting and 2/3 at tillering stage of the crop. The trials were weeded two times; first at one month after sowing and second at two months after sowing of improved bread wheat varieties. Farm operations (land preparation-ploughing four to five times using oxen plough) were carried out by hosting farmers, whereas activities such as land leveling, planting, first and second weeding, agro-chemical spray, harvesting, threshing were handled by SARC.

Technology demonstration and evaluation techniques

FRGs/FREGs members and other follower farmers were encouraged to participate on different extension/promotional events organized at each demonstration site. These were mechanisms used to enhance farmer-to-farmer learning and information exchange such as trainings, field visits/tours, experience sharing, field days, etc.

Training

Training (both theoretical and practical) is very important for awareness creation and to bring improvement filling the knowledge gap, skill and attitude. Hence, stakeholders such as zone and district level Agriculture and Natural Resource Office, Unions, private service providers, Arsi-Bale Plant Health Clinic Office, zone and district level agricultural inputs regulations and quarantine experts were invited and participated during consultation meeting and training.

Monitoring and evaluation, field visit and field day

Initially, agreement was made with farmers, DAs, supervisors and experts on responsibility sharing since the activity needs collaborative work and partnership. 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, especially in UREA application.

Field visit was arranged to create awareness, and farmers shared experience and knowledge. 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 technologies 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.

Farmers' preferences and selection criteria

The variety/ies were demonstrated, evaluated at crop maturity stage and validated by farmers, agricultural experts, development agents, researchers and other stakeholders based on the following selection criteria. The criteria were tillering capacity (fertile tillers), disease tolerance (for rusts), spike length, fertile spikelets, seeds per spike, plant height, lodging resistant, crop stand, seed color and size (marketable), threshability and overall yield. Each selection and evaluation criteria were rated using the following rating scale; 1= Very poor, 2= Poor, 3= Fair, 4= Good and 5= Very Good

Data collected

Both qualitative and quantitative data were collected using appropriate data collection methods such as FGD, direct field observation and measurements. Agronomic data and grain yield per plot were recorded. Total number of farmers participated on extension/promotional events such as training, field visits and mini field days were recorded by gender composition. Feedback assessment on farmers' preference to the demonstrated varieties (likes and dislikes, which is the base for plant breeding process) and farmers' perception towards the performance of the technologies were also identified.

Data analysis

The collected data was analyzed using SPSS and descriptive statistics such as mean, frequencies distribution and percentages. Besides, pair wise ranking matrix was used to evaluate and select best performing varieties and rank the varieties in order of their importance.

Results and Discussions

Inputs used and yield harvested

Demonstrations of improved durum wheat varieties (Dirre and Toltu) with one standard check (Bakkalcha) were undertaken for one year in AGP-II beneficiary four districts of Bale zone and two districts of West Arsi zone in the 2016/17 cropping season. The varieties were treated with full recommended durum wheat production and management packages. SARC was the source of all inputs (seed, fertilizers and agro-chemicals) required for the demonstration activity implementation.

Table 2: Lists of demonstrated durum wheat varieties on hosting farmers' field

Variety	Locations/ Districts	No. of trial farmer	Plot size	Seed per farmer (kg)	Total seed distributed (qt)	Fert. farmer UREA/ NPS (Kg)		Total Area (ha)	Harvested seed (qt)
Toltu	Agarfa. Gassara	9	32 x 32	16	1.44	11.3	11	0.96	59.5
Dirre	Sinana, Agarfa Gassara, Ginnir Adaba, Dodola	34	32 x 32	16	5.44	11.3	11	3.63	225
Total		**43**			**6.88**			**4.59**	**284.5**

Training on capacity building

Participatory training was given by multidisciplinary team of SARC researchers (Breeder, Agronomist, Weed Scientist, Pathologist, Entomologist, Economist and Extensionist) in the participant districts of Bale and West Arsi zones at Dodola, Robe and Ginnir towns.

A total of 384 participants: - 300 farmers (240 FRGs/FREGs members and 60 follower farmers), 36 DAs, 12 supervisors, 36 experts and 12 researchers were participated on the training. The theme of the training were included the availability of improved durum wheat technologies and utilization, durum wheat (both in quantity and quality) production and management packages, major wheat diseases and their control measures, agro-chemicals utilizations/applications and safety precautions, grain marketing and on creating strong linkage among relevant actors through multi-stakeholder approach.

Field Day organized

At physiological maturity stage of the crop, field day was jointly organized in collaboration with other stakeholders (zone and district level agriculture development offices and participant farmers) in the participant districts to create awareness about the importance and availability of the new improved wheat technologies. About 470 participants (357 farmers from all category including FRGs/FREGs members and follower farmers, 68 DAs and supervisors, 45 agricultural experts and cooperative leaders and 12 researchers) were participated on this extension/promotional event. Participants were shared their best experiences especially on how to preserve the quality seeds of durum wheat varieties by cleaning combiner during harvesting, manual harvesting of the plot and other seed cleaning and preservation mechanisms). In addition, participant farmers were shared information on the local seed exchange mechanisms (informal) and producing durum wheat grain for agro-industries.

Yield performance of the demonstrated varieties

On-farmers field, the overall mean yield 64qt ha^{-1}, 55.5qt ha^{-1} and 50.9qt ha^{-1} were obtained from Dirre, Toltu and Bakkalcha, respectively. Dirre gave the highest yield followed by Toltu variety.

Table 3: Yield advantage of the demonstrated varieties over the standard check

District	Mean yield of standard Check (qt/ha)	Mean yield of improved durum wheat varieties (qt/ha) and yield advantage over the check			
	Bakalcha	Dirre	%	Toltu	%
Sinana	52.0	68.0	30.77	-	-
Agarfa	53.4	69.0	29.20	55.0	3.0
Gassara	53.5	67.5	26.17	56.0	4.67
Ginnir	50.0	58.0	16.0	-	-
Adaba	48.0	59.5	23.96	-	-
Dodola	48.5	60.0	23.71	-	-

The result in table 3 indicates that the hosting farmers had obtained more than 20% yield advantage from improved durum wheat variety (Dirre) over the standard check (Bakkalcha). This figure was competent with the potential yield of the variety at research field since packages approach was employed during demonstration activity. Protein analysis of the demonstrated and other improved durum wheat varieties was made at SARC Quality

Laboratory. Thus, Ejersa variety has high protein quality (13.3%) followed by Bakkalcha (12.7%) and Obsa (11.9%) when compared with others.

Table 4: Protein content of demonstrated durum wheat varieties

No	Variety	Gluten (%)	Moisture (%)	Protein (%)
1	Dirre	19.50	11.40	10.30
2	Toltu	24.40	11.60	10.90
3	Ejersa	30.00	11.70	13.30
4	Obsa	25.40	11.60	11.90
5	Bakkalcha	27.80	11.65	12.70
6	Tate	20.00	12.00	10.20
7	Ude	24.00	11.90	10.60

Source**:** Report of sample analyzed in Wheat Quality Laboratory of SARC, 2017

Participatory Evaluation and Farmers' Preference

Farmers are strongly inclined to their likes and dislikes (preferences) and participated during the assessment. First, the evaluators were grouped in to small manageable group (one group had 10 members including one group leader and one secretary). At each Kebele and 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. Thus, a total of 318 participants from six AGP-II beneficiary districts (240 FRGs/FREGs member farmers, 36 DAs, 12 supervisors and 30 experts) and 6 researchers were participated on participatory assessment and evaluation (PAE) of the varieties at maturity stage of the crop.

Farmers' perception on the performance of improved durum wheat varieties were tested at each district and analyzed using pair wise ranking. Thus, pair wise ranking was used as a tool to summarize farmers' preference towards important variety traits (Boef and Thijssen, 2007).

Table 5: Pair wise ranking matrix result to rank the varieties

No	Variety	Dirre	Toltu	Bakkalcha
1	Dirre			
2	Toltu	1		
3	Bakkalcha	1	2	

All participant farmers were very interested with the stands of the demonstrated varieties and good awareness was created among stakeholders about improved durum wheat technologies. Based on farmers' assessment and evaluation, Dirre ranked first followed by Toltu and Bakalcha.

Table 6: Rank of the varieties based on farmers' selection criteria

Varieties	Rank	Reasons
Dirre	1st	Good tillering capacity, disease tolerance (Ys and Sr), spike length, seeds per spike, plant height, seed color and size (marketable), adaptable to the area, uniformity, crop stand, and overall yield
Toltu	2nd	Has medium tillering capacity, disease tolerance, spike length, seeds per spike, plant height, adaptability to their locality, crop stand, marketable and overall yield
Bakkalcha	3rd	Susceptible to diseases (yellow rust, stem rust), has medium tillering capacity, crop stand and low yielder

Conclusion and Recommendations

There are opportunities to harvest high yield from commercial durum wheat variety/ies if and only if our farmers use appropriate production and integrated weed/disease management practices. But, practical field observation and assessment result indicated that, there is a knowledge gap on appropriate agro-chemicals application (utilization) by those smallholder farmers in the study zones. Trainings (both theoretical and practical), joint supervision, field days and focus group discussions were organized at all demonstration sites as part of capacity building, technology and information diffusion mechanisms in order to make adoption rate faster. Tillering capacity (fertile tillers), disease tolerance for rusts (Yr,Sr), spike length, fertile spikelets, seeds per spike, plant height, lodging resistant, crop stand, seed color and size (marketable), threshability and overall yield were the best selection criteria identified by the

evaluators for selecting the best performing improved durum wheat varieties. Therefore, farmers' preferences (likes and dislikes) are the base for breeding process. Thus, in this activity, farmers were identified as reliable partners in the participatory plant breeding program.

The overall harvested mean yield of Dirre, Toltu and Bakkalcha were 64qt ha^{-1}, 55.5qt ha^{-1} and 50.9qt ha^{-1}, respectively. The hosting farmers had obtained more than 20% yield advantage from Dirre over the standard check (Bakkalcha). Agronomic data result shows that Dirre gave the highest yield than Toltu and Bakkalcha in all demonstration sites and selected pre-scaling up/out activity. Revolving seed and farmer-to-farmers seed exchange mechanisms were designed to access seed for FRG/FREG members and interested farmers in the study area. During focused group discussion (FGD), the participant farmers highly emphasized the constraint of row planter, seed supply shortage (in quantity, quality, with reasonable price and at required time), marketing problem (equal price of durum wheat with bread wheat at local market), cereal based mono-cropping problem and emerging big challenge of wheat rust disease epidemics in the study zones.

Strengthening the pre-extension demonstration, participatory evaluation and validations of newly released/registered durum wheat technologies under farmers' condition is important to make our research demand-driven and enhance wheat production and productivity. Farmers' preferences should be considered and taken into consideration in breeding program in order to save resources in terms of preferred variety/ies promotion/dissemination, time and make technology adoption faster. Molecular breeding is indispensable to counteract the disease epidemics, to ensure sustainable wheat production and its contribution to food security. Dirre needs early planting using the first rain shower since it has more late tillers.

Based on farmers' assessment, Dirre was selected and recommended for pre-scaling up activity on wider plot (at least 0.25 ha per farmer) in the participant districts and similar agro-ecologies of the zones. Thus, popularization of the varieties should be made on different promotional events in order to create high demand. Finally, strengthening the linkages among relevant actors and key potential stakeholders (research-extension-farmers-private service dealers and agro-processors) can facilitate the adoption of improved durum wheat technologies and improve the income of small scale farmers.

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Pre-extension Demonstration of Improved Teff Technologies in AGP- II Districts of East and Horro Guduru Wollega Zones

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Abstract

This activity was conducted at Gida-Ayana, Wayu-Tuqa, Jarte Jardaga, Guduru and Jimma-Rare districts of Western Oromia with the objective of demonstrating the recently released teff varieties, Kenna and Guduru to the farming community in these districts. The districts were purposively selected based on potentiality for teff production; and one potential Kebele were selected from each district on the basis of accessibility and potentiality. One FRG/FREG was established at each Kebele and trained on teff crop production and management packages. Two teff varieties; Kenna and Guduru (as a recently released variety) with one local check were planted on 20 m x10 m adjacent plots on 20 farmers' field. All recommended agronomic practices were equally applied to all the plots and the fields were closely supervised and were managed well. At maturity stage of the crop, the varieties were jointly evaluated with a team composed of researchers, farmers, development agents and experts. Based on the evaluators, tillering capacity, disease tolerance, seed color, plant height, lodging resistant, overall yield, pest resistance, seed size, early maturity, spike length, threshability were the common selection criteria across all locations. In almost the entire criterion, Kenna and Guduru were selected by the farmers and met the set criteria than the local check. With regard to the overall mean yield, 15.38qt ha^{-1}, 13.78qt ha^{-1} and 9.33 qt ha^{-1} were obtained from Kenna, Guduru and local variety, respectively, by putting Kenna on the first rank. The preferred variety, Kenna, should be pre-scaled up in the next cropping season. Besides; Kenna 64.84 % and Guduru 47.7% had yield advantage than the local check. Furthermore; the technology gap observed from the demonstration yield on Kenna and Guduru were 5.62 and 5.22 quintal less than as it is on- station yield. This means both varieties had performing lesser than their potential as compared with the on-station potential yield. Lastly, technology index observed for both Kenna and Guduru were26.76% and 27.47%, respectively.

Keywords*: Teff, FREG, participatory evaluation; technology index, Kenna, Guduru*

Introduction

Ethiopia is the center of origin and diversity for teff. It is adapted to a wide range of environments and performs well between 1700 and 2400 m a.s.l (Ayalewu *et.al.*, 2015). Among cereals, Teff accounts for the largest share of the cultivated area (28.5 % in 2011), followed by maize (20.3%). Teff is second (to maize) in terms of quantity of production.

However, because its market price is often two or three times higher than maize, Teff accounts for the largest share of the total value of cereal production. Teff is grown by a total of 6.2 million farmers. Since Teff farm operations such as land preparation, weeding and harvesting are highly labor intensive, with limited availability of suitable mechanical technology, there are no large scale Teff farmers in the country.

In Ethiopia, many farmers grow Teff as cash crop because of its higher and more stable market price (Demeke *et al*., 2013). Teff production expanded by 72 percent between 2004/05 and 2010/11 (CSA, 2011). This growth was achieved mainly due to 29 percent expansion in area under cultivation and 33 percent increase in yield levels. The share of Teff in total cultivated areas increased by 2 percent, compared to the decline in barely (25 %) and wheat (12 %), and rapid expansion in coarse grains (maize by 11% and sorghum by 19 %). 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).

Teff 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 Teff is a gluten free crop, which makes it a suitable for patients with celiac disease (Dekking and Koning, 2005). CSA data over the past few years show that Teff ranked first in terms of area coverage (accounting for 28% of the area) and is second to maize in terms of volume of production among cereals, accounting for about 20% of the total produce in the category (Bekabil *et al*., 2011). At national level, during 2015/16 cropping season 2,866,052.99 ha of land was covered by teff and over 44,713,786.91quintals was harvested with the average yield of 15.6 quintals per hectare (CSA, 2016).

However, productivity has remained stagnant or has even declined in some cases until recent years due to several technical and socio-economic constraints. Limited number of released varieties, 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. 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). 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). Therefore, this research work was initiated to demonstrate and evaluate improved teff technologies with Farmer Research Extension Groups and recommend farmers preferred variety.

Materials and Methods

Site and FRGs/FREGs Selection

This activity was conducted in purposively selected districts of East and Horro-Gudru Wollega zones. Selection of the districts was based on potentiality for teff production, accessibility for supervision and compatibility with the AGP-II criteria. Accordingly, Wayu-Tuka, Guduru, Jardega-Jarte, Jimma-Rare and Gida-Ayana districts were selected based on the aforementioned criteria.

Two potential Kebeles from each district were selected based on accessibility and potentiality for teff production. In each Kebele, one FRG/FREG units comprising of 15-20 farmers were established. Gender and youth balance in each FRG/FREG unit was strictly considered (at least 40%). In each FRG/FREG unit four trial/experimental farmers were selected with the rest being participant farmers. Development agents and experts were collaborating in site and farmer selection.

The FRG member farmers were selected based on 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 trial/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 FRGs/FREGs a theoretical training session was arranged to farmers, DAs, and experts. Multidisciplinary team of researcher from Bako Agricultural Research Center (BARC) delivered training to a total of 110 participants:- FRGs/FREGs members (75), DAs and supervisors (20), and experts (15) on the following topics: participatory agricultural research and promotion through FRGs/FREGs, suitable agro-ecologies and weather condition for teff production, teff production and management packages, agronomic practices, economic and nutritive importance of teff, post-harvest managements and storage facilities of teff.

Implementation activity and field design

Every field was supervised at a monthly interval 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 and other stake holders. The plots were properly ploughed and made ready for planting ahead of the planting date. Three teff varieties Guduru, Kenna (as a standard check) and one local check were planted on adjacent plots of 10 m x 20 m each. All the necessary recommended agronomic practices were equally applied for all of the plots. For teff, the spacing of 20 cm between rows was used. The recommended seed rate of 15kg ha^{-1} was used by drilling in the prepared rows. Shallow planting of 2-4 cm depth was employed in the presence of ample soil moisture.

The recommended fertilizer rate of UREA 80 kg ha^{-1} and DAP/NPS 130 kg ha^{-1} were applied. All DAP/NPS was applied at sowing/planting time while 1/2 of UREA was used at sowing/planting and the remaining 1/2 was applied at the time of tillering of the crop. For joint monitoring and evaluation, the demonstration sites were supervised at a monthly interval to check the status and to identify gaps. At maturity stage, participatory variety evaluation platform was arranged that attended by the FRG/FREG members, the trial farmers, neighboring/follower farmers, researchers from BARC and other stakeholders. Lastly, the varieties were evaluated based on the farmers' selection criteria.

Data collected

Appropriate data collection methods (direct field observation/measurements, focused group discussion, and knowledge test) were employed to collect both qualitative and quantitative

data. The types of data collected include yield data, change in level of knowledge and skill of farmers, farmers' perception towards the performance of the technologies, farmers' preferences and their variety selection criteria, total number of farmers participated on extension/promotional events such as training, field visits and field days, and stakeholder's participations and role in technology demonstration and evaluation.

Data analysis

The data was analyzed using descriptive statistics such as mean, frequencies, distribution, and percentages were used. Besides, pair wise ranking matrix techniques was administered and used to evaluate and select best bet varieties and rank the varieties in order of their importance according to real situation of the area.

Result and Discussion

Participatory variety evaluation and selection

The target beneficiaries of improved agricultural technologies are strongly inclined to their likes and dislikes (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). Thus, a total of 119 participants from 5 districts, 75 farmers, 20 DAs and supervisors and 12 experts and 9 researchers were participated on the process at maturity stage of the crop. Consequently, at maturity the varieties were evaluated based on the farmers' selection criteria. During the assessment, the farmers were assisted to list their own evaluation criteria, which then be ordered using pair-wise ranking matrix technique.

First, the evaluators were grouped in to small manageable group (one group had 10 members including one group leader and one secretary). At each district, Kebele and 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. Each variety was evaluated against the criteria ordered based on the weight attached to each parameter. At the end of the evaluation process, result of the evaluation was displayed to the evaluators, and discussion (FGD) as made on the way ahead. The variety/ies selected, accordingly, will be proposed for further pre-scaling up.

Table 1: Rank of the teff varieties based on farmers' selection criteria

Varieties	Rank	Reasons
Kenna	**1st**	Good tillering capacity, tolerant to disease, crop stand, attractive seed color for market, very good yield, relatively late maturing, good seed size and tolerant lodging
Guduru	**2nd**	Good tillering capacity, relatively tolerant to disease, crop stand, attractive seed color for market, very good yield, early maturing, good seed size and relatively tolerant to lodging
Local variety	**3rd**	Medium tillering capacity, early maturing, poor in diseases and insect pests tolerance, very good seed ssize low yielder and poor lodging tolerance

Table 2: Pair wise ranking matrix result to rank variety traits in order of importance

No	Parameters	Disease res.	Seed color	Tiller	Insect res.	Seed Size	Yield	Lodg.	E.M
1	Disease tolerance		8	6	5	4	4	3	1
2	Seed color			6	7	4	5	4	1
3	Tillering capacity				5	4	6	5	1
4	Insect tolerance					4	7	6	1
5	Seed Size						8	7	1
6	Overall yield							8	1
7	Lodging resistance								1
8	Early maturing								

Table 3: Summary of matrix ranking and rank of variety traits

No	Variety Traits	Frequency	Rank
1	Disease tolerance	7 times	1st
2	Seed color	0	0
3	Tillering capacity	1time	7th
4	Pest tolerance	6 times	2nd
5	Seed Size	4 times	3rd
6	Overall yield	4times	3rd
7	Lodging resistance	3 times	5th
8	Early maturing	3 times	5th
	Total	**28**	

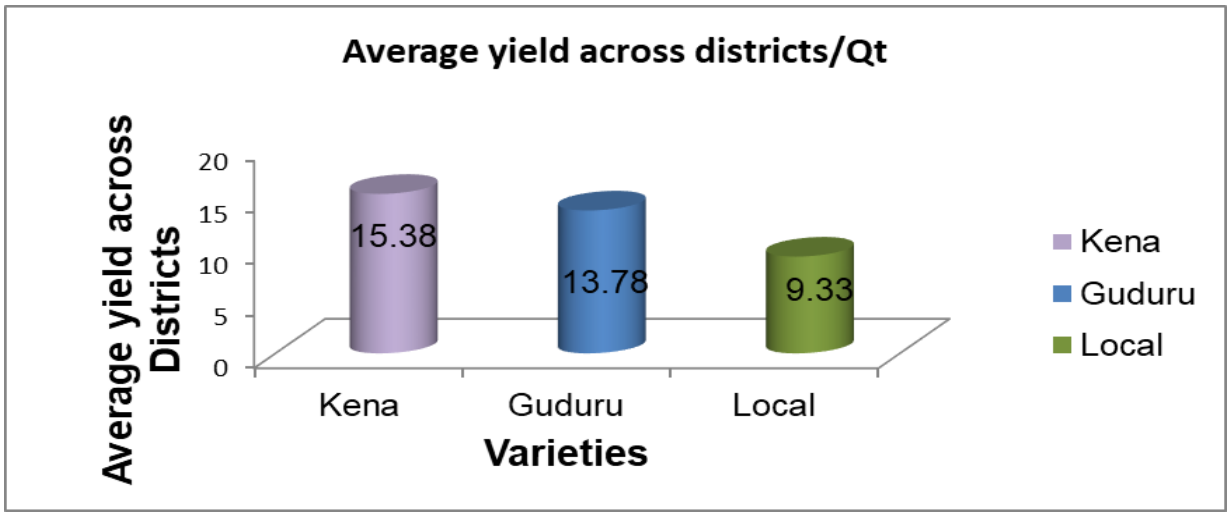

Figure 1. On-farm yield performance of the varieties

Yield advantage %= $\frac{\text{Yield of new variety (qt/ha) - Yield of standard check (qt/ha) X 100}}{\text{Yield of standard check (qt/ha)}}$

Yield advantage % of Guduru over Kenna= $\frac{\text{13.78 qt/ha – 15.38 qt/ha X 100}}{\text{15.38 qt/ha}}$ = -10.40 %

Yield advantage % of Kenna over Guduru= $\frac{\text{15.38 qt/ha – 13.78 qt/ha X 100}}{\text{13.78 qt/ha}}$ = 11.61 %

Yield advantage % of Kenna over local check = $\frac{\text{15.38qt/ha – 9.33qt/ha X 100}}{\text{9.33 qt/ha}}$ = 64.84 %

Yield advantage % of Guduru over local check = $\frac{\text{13.78qt/ha – 9.33qt/ha X 100}}{\text{9.33 qt/ha}}$ = 47.7 %

The above result revealed that both Kena and Guduru had higher yield advantage which is 64.84 % and 47.7 % over the local check, respectively.

Technology gap

It is undeniable that a lot of factors contributed to the gap between potential yield of the variety obtained on-station under management of breeder and that obtained during on-farm demonstration on farmers' field. Among which, differences in fertility of soil, variability on

wider plots, follow up and less frequent supervision of the on-farm trial, varying weather conditions and other factors contributed to this gap.

Technology gap = Potential yield (qt/ha) – Demonstration yield (qt/ha)

Technology gap for Kenna = 21 qt/ha -15.38qt/ha = 5.62 qt/ha

Technology gap for Guduru= 19qt/ha – 13.78qt/Ha = 5.22 qt/ha

The technology gap for both of the two varieties is nearly the same. This means both varieties had performing lesser than their potential as compared with its on-station potential yield and performance.

Technology index

$$\textbf{Technology index (\%)} = \frac{\textbf{Potential yield (qt/ha) - Demonstration yield (qt/ha)}}{\textbf{Potential yield (qt/ha)}} \textbf{ X 100}$$

$$\text{Technology index for Kenna} = \frac{21\text{qt/ha} - 15.38\text{ qt/ha}}{21\text{ qt/ha}} \text{ X } 100 = 26.76\%$$

$$\text{Technology index for Guduru} = \frac{19\text{ qt/ha} - 13.78\text{qt/ha}}{19\text{ qt/ha}} \text{ X } 100 = 27.47\%$$

Lessons learned

On-farm demonstration is bidirectional process where farmers and researchers learn from each other. During the study, farmers had first hand observation on the actual performance of new released teff varieties. Farmers got familiar with and access to improved teff technologies demonstrated to them, had better knowledge and/or skill on teff production and management, each FRG/FREG got improved teff variety/ies of their own preference which is adaptable to their local socioeconomic, cultural and ecological circumstances, research team exposed to collective variety evaluation and feedback for future research work to improve production and productivity of the varieties and linkage among research team, experts, DAs, farmers and other stakeholders were strengthened for dissemination of the technologies.

Conclusions and recommendations

Based on the evaluators, tillering capacity, disease tolerance, seed color, plant height, lodging resistant, overall yield, pest resistance, seed size, early maturing, spike length, threshability were the common identified selection criteria across all locations for selecting the best performing teff variety/ies.

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 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 15.38 qt ha^{-1}, 13.78 qt ha^{-1} and 9.33 qt ha^{-1}, respectively.

Above all, in all of their traits, almost all of the farmers' selected Kenna in the first place followed by Guduru. 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. Now days, farmers' group are seen as the smallest unit of the farmers. Hence, establishing and strengthening FRGs/FREGs is one of the extension approaches, which make the farmer to be central to agricultural research, technology promotion and dissemination. Teff variety (Kenna) was selected and recommended for pre-scaling up activity on wider plot (at least 0.25ha per trial farmer) for popularization. Strengthening the linkage among stakeholders is paramount to achieve the desired goal.

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Pre-extension Demonstration of Improved Bread Wheat Technologies in Selected AGP-II districts of Bale and West Arsi Zones

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Abstract

This activity was conducted during 2016/17 cropping season in Adaba and Dodola districts of West Arsi Zone, and Sinana, Agarfa and Gassara districts of Bale Zone with the objectives of demonstrating the recently released bread wheat variety (Sannate) to the farming community and to build farmers' knowledge and skill of wheat production and management packages in these districts. These districts were AGP-II beneficiary and purposively selected based on their potential for bread wheat production and two Kebeles from each district were selected on the basis of accessibility and potentiality. One FRG/FREG having 20 member farmers was established at each Kebele and trained on wheat crop production and management packages. One improved variety (Sannate) and one standard check (Hidase) were planted on adjacent plot size of 32 m x32 m (1024 m^2) on 35 farmers' fields. All recommended agronomic practices were equally applied to all the plots and the fields were closely supervised and were managed well. Participatory training was given for a total of 324 participants (255 farmers, 40 DAs and Supervisors, 29 experts and 12 researchers) on important agronomic and management practices. Field day also organized in representative potential Kebeles on which a total of 466 participants (357 farmers and 109 experts) were attended on the event to show the field performance of the varieties. At maturity stage of the crop, the varieties were jointly evaluated with a team composed of researchers, farmers, development agents and experts. Tillering capacity (fertile tillers), disease tolerance for rusts, spike length, fertile spikelets, seeds per spike, plant height, lodging resistant, crop stand, seed color and size and overall yield were the common identified selection criteria across all locations for selecting the best performing variety/ies. Agronomic data and yield data were collected and analyzed using descriptive statistics in order to evaluate the performance of the varieties. With regard to mean yield, 69.5qt ha^{-1} and 56.32qt ha^{-1} were obtained from Sannate and Hidase, respectively. The maximum yield of Sannate (72 qt ha^{-1}) was recorded in Dodola district where as the minimum yield was recorded in Adaba district (67 qt ha^{-1}). Besides, the combined analysis showed that Sannate has 23.4 % yield advantage over Hidase. Since, Sannate was selected by the farmers, it is recommended to be scaled up/out in all demonstration sites and similar agro-ecologies of the study zones.

Key Words: *Bread wheat, Technology, Farmers' preferences, FRG/FREG approach, Sannate, Hidase*

Introduction

Ethiopia is the largest producer of wheat in Sub-Saharan Africa. Recently, wheat in general has become one of the most important cereal crops (strategic crop) in terms of production and food security in Ethiopia (Tolesa, 2014). Two wheat species are dominantly grown in the country. These two economically important wheat species are bread wheat (*Triticum aestivum* L.) and durum wheat (*T. turgidum var*. durum). Bread wheat is of recent introduction; durum wheat is indigenous to the Ethiopia, which is considered as 'the secondary center of diversity for tetrapod wheat'.

Wheat is one of the major cereal crops grown within the range of 1500 to 2800 m.a.s.l in Bale, Arsi, West Arsi and Shoa zones of Oromia National Regional State (SARC Profile, 2015). During 2015/16 cropping season 1,664,564.62 ha of land was covered by wheat (bread and durum) and over 42,192,572.23 quintals was harvested with the average yield of 25.35 qt ha^{-1} at national level. Similarly, the land covered by wheat production in West Arsi and Bale zones in 2015/16 Meher production season was120,067.9 and 143,971.78 hectares respectively. Whereas, the average yield of wheat produced from the two zones was 32.97 qt ha^{-1} and 28.97 qt ha^{-1} respectively (CSA, 2016).

Now days, wheat rusts are becoming major threats in Ethiopia (especially current wheat rust disease epidemics in Arsi, West Arsi and Bale Zones) and most of commercial bread wheat varieties under production are losing their potential to resist diseases. Thus, replacing these varieties with the new ones that have relatively better tolerance towards wheat rust diseases and good in yield is vital. To this end, wheat improvement program emphasis on breeding for durable resistance and continuously come up with more improved variety choices associated with other agronomic and management practices. Accordingly, SARC has been conducting intensive research work on the crop and has recently released one wheat variety (Sannate) that have better disease tolerance (rusts) than the previous commercial varieties. Sannate has 53-67 qt ha^{-1} yield potential, 11% yield advantage over standard check (Madda Walabu) and 25.4% over local check (Holandi) (Crop Variety Registration Book, 2015). Accordingly, this experiment was conducted with the objectives to demonstrate and evaluate improved bread wheat variety through FREG approach and build famers, development agents' and experts' knowledge, skill and attitude on wheat production and management practices;

Material and Methods

Description of the study area

The research 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 of the ONRS and located in southeastern Oromia.

West Arsi Zone

West Arsi zone has eleven (11) rural and one (1) town districts. The zone extends from 6012'29" to 7042'55" latitude and 38004'04" to 39046'08" longitude. *Shashamanne* town is the capital town and the administrative center of the zone and located at 251km from Finfinne/Addis Ababa. The total area of West Arsi zone is about 12409.99 km^2 (1,240,999 ha). Geological survey show 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 (BOFED, 2009).

Farming system of the zone is characterized by mixed crop-livestock farming. About 95% of the population is engaged in agriculture. Most parts of the zone have elevations of ranging from 1500 to over 2300 m.a.s.l. The mean annual temperature of the zone is found between 10^oc -25^oc. On average, the zone gets annual mean rainfall of 1300 mm. The total length of the boundary line is about 174 km. It shares bounder line with East Shewa zone to the north, South Nations, Nationalities and People National Regional State (SNNPRS) to the west, Arsi zone to the northeast, Guji zone to the south and Bale zone to the east (WAZANRO, 2016).

The study was conducted in two districts of West Arsi zone; namely Adaba and Dodola. The districts were selected purposively based on their potentiality to wheat production and beneficiaries of AGP II.

Bale Zone

Bale zone has eighteen (18) rural and two (2) town districts, out of which nine (9) rural districts are found in the highlands and suitable for crop production. The other nine (9) rural districts are found in the mid and low lands, and agro-pastoralists and pastoralists. Robe town

is the capital town and the administrative center of the zone and located at 430 km from Finfinne/Addis Ababa. The total area of Bale zone is about 63,555 km^2 (6,355,500 hectares), which is 16.22% of ONRS. It is estimated that 88% and 22% are rural and urban dwellers, respectively.

Farming system of the zone is characterized by mixed crop-livestock farming. About 95% of the population is engaged in agriculture. The altitude ranges from 300m to 4377 m.a.s.l. The agro-ecological zonation includes extreme highland (cold) 0.04%, highland (14.93%), midland (21.5%) and lowland (63.53%). The mean annual temperature of the zone is found between 3.5^{o}c and 32°c, respectively. The area receives an average annual rainfall of 1450mm where as the minimum and maximum rainfall is 400mm and 2500 mm, 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 Arsi and Arsi zones to the North, Guji zone to the South, by West Hararghe zone and Somali National Regional State to the East and West Arsi zone to the West (BZANRO, 2016).

The study was conducted in three districts of Bale zone; namely Sinana, Agarfa and Gassara. The districts were selected purposively based on their potentiality to wheat production and beneficiaries of AGP II project.

Site and farmers' selection

Site selection

Purposive sampling methods were employed to select five representative districts from the two zones based on being AGP-II beneficiary districts. For this study, three districts (Sinana, Agarfa and Gassara) from Bale zone and two districts (Adaba and Dodola) from West Arsi zone were selected due to their potential for bread wheat production and the high demand for the crop. From each district, two representative Kebele were also selected purposefully as demonstration sites of the varieties based on their accessibility and potentiality.

Farmers (FRGs/FREGs) selection

Now days, group approach is more efficient than dealing with individuals especially in our context where the majority of farmers are smallholders and clear socio-economic differences are existing. It enhances the development, popularization, dissemination and adoption of

improved agricultural technologies meant for our farmers. Thus, selection of FRGs/FREGs members was based on farmers' willingness to be held as member, accessibility for supervision of activities (vicinity), good history of compatibility with groups and genuineness and transparency to share innovations to other farmers. Consequently, one FRG/FREG having 20 members with the composition of resource rich, medium and poor category of farmers including men, women and youth farmers was established at each kebele. Gender and youth balance in each FRG/FREG unit was strictly considered (at least 40%).

After establishment of the FRGs/FREGs, a theoretical training session was arranged to farmers, DAs, and experts at Dodola and Robe towns. Multidisciplinary team of researchers from SARC delivered on the following topics: participatory agricultural research and promotion through FRGs/FREGs, suitable agro-ecologies and weather condition for wheat production, wheat production and management packages, agronomic practices, economic and nutritive importance of bread wheat, post-harvest managements and storage of the crop.

Table 1: List of new FRGs/FREGs established for the demonstration activity

		Members by Gender				
FREGs	District and kebeles	Adult (Male)	Adult (Female)	Youth (Male	Youth (Female)	Total
2	Sinana (Hawusho and Gamora)	20	15	4	1	40
2	Agarfa (Ali and Sabaja)	22	14	2	2	40
2	Gassara (Nake Nagawo and Guranda)	23	16	1	0	40
2	Adaba (Washa and Ejersa)	24	16	0	0	40
2	Dodola (Katta Baranda and Kachama Chare)	23	15	1	1	40
10	Total	112	76	8	4	200

Selecting participant farmers

Having suitable and sufficient land to accommodate the demonstration activity, willingness to contribute the land, vicinity to roads so as to facilitate the chance of being visited by many farmers, initiatives to implement this activity in high-quality, good in field management and willingness to explain the technologies to others were criteria used to select the hosting farmers. Then, three to four representative hosting farmers from each FRG/FREG were

selected at each kebele with the help of group members and DAs. Thus, a total of thirty five (35) hosting farmers were selected for the purpose. Farmers (FRG/FREG members and other follower farmers) were encouraged to participate in the physical activities from the beginning up to the end of the demonstration activity.

Implementation design

Improved bread wheat variety (Sannate) and one standard check (Hidassie) were planted on selected farmers' land with simple plot design (32 m x 32 m) in 2016/17 main cropping (Meher) season with full recommended management practices. The demonstration activity was replicated on at least on three farmers per Kebele. Row planting method was employed and spacing of 20 cm between rows was used for the demonstration trial. The recommended seed rate of 150 kg ha^{-1} was used by drilling in the prepared rows. Shallow planting of 5 cm depth was used in the presence of sufficient soil moisture. The recommended rates of 100 kg ha^{-1} UREA and 100 kg ha^{-1} DAP were used to conduct the experiment. All DAP was applied at planting time with split application of UREA or *Nitrogen:* 1/3 at planting time and 2/3 at tillering stage of the crop. The trials were weeded two times; first at one month after sowing and second at two months after sowing of improved bread wheat varieties. Farm operations (land preparation-ploughing four to five times using oxen plough) were carried out by hosting farmers, whereas activities such as land leveling, planting, first and second weeding, agro-chemical spray, harvesting, threshing were handled by SARC.

Technology demonstration and evaluation techniques

FRGs/FREGs members and other follower farmers were encouraged to participate on different extension/promotional events organized at each demonstration site. These were mechanisms used to enhance farmer-to-farmer learning and information exchange such as trainings, field visits/tours, experience sharing, field days, etc.

Training

Training (both theoretical and practical) is very important for awareness creation and to bring improvement on the job after filling the gap on knowledge, skill and attitude. Hence, stakeholders such as zone and district level Agriculture and Natural Resource Office, Unions,

private service providers, Arsi-Bale Plant Health Clinic office, zone and district level agricultural inputs regulations and quarantine experts were invited and participated during consultation meeting and training.

Monitoring and evaluation, field visit and field day

Initially, agreement was made with farmers, DAs, supervisors and experts on responsibility sharing since the activity needs collaborative work and partnership. 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 visit was arranged to create awareness and farmers shared experience and knowledge.

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 technologies 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.

Farmers' preferences and selection criteria

The variety/ies were demonstrated, evaluated at crop maturity stage and validated by farmers, agricultural experts, development agents, researchers and other stakeholders based on the following selection criteria. The criteria were tillering capacity (fertile tillers), disease tolerance (for rusts), spike length, fertile spikelets, seeds per spike, plant height, lodging resistant, crop stand, seed color and size and overall yield. Each selection and evaluation criteria were rated using the following rating scale; 1= Very poor, 2= Poor, 3= Fair, 4= Good and 5= Very Good

Data collected

Both qualitative and quantitative data were collected using appropriate data collection methods such as FGD, direct field observation and measurements. Agronomic data and grain

yield per plot were recorded. Total number of farmers participated on extension/promotional events such as training, field visits and mini field days were recorded by gender composition. Feedback assessment on farmers' preference to the demonstrated varieties (likes and dislikes, which is the base for plant breeding process) and farmers' perception towards the performance of the technologies were also identified.

Data analysis

The collected data was analyzed using SPSS and descriptive statistics such as mean, frequencies distribution and percentages. Besides, pair wise ranking matrix was used to evaluate and select best performing varieties and rank the varieties in order of their importance.

Results and Discussions

Inputs used and yield harvested

Demonstrations of improved bread wheat variety (Sannate) with one standard check (Hidase) were undertaken for one year in AGP-II beneficiary three districts of Bale zone and two districts of West Arsi zone in the 2016/17 cropping season. The varieties were treated with full recommended bread wheat production and management packages. SARC was the source of all inputs (seed, fertilizers and agro-chemicals) required for the demonstration activity implementation.

Table 2: Lists of demonstrated bread wheat varieties on hosting farmers' field

Variety	Locations/ Districts	No. of trial farmer	Plot size	Seed for one farmer (kg)	Total seed distributed (qt)	Fertilizers for one farmer (kg) UREA	NPS	Total Area (ha)	Harvested seed (qt)
Sannate	Sinana, Agarfa Gassara, Adaba Dodola	35	32X32	16	5.6	11	11	3.77	262
Total		**35**			**5.6**			**3.77**	**262**

Training on capacity building

Participatory training was given by multidisciplinary team of SARC researchers (Breeder, Agronomist, Weed Scientist, Pathologist, Entomologist, Economist and Extensionist) in the participant districts of Bale and West Arsi zones at Dodola and Robe towns. A total of 400 participants:- 320 farmers (200 FRGs/FREGs members and 120 follower farmers), 30 DAs, 10 supervisors, 40 experts and 8 researchers were participated on the training. The theme of the training were included the availability of improved bread wheat technologies and utilization, bread wheat (both in quantity and quality) production and management packages, major wheat diseases and their control measures, agro-chemicals utilizations/applications and safety precautions, the importance of crop rotation to break cereal based mono-cropping practices in the zones through pulse crops (commodity) integration and on creating strong linkage among relevant actors through multi-stakeholder approach to tackle the problem in joint action through taking emergent, medium and long term actions/measures.

Field Day organized

At physiological maturity stage of the crop, field day was jointly organized in collaboration with other stakeholders (zone and district level agriculture development offices and participant farmers) in the participant districts to create awareness about the importance and availability of the new improved wheat technologies.

About 466 participants (357 farmers from all category including FRGs/FREGs members and follower farmers, 58 DAs and supervisors, 41 agricultural experts and cooperative leaders and 10 researchers) were participated on this promotional event. Participants were shared their best experiences especially on how to preserve the quality seeds of bread wheat varieties by cleaning combiner during harvesting, manual harvesting of the plot and other seed cleaning and preservation mechanisms). In addition, participant farmers were shared information on the local seed exchange mechanisms (informal).

Yield performance of the demonstrated varieties

On-farmers field, the overall mean yield of Sannate variety was 69.5qt/ha, while that of the standard check (Hidase) was 56.32qt/ha. Sannate gave the highest yield than Hidase in all demonstration sites.

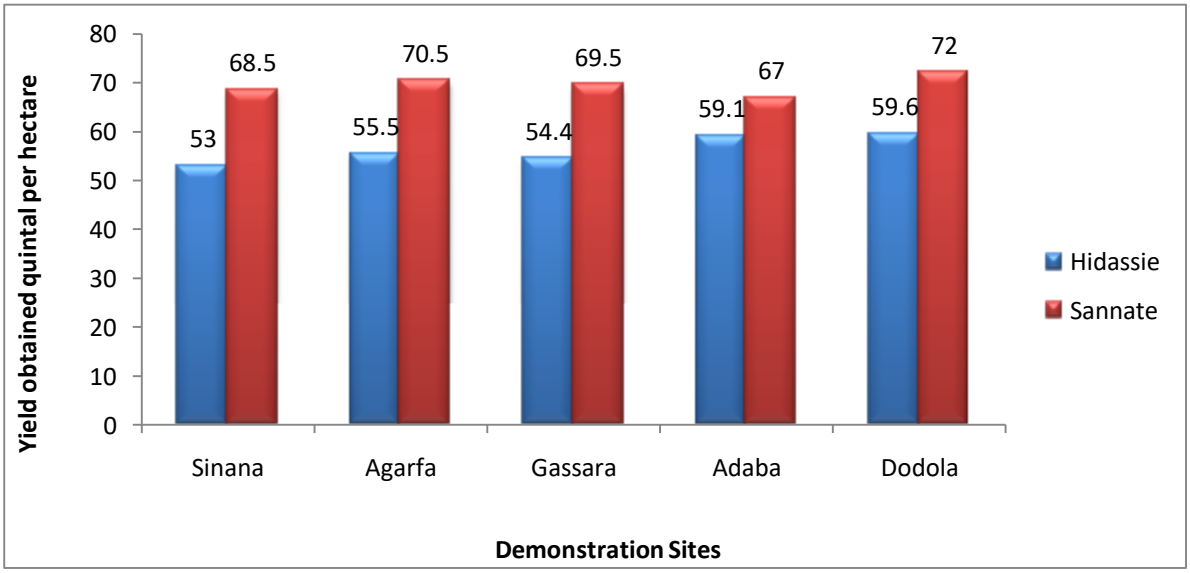

Figure 1: Mean yield data of the demonstrated varieties in the districts

Table 3: Yield advantage of the demonstrated variety over the standard check

Mean yield of standard Check (qt ha^{-1})	Mean yield of improved bread wheat variety (qt ha^{-1}) and yield advantage over the check	
Hidase	Sannate	%
56.32	69.5	23.4

The above table 3 indicates that the hosting farmers had obtained more than 20% yield advantage from improved bread wheat variety (Sannate) over the standard check (Hidase). This figure was competent with the potential yield of the variety at research field since packages approach was employed during the demonstration activity.

Participatory Evaluation and Farmers' Preference

Farmers are strongly inclined to their likes and dislikes (preferences) and participated during the assessment. First, the evaluators were grouped in to small manageable group (one group had 10 members including one group leader and one secretary). At each kebele and 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.

Thus, a total of 270 participants from five AGP II beneficiary districts (200 FRGs/FREGs member farmers, 30 DAs, 10 supervisors and 25 experts) and 6 researchers were participated on participatory assessment and evaluation (PAE) of the varieties at maturity stage of the crop. Farmers' perception on the performance of improved bread wheat varieties were tested at each district and analyzed using Pair Wise Ranking. Thus, Pair Wise Ranking was used as a tool to summarize farmers' preference towards important variety traits (Boef and Thijssen, 2007).

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

Code	Variety Traits	Tillering	Disease Tolerance	Spike Length	Spikelet/ Spike	Seeds/ Spike	Crop stand	Biomass Yield	Seed color	Yield
1	Tillering									
2	Disease Tolerance	2								
3	Spike Length	1	2							
4	No. of Spikelet/Spike	1	2	3						
5	Seeds per Spike	5	2	5	5					
6	Crop stand	1	2	6	6	5				
7	Biomass Yield	1	2	3	4	5	6			
8	Seed colour, hard, soft	1	2	3	4	5	6	8		
9	Overall yield	9	2	9	9	9	9	9	9	

The result showed that disease tolerance (especially to Yr and Sr) was the most preferred bread wheat variety trait followed by overall yield, seeds per Spike and tillering capacity of the variety (Table 4).

Table 5: Comparing of the varieties based on important variety traits

District	Variety Trait	Sannate (Mean)	Hidase (Mean)
Sinana	Tillering (count) (≥10) fertile tillers	14	11
	Seed per spike (≥60)	73	51
	Crop stand (%)	90	85
Agarfa	Tillering (count)	9	7
	Seed per spike (count	73	74
	Crop stand (%)	95	85
Gassara	Tillering capacity	12	10
	Seed per spike (count	73	69
	Crop stand (%)	90	80
Adaba	Tillering (count)	9	8
	Seed per spike (count	60	51
	Crop stand (%)	95	80
Dodola	Tillering (count)	9	7
	Seed per spike (count	65	53
	Crop stand (%)	90	80

All participant farmers were very interested with the stands of Sannate especially based up on its high tillering capacity (>10), spike length, spikelet per spike, seeds per spike (>60), disease tolerance (Yr and Sr), crop stand, good plant height for mechanization and high yield. Based on farmers' assessment and evaluation, Sannate ranked first followed by Hidase. Sannate needs early planting using the first rain shower since it has more late tillers. Good awareness was created among stakeholders about Sannate variety and other associated technologies (demand pull). Revolving seed and farmer-to-farmers seed exchange mechanisms were designed to access seed for farmers in the study area.

Conclusion and Recommendations

There are opportunities to harvest high yield from commercial bread wheat variety/ies if and only if our farmers use appropriate production and integrated weed/disease management practices. But, practical field observation and assessment result indicated that, there is a knowledge gap on appropriate agro-chemicals application (utilization) by those smallholder farmers in the study zones. Trainings (both theoretical and practical), joint supervision, field days and focus group discussions were organized at all demonstration sites as part of capacity building, technology and information diffusion mechanisms in order to make adoption rate faster.

Tillering capacity (fertile tillers), disease tolerance for rusts, spike length, fertile spikelets, seeds per spike, plant height, lodging resistant, crop stand, seed color and size (marketability) and overall yield were the best selection criteria identified by the evaluators for selecting the best performing improved bread wheat varieties. Therefore, farmers' preferences (likes and dislikes) are the base for breeding process. Thus, in this activity, farmers were identified as reliable partners in the participatory plant breeding program. The overall harvested mean yield of Sannate variety was 69.5qt/ha, while that of the standard check (Hidase) was 56.32qt/ha. The hosting farmers had obtained more than 20% yield advantage from Sannate over the standard check (Hidase). Agronomic data result shows that Sannate gave the highest yield than Hidase in all demonstration sites and selected pre-scaling up/out activity.

During focused group discussion (FGD), the participant farmers highly emphasized the constraint of row planter, seed supply shortage (in quantity, quality, with reasonable price and at required time), cereal based mono-cropping problem and emerging big challenge of wheat rust disease epidemics. Based on farmers' assessment, Sannate was selected and recommended for pre-scaling up activity on wider plot (at least 0.25ha per farmer) in the participant districts and similar agro-ecologies of the zones. Thus, popularization of the demonstrated variety/ies should be made on different extension/promotional events in order to create high demand. Strengthening the linkage among stakeholders is paramount to achieve the desired goal and improve the income of small scale farmers.

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Pre-extension Demonstration of Improved Food Barley Technologies in AGP-II Districts of East and Horro Guduru Wollega Zones

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Abstract

This activity was conducted at Jardaga-Jarte, Guduru and Jimma-Rare districts of western Oromia with the objective of demonstrating the recently released food barley variety, HB-1307 to the farming community in these districts. These districts were purposively selected based on potentiality for food barley production; and one potential Kebele from each district were selected on the basis of accessibility and potentiality. One FRG/FREG was established at each Kebele and trained on barley crop production and management packages. Recently released food barley variety (HB 1307) and one local check were planted on 20 m x 10 m adjacent plots on 12 trial 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 of the crop, the varieties were jointly evaluated with a team composed of researchers, Farmers and development agents. Disease tolerance, tillering capacity, lodging resistant, spike length, seeds per spike, plant height, seed color, early maturity, overall yield and threshability were the common selection criteria across all locations for selecting the performing variety. HB 1307 were selected by the evaluators with overall mean yield data 32.2 qt ha^{-1} as compared to local check (16.5 qt ha^{-1}).Besides, HB 1307 has 95.15% yield advantage over the local check and recommended for further pre-scaling up activity in similar agro-ecology of the study zones in the next season.

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

Introduction

Barley is the fourth most important crop in the world after maize, rice and wheat used mainly as feed for poultry, swine and cattle, and for preparing beverages. In Ethiopia, it is one of the top five cultivated cereal crops after tef, maize, wheat and sorghum with main use as food, local beverages and beer. From 9,974,316.28 hectares of land allocated for cereals in 2015/16 production season, barley (food and malt) covered 944,401.34 ha of land from which

18,567,042.76 quintals of grain was produced with the productivity of 19.66 qt ha^{-1} (CSA, 2016).

Area coverage; which is 90,316.67 hectare in Horro-Guduru Wollega for barely productivity in Ethiopia (1.965 t ha^{-1}) is low compared to world average of 3.095 t ha^{-1} (barley commodity strategic plan document, 2016). Despite its enormous economic and nutritive importance its productivity is very low as compared to other cereals (1.2 ton ha^{-1}). There are a lot of factors that contributed to the lower productivity of the crop. Among which limited improved varieties, inappropriate agronomic and low crop management practices, low soil fertility, water logging, leaf and grain diseases, pests, weed competition are the major ones.

To tackle productivity problem the national and regional research systems in the country have been conducting a series of research activities on improvement of the crop and have been releasing many varieties. Among them HB-1307 has better productivity and disease resistance compared to local and other released commercial varieties. Despite the availability of this variety many farmers in the region haven't yet got access and still are using local varieties characterized by very low productivity and susceptibility to diseases.

This project, therefore, is initiated with the objectives of demonstrating, evaluating and validating the variety so as familiarize the farming communities with the best variety which in turn will facilitate the adoption process and bridge the productivity gap.

Materials and Methods

Site and FRG/FREG selection

This activity was conducted in purposively selected districts of East and Horro-Guduru Wollega zones in 2016/17 production season. 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 were selected based on the aforementioned criteria. From each district one representative potential PA was also selected purposively based on accessibility and potentiality for barley production. In each Kebele, one FRG/FREG units comprising of 12 farmers was established. A total of 4 FRG units were established. Under FRGs/FREGs members other farmers were organized as follower farmers to share experience and

knowledge for further promotion mechanism. For gender equity issue 40% of the participants were women farmers and 60% were male. Development agents and district experts were collaborating in site and farmer selection. The FRG/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.

In each FRG unit, 4 representative trial/hosting farmers were selected with the rest being participant farmers. Besides; the trial/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 FRGs/FREGs a theoretical training session was arranged to farmers, DAs, and experts. Multidisciplinary team of researcher from Bako Agricultural Research Center (BARC) delivered training to a total of 88 participants:- FRGs/FREGs members (60), DAs and supervisors (16) and experts (12) on the following topics: participatory agricultural research and promotion through FRGs/FREGs, suitable agro-ecologies and weather condition for barley production, barley production and management packages, agronomic practices, economic and nutritive importance of barley, post-harvest managements and storage facilities of barley.

Activity implementation and 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 local check were planted on adjacent plots of 10 x 20 m^2 each. All the necessary recommended agronomic practices were equally applied for all of the plots. For food barley, the spacing of 20 cm between rows was used. The recommended seed rate of 120 kg ha^{-1} used by drilling in the prepared rows. Shallow planting of 2-4 cm depth was employed in the presence of ample soil moisture. The recommended fertilizer rate of DAP/NPS 100 kg ha^{-1} was also applied at sowing/planting time of the varieties. For joint monitoring and evaluation, the demonstration sites were supervised at a monthly interval to check the status and to identify gaps. At maturity stage of the crop, participatory variety evaluation platform was arranged that attended by the experimenting

farmers, FRG/FREG members, neighboring/follower farmers, researchers from BARC and other stakeholders.

Data collected

Appropriate data collection methods (direct field observation/measurements, focused group discussion, and knowledge test) were employed to collect both qualitative and quantitative data. The types of data collected include yield data, change in level of knowledge and skill of farmers, farmers' perception towards the performance of the technologies, farmers' preferences and their selection criteria, total number of farmers participated on extension/promotional events such as training, field visits and field days, and stakeholder's participations and role in technology demonstration and evaluation.

Data analysis

The data was analyzed using descriptive statistics such as mean, frequencies distribution, and percentages were used. Besides; pair wise ranking techniques was administered and used to rank the varieties in order of their importance.

Result and Discussion

Participatory variety evaluation and selection

The target beneficiaries of improved agricultural technologies are strongly inclined to their likes and dislikes (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). Thus, a total of 93 participant**s** from 4 districts 60 farmers, 16 DAs and supervisors and12 experts) and 5 researchers were participated on the process at maturity stage of the crop. Consequently, at maturity the varieties were evaluated based on the farmers' selection criteria. During the assessment, the farmers were assisted to list their own evaluation criteria, which then be ordered using pair-wise ranking technique.

First, the evaluators were grouped in to small manageable group (one group had 10 members including one group leader and one secretary). At each district, Kebele and 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. Each variety was evaluated against the criteria ordered based on the weight attached to each parameter. At the end of the evaluation process, result of the evaluation was displayed to the evaluators, and discussion (FGD) was made on the way ahead. The variety/ies selected, accordingly, will be proposed for further pre-scaling up.

Table 1: Rank of the varieties based on farmers' selection criteria

Varieties	Rank	Reasons
HB 1307	**1st**	Tillering capacity, disease tolerant (Yellow rust, stem rust), seeds/ spike, crop stand, attractive seed color, very good overall yield, lodging resistant, early maturity, very good seed size, Threshability, late maturing and not susceptible to bird attack
Local variety	**2nd**	Low tillering capacity, low seeds/spike, susceptible to diseases, has lodging character, low thrash ability, small seed size, early maturing and susceptible to bird attack

Table 2: Pair wise ranking result to rank variety traits in order of importance

No	Traits	Disease Tolerant	Seed color	Tiller	Pest R	Seed size	Yield	Lodg. %	E.M	Thrash ability
1	Disease tolera		9	8	6	6	4	4	3	1
2	Seed color			7	6	7	4	5	4	1
3	Tillering				6	8	4	6	5	1
4	pest tolerance					9	4	7	6	1
5	Seed Size						4	8	7	1
6	Overall yield							9	2	1
7	Lodging %								9	1
8	Early Maturity									1
9	Threshability									

Table 3: Summary of matrix ranking and rank of variety traits

No	Variety Traits	Frequency	Rank
1	Disease tolerance (yellow rust, Stem rust)	8 times	1st
2	Seed color	1 time	8th
3	Tillering capacity	1 time	8th
4	Pest tolerance	7 times	2nd
5	Seed size, hardness and softness	2 times	7th
6	Overall yield	6 times	3rd
7	Lodging %	4 times	4th
8	Early maturing	3 times	6th
9	Threshability	4 times	4th
	Total	36	

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 and site specific varying weather conditions (for instance, ice rain, rainfall intensity i.e. flooding or shortage. The overall harvested mean yield of HB 1307 and the local variety was 32.2 qt ha^{-1} and 15-18 qt ha^{-1}, respectively.

$$\textbf{Yield advantage \%} = \frac{\textbf{Yield of new variety (qt/ha) - Yield of standard check (qt/ha)}}{\textbf{Yield of standard check (qt/ha)}} \textbf{ X 100}$$

$$\text{Yield advantage \% for HB-1307} = \frac{32.2 - 16.5}{16.5} \text{ X } 100 = \underline{95.15\ \%}$$

Therefore, HB 1307 has 95.15 % yield advantage over the local check.

Lessons Learned

On-farm demonstration is bidirectional process where farmers and researchers learn from each other. During the study, farmers had first hand observation on the actual performance of HB-1307. Farmers got familiar with and access to improved food barley technologies demonstrated to them, had better knowledge and/or skill on barley production and management, got improved barley variety of their own preference which is adaptable to their local socioeconomic, cultural and ecological circumstances, research team exposed to

collective variety evaluation and got feedback for future research work to improve production and productivity of the varieties and linkage among research team, experts, DAs, farmers and other stakeholders were strengthened for dissemination of the technologies.

Conclusions and recommendation

Based on the evaluators, disease tolerance, seed color, plant height, overall yield, pest resistance tolerance, tillering capacity, seed size, lodging resistant, early maturity, spike length, threshability were the common identified selection criteria across all locations. In spite of the inevitable variability in performance between and even within locations, yield performance of the varieties was still promising.

The overall harvested mean yield of HB 1307 and the local variety was 32.2 qt ha^{-1} and 15-18 qt ha^{-1}, respectively. Besides, HB-1307 has 95.15 % yield advantage over the local check. 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 FRGs/FREGs is one of the extension approaches, which make the farmer to be central to agricultural research, technology promotion and dissemination. HB 1307 was selected and recommended for pre-scaling up activity on wider plot (at least 0.25ha per trial farmer) for popularization. Strengthening the linkage among stakeholders is paramount to achieve the goal.

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Pre-Extension Demonstration of Improved Potato Technologies in AGP –II Districts of Horro Guduru Wollega Zone

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Abstract

Potato (Solanum tubersom L.) is an important crop for smallholder farmers in Ethiopia, serving as both a cash and food security crop. Regardless of all the above fact, average productivity of the crop both at National and Regional level is very low as contrasted with the world average yield. Various factors such as shortage of disease resistant, adaptable and high yielding varieties, appropriate crop management practices and post-harvest management might have been the influenced. Hence, this activity was conducted during the 2016 main cropping season at Guduru, Jarte-Jardage and Jimm- Rare district of Horro-Guduru Wollega Zone to evaluate and select the best the potato varieties suitable to farm condition using farmers selection criteria and to generate knowledge and information that can contribute for the seed value chain development. A total of ten farmers were participated on the experiment. Belete, Horro and Local check varieties were evaluated and demonstrated on 100m^2 plots at each site. In each Kebele one farmer research group members comprising of 15-20 farmers were established to evaluate and select the varieties. Gender and youth balance in each farmer research group member was strictly considered. Agronomic data and farmer feedback/preference were collected. The collected data were analyzed through descriptive statistics (mean and standard deviation) and graphs by SPSS software and qualitatively. The agronomic result shows that the average total yield harvested from Belete and Horro varieties were 35 ton ha^{-1} and 25 ton ha^{-1}, respectively. In addition, participants of farmers research group members were also select those varieties based on criteria's like disease reaction, tuber size, marketability, number of tubers and ways of giving tubers from one plant, color, perishability, yield amount, sweetness and short time take during catering. According to other agronomic data result shows that and farmer preference criteria like disease resistant, high yielder, larger tuber size, marketable, good color and high number of tuber and others, Belete and Horro varieties were selected as compared to local varieties. Therefore, Belete and Horro varieties will recommend for further scale up/out for Guduru, Jatre and Jimma rare districts and others area which is similar agro-ecology to the districts.

Keywords: Pre-Extension, Demonstration, Improved Potato Technology, Farmers Research Extension Groups

Introduction:

Potato is an important crop for smallholder farmers in Ethiopia, serving as both a cash and food security crop. It is one of the tuber 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, average productivity of the crop both at National and Regional level is very low (4.77-5.72t ha^{-1}) as contrasted with the world average yield of 16.45t ha^{-1} (FAO, 2008). Various factors such as shortage of disease resistant, adaptable and high yielding varieties, appropriate crop management practices and post-harvest management might have been the major constraint.

Research center have made all-round effort to provide solution to these problems. As result more than 27 potato varieties with their full package were formally released for production from regional and national research centers. However, the technologies developed at research stations are evaluated by the researchers' criteria only, might not meet farmers' needs and thus farmers simply thrust aside or do not adopt such type of technologies. Hence, farmers' technology evaluation criteria would help researchers to develop technologies appropriate to local situation and in line with the farmers' criteria. Therefore, this activity was designed to evaluate and select best improved potato varieties by farmers' indigenous criteria via FRG approach.

Material and methods

Site and farmers selection

This activity was conducted in Guduru, Jarte and Jimma Rare districts of Horro Guduru Wollega Zone. Selections of the districts were based on potentiality for potato production, accessibility for supervision. Accordingly, one potential Kebele from each district was selected based on the aforementioned criteria. In each Kebele one FRG members comprising of 15-20 farmers was established and managed. Gender and youth balance in each FRG member was strictly considered. In each FRG unit 4 experimental farmers was be selected with the rest being participant farmers. The experimenting farmers were selected based on: Having 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.

Stakeholder training

After the establishment of the FRGs a theoretical training session was arranged to farmers, development agent and district experts. At this juncture 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 economic and nutritive importance of potato, suitable ecologies and weather condition for potato production, agronomic practices, post-harvest and storage strategies of potato.

Demonstration design (treatment)

The demonstration field was not a complex multifactorial experiment, it included only two improved potato varieties ***Belete and Horro*** with one local check was established on adjacent plots of 100 m^2. The plots were replicated by the number of experimenting farmers. The demonstrations plots were established and managed exclusively by the researcher/extension worker or together with farmers. The plot was labeled with a sign giving the name of the variety, its duration, yield, performance on station. Spacing of 70 cm and 30 cm between rows and plants respectively were used for the experiment. Recommended rate of 200kg ha^{-1} of DAP and 100 kg of UREA fertilizer were used to conduct experiment. All other

recommended agronomic practices were maintained equally for all plots. Finally, field day and training materials (leaflet) were prepared at farmer's field.

Data Collection and analysis

Potato late blight reaction, agronomic data, total number of farmers participated in training, field visits and field days change in level of knowledge and skill of farmers; Farmers' perception on the characteristics of technology stakeholders participation, marketable tuber yield unmarketable tuber yield (ton ha^{-1}) and disease and pest reaction was collected. The collected data was analyzed using SPSS statistical package. Descriptive statistics tools such as mean, standard deviation (SD), frequencies, and percentages were used to analysis the data.

Important tools for implementation

Continues supervision of field, conducting training for knowledge sharing, development of training materials (leaflet) and field day was conducted to implement and achieve objectives of participatory selection.

Monitoring and evaluation

From beginning of site selection until harvesting, frequent visits to farmers, monitoring and provision of technical advice, follow up actions were designed based on emerging knowledge/ skill and technical needs. Researchers, extension agent, supervisor of extension agent, experts and farmers were jointly participated on continues supervision of the experiment. The outstanding variety/ies were finally evaluated and, then, selected jointly with farmers' group, researchers from Bako Agricultural Research Center (BARC), extension workers and other stakeholders.

Results and discussion

Stakeholders' awareness creation means

Training 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 potato, suitable ecologies and weather condition for potato production, crop production management , post-harvest and storage strategies of potato crops. A total of 233

participants (180 farmers, 30 DAs and Supervisors, 15 agricultural experts and 8researchers) were participated on this training as mentioned in table below.

Table1. Stakeholders training participants across three demonstration districts

	Districts			
Participants	Guduru	Jimma Rare	Jarte Jardaga	**Total**
Experts	6	4	5	15
DAs and supervisors	10	10	10	30
Farmers	60	60	60	180
Researchers	-	-	-	8
Total	76	74	75	233

Source: own data, 2016

Field day Organized

Field day was jointly organized in collaboration with other stakeholders (district level agriculture development offices and participant farmers) at Jarte, Guduru and Jimma rare districts to expose farmers to new technologies, such as varieties, practices, and inputs, and get farmers' feedback on the new technologies. A total of 127 participants at Jimma rare, 120 participants at Guduru and 90 participants at Jarte district (mostly farmers, some researchers, seed agencies, Office head and extension expert of Woreda Agriculture and rural development, head and extension expertise of Horro Guduru Wollega zone Agriculture and rural development office, administrators of Woreda and development agents) have attended the program. Brief explanation on the progress and prospect of AGPII project was presented for participant a head of field visit at each site. On field work, questions and comments were entertained. Farmers, administrators, researchers and stakeholders were invited to give feedback. Farmers, administrators and all participants were very much attracted with the performance of improved potato variety grown with fertilizer at each site.

Table 2: Illustrates participants of field day organized at demonstration districts

Districts	Farmers		Das		District admin.		Experts		Researchers		Total participants
	M	F	M	F	M	F	M	F	M	F	
Jimma rare	80	20	10	5	2	0	3	1	6	0	127
Guduru	75	25	8	2	1	0	3	0	6	0	120
Jarte	60	10	6	2	2	0	4	0	6	0	90
Total											237

M=male, F=female

Pairwise matrix ranking for farmers Preference of the Varieties

Pair wise matrix ranking was used to rank the most important listed farmers criteria to be used for the variety selection. To select varieties and achieve objective of the demonstration, field day was prepared in farmer's field. Researchers, experts, head of district and zonal agricultural development office, extension agents, farmers were participated on selection of varieties on ten farmers' fields in Horro Goduru Zone at three AGP-II districts of activity sites. The groups identified and listed the major criteria recognized and agreed on by most participants in the demonstration sites (Table 3). The criteria of variety listed were including disease resistance, early maturity, crop stand, productivity (Yield), Tuber size and taste of the crop. Farmers were then guided to prioritize the criteria under each category in each kebele which, in turn, helped to establish the single most important criteria from each of the five criteria so as to make pair-wise comparisons among the selected constraints independently for each kebele Overall, there were coincidences of similarity between kebele in their prioritization of criteria. In all kebele there were similar priorities and therefore, rankings in their pair-wise comparisons were merged and presented in pairs in table 3.

Table 3: Farmers potato variety selection criteria used across the demonstration site

Criteria	1	2	3	4	5	6	Score	Ranking
Resistance to disease (DR)	x	DR	DR	Y	DR	DR	4	2
Early Maturity(EM)		X	CS	Y	TU	Ta	0	6
Crop stand (CS)			x	Y	TU	Ta	1	5
Yield (Y)				x	Y	Y	5	1
Tuber size (TU)					x	Ta	2	4
Taste and cooling quality (Ta)						X	3	3

A total 170 farmers (having male and women farmers group) performed selection of varieties based on the most important listed criteria like yield, disease resistance, maturity, cooking quality and taste. The result of the evaluation by the combined men plus women group showed that Belete variety was ranked first for its highest total yield, resistance to leaf diseases, general stand, tuber size and taste. It was ranked second for its early maturity. The variety Horro was ranked second for all of the selection criteria. Local Variety was the last for all of the criteria considered by the group. The Local variety was attack by late blight and bacterial wilt and perishables, low yielder as compared to selected varieties. Belete and Horro

varieties were selected and ranked by participants for further scaling up and multiplication on their agro-ecologies.

Table 4: Farmers' selection criteria and rank of the three potato varieties

No	Farmers selection criteria	Potato varieties		
		Belete	**Horro**	**Local**
1	Resistance to disease	1	2	3
2	Early Maturity	3	2	1
3	Crop stand	1	2	3
4	Yield	1	2	3
5	Tuber size	1	2	3
6	Taste	1	2	3

On- farm productivity of potato varieties

Data of the three varieties on yield parameters was taken from the demonstration plots in the districts. The average sample data collected from the demonstration plots suggests that Belete (35 MT ha^{-1}), Horro (25 MT ha^{-1}), and Local (4 MT ha^{-1}) were first, second, and third, respectively, in terms of both the total yield and marketable yield.

Farmers yield advantage obtained

The hosting farmers across the all site obtained the yield advantage from the demonstrated improved potato technologies. They had obtained 86% yield advantage from Belete varieties over the local while 84% yield advantage from Horro varieties over the local one.

Stakeholders' feedback on potato technology

During these feedback sessions, farmers were asked about the advantages and disadvantages they perceived in these technologies. This collected information will be used for future improvement of research technology development and dissemination process. Accordingly, FRG farmers listed the advantage of new technologies over the standard check as follows.

- For their good yield as compared to the local potato varieties at different areas of demonstration site of the respective districts than the standard check.
- Easily cooked with small amount of energy than standard check
- Relatively resistant to early and late blight

High demand which fetches higher market price than standard check

The participants' farmers also appreciated the FRG research approaches than the conventional research system and the advantage over precious approach for its quick operations, team spirit, share knowledge and experiences, team up to buy inputs, share labor and encourage each other

Conclusion and recommendation

Generally, improved varieties gave better tuber yield and benefit on the district where the demonstration had been carried out. The use of improved potato variety with its full production package, farmers could get an additional yield benefit of over the local varieties. Many farmers built their awareness on the quality of technology and understood that technology can give reliable yield than the ones that they are previous used if they are used together with associated improved package of production. Therefore, Belete and Horro varieties will recommend for further scale up and scale out for Jima rare, Jarte and Guduru districts and others area which is similar agro-ecology to districts. The unions, research organization, agricultural development office, NGOs, private and public seed sector, farmers' cooperative and others organization mainly focus on seed sector will promote and scale up those varieties in reducing quality seed problem of country and boost the economy by reducing poverty and addressing food security.

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Pre-Extension Demonstration and Participatory Evaluation of Improved Sesame Technologies in Selected AGP-II Districts of East Wollega Zone

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Abstract

This activity was conducted at Diga, Guto-Gida and Gida-Ayana districts of East Wollega zone, western Oromia with the objective of demonstrating the newly released sesame variety, Chalasa to the farming community. These districts were purposively selected based on potentiality for sesame production; and one potential Kebele was selected from each on the basis of accessibility and potentiality. After establishing one FRG unit in each Kebele, training was delivered to the FRG/FREG units at each district. Three varieties of sesame, Obsa and Dicho (as standard checks); and Chalasa (as a new variety) were planted on 20 m x 10 m 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 of the crop, the varieties were jointly evaluated with a team composed of researchers, experts, Farmers and DAs. Despite the slight variability in criteria set by farmers at the respective locations, disease tolerance, number of branches per plant, number of nodes per plant, inter node distance, capsules per plant, capsule length (cm), height of the first branch from the ground, early maturity and overall yield were the common selection criteria across all locations. In almost all of the selection criteria, Obsa was found to beat the recently released variety (Chalasa) and has met the set criteria, impressing the farmers. With regard to yield, 8.5qt ha^{-1}, 8.12qt ha^{-1} and 7.44 qt ha^{-1} were obtained from Obsa, Dicho and Chalasa, respectively. As the variety has meet criteria and liked, the pre-scaling up activity should follow the next season. Besides; Obsa and Dicho has 12.47 % and 8.37% yield advantage than Chalasa, respectively

Keywords: Sesame; FRG/FREG unit; Participatory evaluation; Chalesa, Obsa, Dicho

Introduction

Sesame is indigenous to countries on the Eastern shores of the Mediterranean, but widely cultivated in India, Egypt, Ethiopia, Morocco and occasionally in England (Polhil and Raven, 1981; Davoud *et al*., 2010). The world of sesame seed market is a billion dollar industry that supports the livelihoods of millions of farmers throughout the world (USAID, 2010).

Currently, Ethiopia is among the top five producers of sesame seed in the world, ranked at fourth place by covering about 8.18 percent of the total world production (FAOSTAT, 2012).

Next to coffee, sesame seed is the second largest agricultural export earner for Ethiopia, involving a number of small-holder farmers in its production throughout the nation (CSA, 2011). It served as a source of income at household level and a contributor for the country's foreign currency earnings, among others (CSA, 2016). In 2010/2011 production year, about 763, 893 smallholder farmers participate in sesame production; while in year 2011/2012 the number of participants has increased to about 893, 883 private peasants (CSA, 2011). This indicates as sesame sector has potential to involve more smallholders under its production, hence one way of linking them to domestic and international markets.

Sesame production ranks the first among oilseed crops (Noug, Groundnuts, Linseed, Rape seed and Sunflower) in area and volume of production in the country. From 859,110.39 hectares of land allocated for oilseed crops in 2015/2016 production season, Sesame covered 388,245.5 hectares of land from which 2,742,174.27 quintals of grain was produced with the productivity of 7.06 qt ha^{-1} (CSA, 2016).

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

Sesame in Ethiopia is grown mainly for the export market (Aysheshm, 2007; Alemu and Meijerink, 2010). However, productivity per unit area is very low that hindering the farmers to exploit the advantage. Consequently, developing high yielding, disease tolerant and stable

varieties are very important. This calls for demonstrating, validating and disseminating of the already released high yielding and quality sesame varieties that can make producers competitive in the today's competing markets.

Materials and methods

Site and FRG/FREG selection

This activity was conducted in some purposively selected districts from East Wollega zone. Selection of the districts was based on potentiality for sesame production, accessibility for supervision and compatibility with the AGP-II criteria. Accordingly, Guto-Gida, Diga, and Gida-Ayana were selected based on the aforementioned criteria.

One potential Kebele from each district was selected based on accessibility and potentiality for sesame production. In each Kebele one FRG/FREG units comprising of 15-20 farmers was established. Under FRGs/FREGs members other farmers were organized as follower farmers to share experience and knowledge for further promotion mechanism. Gender and youth balance in each FRG unit was strictly considered. For gender equity issue 40% of the participants were women farmers and 60% were male. In each FRG/FREG unit 4 experimental farmers were selected with the rest being participant farmers.

Development agents and experts were collaborating in site and farmer selection. The FRG/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 trial/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 FRGs/FREGs a theoretical training session was arranged to farmers, DAs, and experts. Multidisciplinary team of researcher from Bako Agricultural Research Center (BARC) delivered training to a total of 65 participants:- FRGs/FREGs members (45), DAs and supervisors (12), and experts (9) on the following topics:

participatory agricultural research and promotion through FRGs/FREGs, suitable agro-ecologies and weather condition for sesame production, sesame production and management packages, agronomic practices, economic and nutritive importance of sesame, post-harvest managements and storage facilities of sesame.

Activity implementation field design

The plots were properly ploughed and made ready for planting ahead of the planting date. Three sesame varieties (the newly released variety, Chalasa, and two standard checks, Obsa and Dicho) were planted on adjacent plots of 10 m x 20 m each. All the necessary recommended agronomic practices were equally applied for all of the plots. For sesame, the spacing of 40 cm between rows was used. The recommended seed rate of 4 kg ha^{-1} was used by drilling in the prepared rows.

Shallow planting of 2-4cm depth was employed in the presence of ample soil moisture. The recommended fertilizer rate of UREA 50 kg ha^{-1} and NPS/DAP 100 kg ha^{-1} was applied. All DAP/NPS was applied at sowing/planting time while 1/3 of UREA was used at sowing and 2/3 at tillering/stem elongation stage of the crop. Every field was supervised at a monthly interval to check the status and to identify gaps. At maturity stage of the crop, participatory variety evaluation platform was arranged that attended by the trial/experimenting farmers, neighboring farmers, researchers from BARC and other stakeholders.

Data collected

Appropriate data collection methods (direct field observation/measurements, focused group discussion, and knowledge test) were employed to collect both qualitative and quantitative data. The types of data collected include yield data, change in level of knowledge and skill of farmers, farmers' perception towards the performance of the technologies, farmers' preferences and their variety selection criteria, total number of farmers participated on extension/promotional events such as training, field visits and field days, and stakeholder's participations and role in technology demonstration and evaluation.

Data analysis

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

Result and Discussion

Participatory variety evaluation and selection

The target beneficiaries of improved agricultural technologies are strongly inclined to their likes and dislikes (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). Thus, a total of 70 participants' from three districts (45 farmers, 12 DAs and supervisors and 9 experts) and 5 researchers were participated on the process at maturity stage of the crop. Thus, at maturity the varieties were evaluated based on the farmers' selection criteria. During the assessment the farmers were assisted to list their own evaluation criteria, which was ordered using pair-wise ranking technique.

First, the evaluators were grouped in to small manageable group (one group had 10 members including one group leader and one secretary). At each district, Kebele and 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. Each variety was evaluated against the criteria ordered based on the weight attached to each parameter. At the end of the evaluation process, result of the evaluation was displayed to the evaluators, and discussion (FGD) was made on the way ahead. The variety/ies selected, accordingly, will be proposed for further pre-scaling up.

Table 1**:** Rank of the varieties based on farmers' selection criteria

Varieties	Rank	Reasons
Obsa	**1st**	Tolerant to disease, very good crop stand, attractive seed color for market, very good in yield, Late maturity, large number of capsules per plant, very good number of branches per plant and relatively seed color is not as good as others (but not totally)
Dicho	**2nd**	Relatively tolerant to disease, medium crop stand, attractive seed color for market, good yield, Late maturity, number of capsules per plant, good in number of branches per plant and good seed color
Chalasa	**3rd**	Relatively tolerant to disease, good crop stand, attractive seed color for market, low yield, early maturity (high shattering character), number of capsules per plant, very good number of branches per plant and attractive seed color

Table 2: Pair wise ranking result to rank variety traits in order of importance

No	Traits	Disease R/T	Yield	Early maturing	No of capsules/plt	No of branches/plt	Seed color
1	Disease tolerance		6	4	4	2	1
2	Overall yield			6	5	2	1
3	Early Maturing				6	2	1
4	Number of caps./ plant					2	1
5	Number of bra./ plant						1
6	Seed Color						

Table 3: Summary of matrix ranking and rank of sesame variety traits

No	Variety Traits	Frequency	Rank
1	Disease Tolerance	5 times	1st
2	Overall yield	4 times	2nd
3	Early maturing	0 time	
4	Number of capsules per plant	2 times	4th
5	Number of branches per plant	1 time	5th
6	Seed Color	3 times	3rd
	Total	15	

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 and site specific varying weather conditions (for instance, ice rain, rainfall intensity i.e. flooding or shortage) The overall harvested mean yield of Obsa, Dicho and Chalasa varieties were 8.5 qt ha $^{-1}$, 8.12 qt ha^{-1} and 7.44 qt ha $^{-1}$, respectively.

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

Yield advantage of Chalasa over Obsa is:

$$\text{Yield advantage \% for Chalasa} = \frac{7.44\text{ qt/ha} - 8.5\text{qt/ha}}{8.5\text{ qt/ha}} \times 100 = -12.47\ \%$$

Yield advantage of Chalasa over Dicho is:

$$\text{Yield advantage \% for Chalasa} = \frac{7.44\text{qt/ha} - 8.12\text{qt/ha}}{8.12\text{ qt/ha}} \times 100 = -8.37\ \%$$

From the above result one can deduce that Chalasa had lower yield advantage which is -12.47 % and -8.37 % than both Obsa and Dicho; respectively.

Technology gap

It is undeniable that a lot of factors contributed to the gap between potential yield of the variety obtained on-station under management of breeder and that obtained during demonstration on farmers' field. Among which, differences in fertility of soil, variability on wider plots, follow up and less frequent supervision of the on-farm trial, varying weather conditions and other factors contributed to this gap.

Technology gap = Potential yield – Demonstration yield

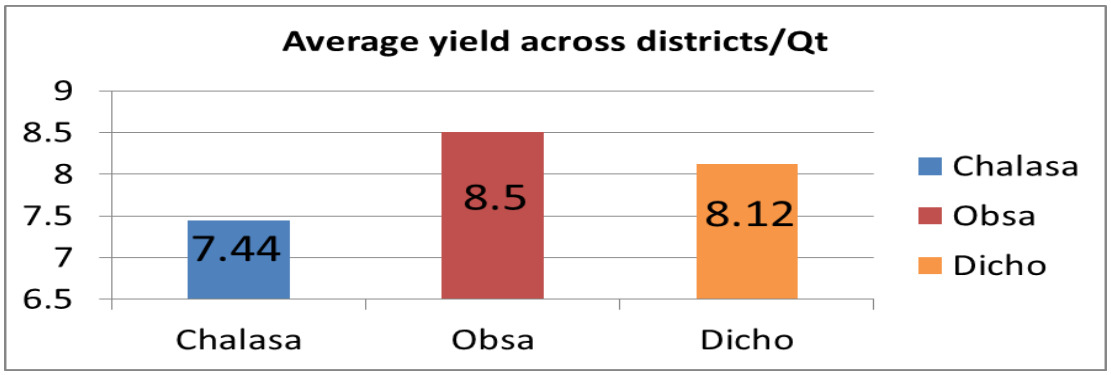
Technology gap for Chalasa = 12.65qt/ha -7.44qt/ha = 5.21 qt/ha

Technology gap for Obsa= 10.96qt/ha - 8.5qt/ha = 2.46 qt/ha

Technology gap for Dicho= 10.63 - 8.12= 2.51 qt/ha

Of the three varieties the lowest gap was observed with Obsa where as the largest gap was observed with Chalasa. This implies that Obsa is nearly as productive as its on-station performance as compared to the other two varieties.

Figure 1: On-farm yield performance of the varieties



Lessons Learned

On-farm demonstration is bidirectional process where farmers and researchers learn from each other. During the study, farmers had first hand observation on the actual performance of sesame varieties. Farmers got familiar with and access to improved sesame technologies demonstrated to them, had better knowledge and/or skill on sesame production and management, got improved sesame variety of their own preference which is adaptable to their local socioeconomic, cultural and ecological circumstances, research team exposed to collective variety evaluation and got feedback for future research work to improve production and productivity of the varieties and linkage among research team, experts, DAs, farmers and other stakeholders were strengthened for dissemination of the technologies.

Conclusion and Recommendations

Based on the evaluators, disease tolerance, number of branches per plant, capsules per plant, capsule length (cm), number of nodes per plant, inter node distance, height of the first branch from the ground, early maturity, seed color and overall yield were the common identified selection criteria across all locations. Of the three varieties the lowest gap was observed with Obsa where as the largest gap was observed with Chalasa. Obsa is nearly as productive as its on-station performance as compared to the other two varieties. In spite of the inevitable variability in performance between and even within locations, yield performance of the

varieties was still promising. Accordingly, the overall harvested mean yield of Obsa, Dicho and Chalasa was 8.5 qt ha^{-1}, 8.12 qt ha^{-1} and 7.44 qt ha^{-1}, respectively. In general, Obsa was selected firstly then followed by Dicho and lastly Chalasa. Technical advice and support to smallholder farmers is highly required to improve sesame production and productivity with the require quantity and quality of market requirement, to be competent at local, national and international market and bring the required impact.

Now days, farmers' group are seen as the smallest unit of the farmers. Hence, establishing and strengthening FRGs/FREGs is one of the extension approaches, which make the farmer to be central to agricultural research, technology promotion and dissemination. Obsa was selected and recommended for pre-scaling up activity on wider plot (at least 0.25ha per trial farmer) for popularization. Strengthening the linkage among stakeholders is paramount to achieve the goal.

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Pre-Extension Demonstration of Animal Drawn Cart through FREG in Selected AGP-II Districts of Bale Zone

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Abstract

In most parts of rural Ethiopia, transportation of goods is carried out women and children who physically carry the goods. The research activity was carried out in two purposively selected AGP-II districts of Bale zone with the objectives of demonstrating and popularizing Asella model animal drawn cart and enhancing linkage between research, extension and farmers in the study area. Based on the topography of the area, Agarfa and Sinana which are appropriate for animal drawn cart were selected purposively and two PAs from each district were selected and total of four FREGs each having twenty member farmers were established based on their willingness and innovativeness. Out of total 71 FREGs members around 34% were females. Practical and theoretical trainings were given to farmers, DAs and district expert on importance of rural transport in general and specifically on Asella model animal drawn cart, how to use and simple maintenances. Training was organized mainly focusing on promotion of technology and awareness creation to farmers and participant stakeholders. All participants in the technology demonstration activities preferred this technology over the traditional way of transporting their agricultural products to different places.

Key word: Animal drawn cart, Demonstration, Popularization, Training.

Introduction

In rural Ethiopia in general and study area in particular the transport operations are carried out by women and children who physically carry the harvested crop and other goods either on their head and shoulder or back. Draft animals such as donkeys, horses, mules and oxen also play a significant role in transporting harvested crops or threshed grains within the farm sites and to/from the rural or urban mills and markets for centuries. Some studies show that the losses caused during on-farm/off-site transporting operation is estimated to be 2-3% due to the extended utilization of old sacks made of goat skin, sisal, plastics or others.

Therefore farmers lack means of transportation to their agricultural produce and farm input from home to field and from farm site to home and usually during market day (Paul Starkey, 1997).

Previously, Asella model animal drawn cart was multiplied and supplied to farmers of Arsi with most parts imported before decades and through time, since there is importation of such parts, the already imported parts were fully consumed and it became difficult to produce/manufacture carts in the center. Series of research activities were conducted to adapt those parts and finally good results were obtained.

Assela research center released/recommended animal drawn cart that has carrying capacity of about 8-15 quintals depending on animal's capacity/power and topography. The newly adapted technology is commonly named as "Asella model lightweight animal drawn cart" (Alemneh, 2012). This technology is supposed to minimize rural resource poor farmers' transportation problem for their agriculture produce and other goods. This technology is widely in use in Arsi zone specially in Doddota, Lode Hetosa, and Hetosa districts and it is on the way to be popularized in other districts while demonstration of the technology is at beginning stage in other zones like Bale (personal observation).

Hence; this study was initiated with the intention to demonstrate and popularize Asella model animal drawn cart in selected AGP-II districts of Bale zone namely Sinana and Agarfa districts.

Objectives

- To demonstrate animal drawn cart to selected AGP-II districts of Bale zone
- To popularize animal drawn cart to selected AGP-II districts of Bale zone
- To enhance linkage between stakeholders like research institutes, extension and farmers

Material and Methods

Materials

Materials needed for the production of animal drawn cart such as timber, wheel, nails and other necessary materials purchased from market in the scheduled/planned time period. Then production of animal drawn cart was done.

Methods

Before introducing these technologies in these areas, quick and simple need assessment type of survey was conducted in these PAs through which rural transportation mechanisms of the areas were identified. Accordingly the main means of transportation in these areas were, back of animal (pack animals), use sledges which are drawn by pair of animals (mostly oxen) and humans back (especially women and children).

To undertake the demonstration and popularization of animal drawn cart, two districts namely Sinana and Agarfa were purposively selected from four AGP-II districts of Bale zone mainly based on their convenience to such technologies which is determined by topography and accessibility. From these districts four peasant associations were randomly. Then, four farmers extension groups (FREGs) having twenty members of farmers composed of male, female and youth were organized in the selected PAs. In this particular activity result demonstration method was employed i.e. the how to use and advantages of the technology over the available options were compared during the demonstration process.

Results and discussions

As it was stated under methodology part of this material, the transportation mechanism being practiced in these areas are incomparable with technologies under consideration for this demonstration purpose as something is better than nothing. Training was the main approach that was used to create awareness about the technology being demonstrated to farmers to capacitate the farmers, DAs and expert knowledge and skill. Multi-disciplinary team from Asella agricultural engineering research center which comprised of socio-economics, agricultural research extensions and engineering researchers have participated to facilitate extension efforts.

Training

Practical and theoretical trainings were given to farmers, DAs and district experts on importance of rural transport in general and specifically on Asella model animal drawn cart, how to use and simple maintenances. Moreover the training was given mainly focusing on promotion of technology and awareness creation in farmers and participant stakeholders. It

also gave due attention to linkage among stakeholders especially the agriculture and natural resource development office, research center and farmers. A total of 71 participants of which 24 (33.8%) female and 47 (66.2%) have participated on the training. The training was given to farmers during pick season (month of December) when there is high need for transportation services as it is time to transport agricultural produces and by-products like straw from farm field to homesteads.

Table 1: Training participants on Asella model animal drawn carts use

Districts	Participants	Male	Female	Total
Sinana	Farmers	18	12	30
	Experts	2	0	2
	DAs	3	0	3
Total		23	12	35
Agarfa	Farmers	19	12	31
	Experts	2	0	2
	DAs	3	0	3
Total		24	12	36
Grand total		47	24	71

Moreover, besides training FREG member farmers on technology use, mass awareness creation activities were conducted in the study districts through organizing mini-field-days for farmers of the respective PAs.

Farmers' perception towards the technology

After theoretical and practical training, farmers were given a cart in a group of twenty and assessment for farmers' comments and suggestion was conducted after a month with pre-developed checklists. The farmers intensively used the carts and became ready for comments and assessments conducted against different attributes like easy of operation, capacity to transport goods, convenience for animals to draw and humans to use, simplicity for simple maintenance and etc.

Accordingly, all the participants in the technology demonstration process preferred this technology over the traditional way of transporting their agricultural produces and by-products and other goods from field to house, from house to nearby market and from market

to house and others. Successive pre-extension demonstration activities and pre-scaling up/popularization and technology transferring activities of the same technology was conducted at Arsi zone since 2013 to 2014 and the same result was obtained in terms of farmers' perception on technology (Tamrat G. *et.al*, 2015).

Conclusion and recommendations

This research was conducted in two purposively selected AGP-II districts of Bale zone namely Sinana and Agarfa because of their appropriateness for the technology that have been demonstrated. To undertake demonstration of this technology two peasant association from each districts were selected and four FREGs of which 24 (33.8%) female and 47 (66.2%) male members were established. To facilitate demonstration process result demonstration method was used.

The technology transports around 600-800kgs of loads which could be transported by 6 to 8 donkeys, mules or horses. Similarly it is possible to transport bundle of un-threshed crops like wheat, barley and sorghum etc.. and un-shelled maize with a single trip of cart which needs up to five to seven pack animals. To transport a bundle of crop on a single pack animal, minimum of three humans are needed while unless it is to save time and ergonomics (work drudgery), a single person can load the whole cart and transport without help/support from others. Therefore by using animal drawn cart for transporting bundles of crop minimum of 4 to 5 pack animals and three human powers can be freed.

As a result all FREG members and other participants preferred animal drawn cart for their transportation purposes over the traditional pack animal back, humans' shoulder and traditional sledges drawn by pair of animals (usually oxen). In addition to their perception on technology's performance simple need assessment was conducted and all of them were willing to purchase the technology and more than 50% of the farmers also submitted application letters to Assela research center. However, there is no multiplied and deliverable technology at the center's stock.

Therefore, successive activities which are pre-scaling/popularization and technology transferring should be followed by the center in the study area. In the long run, this could be

possible through training of potential manufacturers in the area and in the short run the technology can be obtained from Adama, Bishoftu and Finfinne where micro and intermediate enterprises were given enough trainings and full capacity was created to enable them to produce the technology. Hence, concerned extension offices and other interested non-governmental and governmental organization should available the technology in mass supply

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Pre-Extension Demonstration of Milk Churner Technology through FREGs in Selected AGP-II Districts of Arsi Zone

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Abstract

The research activity carried out in two purposively selected AGP-II districts of Arsi zone namely Munessa and Digalu-Tijo with objectives of popularizing plastic milk churner, minimizing women's workload and time consumed to churn milk in traditional way. From these districts four peasant associations were purposively selected from list of peasant associations based on their potential of dairy production. Then, four groups which have twenty members of farmers composed of male, female and youth were organized in the selected peasant associations to undertake demonstration and popularization of plastic milk churner. The training was given to farmers, DAs and districts' dairy experts focusing on how to use the technology, advantages of technology over the traditional ones. A total of 61FREGs member farmers of which around 41% males and 59% females have participated on training and demonstration activities. The use of new technology reduces churning by two-third in relative to traditional one i.e. from 90minutes to 29.5minutes. Moreover, it highly reduces work drudgery and preferred by whole FREG members.

Key words: *Plastic milk churner, demonstration, popularization, FREGs*

Introduction

Arsi zone is known for its huge dairy production and most districts specially located in highland parts like Lemu-Bilbilo, Digalu-Tijo, Munesa etc are commonly named as "the milk sheds". Even though there is some good starts in some dairy cooperatives, the production and processing methods are more of traditional and labor intensive (Bekele and Pillai, 2010).

More of the activities of dairy production are classified as the only job of women's and in addition to their all other duties socially budgeted to women, dairy production especially milk churning is another time taking women's activities in Ethiopia in general and in Arsi specifically. The traditional way of milk churning using clay pot is time consuming, tedious and inconvenient for operation as it needs kneeing behind the pot during churning.

Taking all others and this problem of women's into consideration, JICA in collaboration with Adami –tullu Agricultural Research Center (TARC) and Malkasa Agicultural Research Center (MARC), adopted /developed/ a milk-churner technology which not only make the activity more easiest/simplest for the women but also enable the men to participate in milk-churning activities.

This technology is developed in such a way that it is easily portable and men are able to churn the milk while there are looking after their livestock during morning and evening time around their home compound. The technology was first evaluated at research station and then evaluated with the participation of farmers around Adami Tulu and the result was compared with traditional technology and found to be better for the new technology (Feyisa *et a*l, 2009).

Asella agricultural mechanization research center attempted to adapt this technology. From the result obtained during adaptation it was promising for further demonstration of technology. Even though this technology was available in some government organizations like research center and non-government organization; it was not introduced to farmers of Arsi zone.

Therefore, this study intends to popularize through on-farm participatory demonstration research approach (FREG) in selected districts with the objectives of popularizing JICA type plastic milk churner to farmers in the selected AGP-II districts and contribute to minimize women's workload and time consumed to churn milk in traditional way.

Material and methods

Materials

Materials needed for the production of plastic milk churner such as plastic jar, bronze, round bar and other necessary materials purchased from market in the scheduled/planned time period. Then production of plastic milk churner was done.

Methods

To undertake the demonstration and popularization of plastic milk churner two districts namely Munessa and Digelu-Tijo were purposively selected from four AGP-II districts of Arsi zone based on their accessibility and potentials for dairy production. From these districts four peasant associations (two from each) were again selected purposively based on accessibility and dairy production potential from the list of peasant association. Then, at each PA a group of FREG was established and total of four group which have twenty member farmers each comprised of male, female and youth were organized in the selected peasant associations to undertake demonstration and popularization of plastic milk churner.

Selection of participant farmers

Discussion was held with respective districts' livestock and fishery resources development agency to set criteria for the selection of PAs and participating farmers. Accordingly, selection criteria for the member farmers includes those who owned at least one lactating cow, willing fullness to participate, active and innovative in accepting new technologies and extension processes.

Training

The training was undertaken on JICA type plastic milk churner in two Arsi zone selected AGP-II districts which were Munessa and Digelu-Tijo. A total of 72 participants of which 44 (61.1%) female and 24 (38.9%) male participants have attended the training . The training mainly focuses on promotion of technology and awareness creation among farmers and participant stakeholders. Moreover, the training was given to farmers focusing on how to use the technology, advantages of technology over the traditional ones.

Table 1: Training given to farmers, DAs and districts' dairy experts

Districts	Participants	Male	Female	Total
	Farmers	19	12	31
Munessa	Experts	2	-	2
	DAs	2	1	3
	Farmers	6	24	30
Digelu Tijo	Experts	2	-	2
	DAs	3	1	4

Results and Discussions

Both theoretical and practical trainings were the main approaches that have been used to create awareness about the technology being demonstrated among farmers to capacitate the farmers, DAs and experts' knowledge and skill. Multi-disciplinary team from Asella Agricultural Engineering Research Center which composed of socio-economist, agricultural research extensions and engineers has participated to facilitate extension effort.

In this activity to make comparison of traditional clay pot milk churner and the new technology, assessment was made through interviewing the participating farmers during the training time and on average to churn a five litter of milk it took them up to 1:30 hrs while using the new technology, to churn the same amount of milk, the average time taken was around 30 minutes (one-third of the traditional clay pot).

This shows that using the improved plastic milk churner reduces the time of churning by an hour. The research result at Kofele and Shashamene districts on the same technology also revealed that there was significant difference in time consumption between the traditional clay pots and plastic milk churners with higher time record for the former with amount of 65 minutes and 39 minutes respectively (Fetiya *et.al*, 2014). Previous research results shown that amount of time consumed to churn using the new technology can vary with level of filling the jar, temperature of the area (more cold more time to churn) and etc. Feyisa *et.al*, 2009 recommended that the optimum amount of the milk to be churned should be 2/3 of the total volume of the plastic jar and if it is above this volume the churning time will increase. Therefore, the optimum amount of milk to be churned in a plastic jar of volume 10 litter should be 6.67litters.

Regarding butter yield, continuous assessment was done through personal visit and telephone and the farmers reported that there is no difference between the amount of butter yields between traditional clay pot and that of JICA milk churner. The yield could also be affected by feed type used, and farmers argue that there is better yield difference between breeds.

Farmers' perception towards technology

The most important evaluation criteria for participant farmers were ease of operation (simplicity), convenience to use (reduced/no ergonomics/working drudgery during churning), time reduction, and accessibility of parts. Accordingly, the newly introduced improved plastic milk churner was preferred in terms of all criteria set by the farmers and experts.

Conclusion and Recommendations

This research was conducted in two purposively selected AGP-II districts of Arsi zone namely Munessa and Digelu Tijo because of their appropriateness for the technology being demonstrated in terms of the dairy potential they have. To undertake demonstration of this technology two peasant association from each district were selected and at each PA a FREG having 17 members on average with around 61% female and 39% male was established.

To facilitate demonstration process result demonstration method was used where the technology was availed at each FREG's site and both theoretical and practical trainings were given to FREG member farmers and experts. Participatory type evaluation of the technology was conducted and the improved plastic type milk churner was found to be superior over the traditional clay pot type milk churner in terms of all the criteria set by the participant farmers and experts. Large demand was also created during the demonstration period which shows that there are possibilities of expanding the use this technology. Therefore, it is better to go for the popularization and technology transfer stage by training local micro and intermediate manufacturers around the areas where this research was conducted before this momentum created by the demonstration activity gets stopped.

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Pre-Extension Demonstration of Hay-Box Chicken Brooder through Farmers Research Extension Group in Selected AGP-II Districts of Arsi and West Arsi Zones

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Abstract

The research activity carried out in three purposively selected districts namely Digalu-Tijo from Arsi, Asasa and Adaba from west Arsi zones with objectives of demonstrating and popularizing hay-box chick brooding technology to farmers, and enhancing linkage between research, extension and farmers in the study areas. From these districts six peasant associations were purposively selected based on their accessibility from list of peasant associations. Then, a total of six groups (one at each PA) which have an average of twenty members of farmers composed of male, female and youth were organized to undertake demonstration and popularization of hay-box chick brooder. A total of 92 farmers of which 54.36% were female farmers have attended the training. From each FREG one trial farmer was selected and a brooder having capacity of twenty chicks was given with twenty chicks bought from commercial firms in Bishoftu each including feeds that can serve for three months. Out of the total 121 chicks distributed to farmers only five died and around 96% grown. Mini-field-days where organized to share experiences and knowledge and all the farmers who attended process and result demonstrations understood the double advantages of this technology (reducing number of chicks died because of predator and save time that the broody hens spent to rear chicks) and preferred the technology to rear their chicks.

Key words*: Hay Box Chick Brooder, Demonstration, Popularization, Training*

Introduction

Poultry production is an important economic activity in Ethiopia. Beside its social and cultural benefits it plays a significant role in family nutrition. The country has about 60% of the total chicken population of East Africa (Mekonnen, *et al.*, 1991). Rural small holder farmers keep more than 95% of this population and practice scavenging management conditions. The remaining insignificant proportion comes from the commercial sector.

According to Tadelle and Ogle (2001), more than ninety five percent of the poultry in rural Ethiopia, baby chicks are raised by broody hen, since it is difficult to adopt artificial brooders by household poultry men/women. About 60 % of the chicks hatched in the rural area of

Ethiopia die during the first eight weeks of their life. In rural part of the country, a broody hen raises on average 2.8 chickens and it took her around 81 days to do so after hatching. Sometimes the broody hen may raise zero chicks depending on the maternal instinct of the mother hen and prevalence of predators in the vicinity. The premature chicks may die due to birds prey, pets and some wild animals. on the other hand if the hatched chick are raised by artificial brooder, the broody hen will back to laying of eggs with short period of time and its productivity will increase and moreover, the chicks will be more safer than natural brooding (The Ethiopian Sub-Sector Review 4, 1884; Hoyle, 1992 and CSA, 1985-1996).

Asella agricultural mechanization research center attempted to adapt Hay-box brooding technology, developed at Jimma College of Agriculture. From the result obtained during the adaptation of this technology it seems to hold promise in bridging this gap to some extent. Therefor; this study intends to demonstrate and popularize this technology through establishment of farmer's research and extension groups (FREG) in selected GTP-II districts of Arsi and West Arsi zones with specific objectives of demonstrating and popularizing of hay-box chick brooding technology to farmers in the selected AGP-II districts of Arsi and West Arsi zones

Material and Methods

Materials needed for the production of hay-box chick brooding technology such as timber, mesh wire of different size, nails, sack and other necessary materials purchased from market. Then production of hay-box chick brooding technology was constructed in the wood work workshop. The other material needed was a day-old chick and different stage's poultry feeds and they were obtained from poultry firms and poultry feed processing factories.

To undertake the demonstration and popularization of hay-box chick brooding technology three districts namely Digelu-Tijo from Arsi zone and Gedeb-Asasa and Adaba from west Arsi zone were purposively selected from the given AGP-II districts of two zones based on their accessibility. From these districts six peasant associations were purposively selected from list of peasant association using similar procedure and criteria. In collaboration with districts' agency of livestock and fishery resources development experts and respective PAs' development agents, discussions were held to select willing farmers who are interested on

poultry production and also have some experiences in traditional way of poultry production was selected. Proxy to each other of the households was also considered in order to facilitate group working among group members. Then, six groups each having twenty members of farmers comprised of male, female and youth were organized in the selected peasant associations to undertake demonstration and popularization of hay-box chicken brooding technology. As from the nature of the technology and the enterprise itself, most rural females are working at home and near to poultry productions, and more attention was given to females in selection process of FREG members.

Results and Discussions

Training was the main approach that was used to create awareness about the technology being demonstrated among farmers to capacitate the farmers, DAs and poultry production experts' knowledge and skill. A Multi-disciplinary team of researchers from Asella agricultural engineering research center which composed of socio-economist, agricultural research extensionist and engineers has participated on training the farmers, DAs and experts.

Training

Training given was mainly classified into two parts. First part was on importance and how to use hay-box chicken brooding technology. This training was given by the researchers from Asella agricultural engineering research center. The training given includes raw materials selection in hay-box brooding technology production, importance of the technology compared to traditional hens brooding (advantages over traditional way of rearing chicken/why hay-box brooder), attention to be given while using the technology, and the like.

The second part of the training includes the biological parts and generally it was on importance of poultry production, major determinant factors and cares to be taken while dealing with poultry, disease management, how to feed poultry and etc. this part of the training was given by the poultry experts from the respective districts. A total of 108 participants of which about 48% female and about 52% males have attended the training successfully. The training mainly focuses on promotion of technology and awareness creation among farmers and participant stakeholders. After training, all the six FREGs were provided with a brooder having capacity of twenty chicks and twenty chicks along their feeds which

could serve for three months. Out of the total 121 chicks distributed to farmers around 96% (116) chicks have survived and grown to full stage (layers stage).

Table 1: Training given for farmers, DAs and districts experts

Districts	Participants	Male	Female	Total
Digelu Tijo	Farmers	15	17	32
	Experts	3	-	3
	DAs	2	-	2
Gedeb Asasa	Farmers	15	15	30
	Experts	3	-	3
	DAs	1	1	2
Adaba	Farmers	12	18	30
	Experts	4	-	4
	DAs	1	1	2

Farmers' perception towards technology

All participants in the technology demonstration process prefer this technology over the traditional way of rearing their poultry and show their interest to have this technology for their future poultry production.

Conclusion and Recommendations

This research was conducted in three purposively selected AGP-II districts of Arsi and west Arsi zones namely Digelu-Tijo, Gedeb-Asasa and Adaba because of their appropriateness for the technology being demonstrated. To undertake demonstration of this technology two peasant association from each districts were selected and six FREG of which 56 (57.1%) were female and about 47 (42.9%) of them were male were established. To facilitate demonstration process both process and result demonstration methods were used.

All FREG members and other participants prefer hay-box chick brooding technology for their future poultry production purpose. Therefore, further promotion and popularization and wider multiplication and dissemination of the technology has to the next plan of the center and the livestock and fishery resources development agency. Furthermore, pre-scaling up the technology has to be planned and local manufacturers shall be trained to make the technology available near to the farmers. Moreover, this technology can be considered in plan of the government for unemployment reduction in the country.

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Pre-Extension Demonstration of Soil Test Based Crop Response Phosphorus Recommendation on Maize at Bedele District, Western Oromia

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Abstract

On-farm demonstration of soil test based crop response calibrated phosphorus was conducted at Bedele district, Buno-Bedele Zone of Oromia, during the main cropping seasons of 2016. The aims of the study was to demonstrate P-critical value and P- requirement factor for Phosphorus recommendation of improved maize (BH-661) variety for the district. The results of the study revealed that the soil reaction pH (H_2O) were strongly acidic ranged from ***4.29 to 5.20****, very low available P ranged from 0.137 to 4.306 ppm. Nitrogen fertilizer 92 kg N $ha^{-1}$was selected as N fertilizer recommended for the area. The study also showed that P-critical value (6 ppm) and P- requirement factor (23.55) were determined for phosphorus recommended for the area. Economic analysis was performed to compare treatments advantages. The validity of critical value and economic evaluation showed that STBCRPR would yield 2.23 Ethiopian birr for every birr invested. Thus, farmers in the Bedele area might be advised to use soil test based crop response phosphorus recommendation to increase the productivity of maize.*

Keywords*: Pre-extension, demonstration, soil, Phosphorus, recommendation, Maize*

Introduction

Maize (*Zea mays* L.) is an important cereal crop, which ranks third after wheat and rice, based on area and production in the world with total areas exceeding 160 million hectare (FAO. 2010). It is the second important food crop in Ethiopia, which occupied 20% of total cereal land next to teff, which occupies 30%, followed by sorghum (18%), wheat (16%), and barley (12%) (Diao, 2010). In Ethiopia, maize is first in productivity and second in area coverage after *teff* (CSA. 2010). Research results in high potential maize growing areas are in average 7000-8000 kg ha^{-1}. However, yield levels obtained by small scale farmers remained stagnant despite the availability of improved varieties (Benti, 1993).

Low soil fertility is one among the major factors limiting maize production and productivity in western Oromia, Ethiopia (Wakene *et al*., 2005). In most of maize producing areas in the world, inorganic fertilizers are relied upon to improve crop yields and maintain soil fertility. Insufficient uses of fertilizers result in severe nutrient depletion of soils.

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 are no site-specific fertilizer recommendations for the different soil-crop climatic conditions. Bedele district was selected for pre-extension demonstration of soil test based crop response phosphorus recommendation. The research activity was conducted with the objective to evaluate and create awareness on Phosphorus critical value and Phosphorus requirement factor for maize based on soil test crop response; with this experiment optimum level of Nitrogen, Pc (phosphorus critical level), Pf (phosphorus requirement factor) and verification trial were completed.

Pre extension demonstration activity was conducted before further popularization in order to evaluate and create awareness in the community. Therefore, the objectives of this research activity were: to evaluate soil test based crop response calibrated Phosphorus recommendation on maize under farmers' management and to create awareness on site specific crop response fertilizer recommendation

Materials and methods

The research was carried out on farmers' fields in Bedele district. Four PAs per district were selected based on their willingness, initial soil test value and purposively from previous verification trials had been under taken. One FREG per PA and ten host/test farmers per district were organized. More over under each FREG 15 farmers among which (40%) female farmers were organized through FREG and trained. A total of ten sites (host/test farmers) were selected.

Continuous and intensive training and meetings were conducted with FREG members, development agents (DA), and other stake holders. Field day was conducted with FREG members, other farmers, development agents and other stake holders in the district. 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. Maize variety (BH 661)

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 field day and 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 phosphorus

The pH (H_2O) of the soil samples collected before planting were ranged from (4.29 to 5.20) (Table 1). Accordingly, the soils were strongly acidic in reaction (FAO, 2008). Continuous cultivation and long-term application of inorganic fertilizers lower soil pH and aggravate the losses of basic cations from highly weathered soils (Mokwunye *et al*., 1996). The result showed that soil pH affects maize production which is less than the maize requirement proposed (FAO, 2006). Available Phosphorus (Olsen method) collected before planting were ranged from (0.137 to 4.306) 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 results reported by (Mesfin, 1998; Yihenew, 2002; Dagne, 2016) who reported that the Ethiopian agricultural soils particularly the Nitisols 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, pH and EC) before planting at Bedele district in 2016 cropping season

Sites	Ava.P (ppm)	pH(H_2O)	E.C mm hos/cm
Site 1	3.137	4.54	0.073
Site 2	3.250	4.70	0.072
Site 3	0.137	4.29	0.021
Site 4	2.793	4.62	0.041
Site 5	3.075	4.78	0.046
Site 6	3.672	4.70	0.032
Site 7	2.963	4.70	0.038
Site 8	2.844	4.30	0.042
Site 9	4.306	5.20	0.076
Site 10	4.011	5.01	0.058

Ava.p= available p, E.C= electric conductivity

Maize grain yield at Bedele district

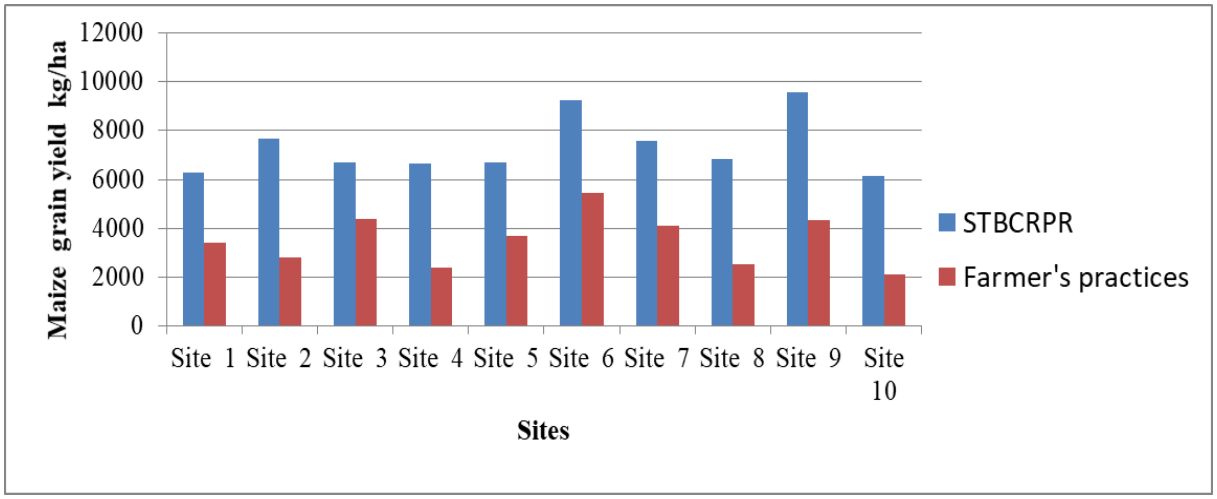
The maximum maize grain yield (9570 kg ha^{-1}) was recorded from the application of STBCRPR (soil test based crop response phosphorus recommendation whereas the lowest (2100 kg ha^{-1}), was recorded from the control plot (Table 2). STBCRPR is maximum in all sites, it ranged from 6150 to 9570 kg/ha, while farmer's practices ranged from 2100 to 5460 kg/ha.

Table 2: Maize grain yield at Bedele district in 2016 cropping season

Sites	STBCRPR (kg/ha)	Farmer practices (kg/ha)
Site 1	6260	3400
Site 2	7670	2800
Site 3	6710	4370
Site 4	6660	2400
Site 5	6700	3660
Site 6	9270	5460
Site 7	7600	4100
Site 8	6840	2520
Site 9	9570	4320
Site 10	6150	2100

STBCRPR=soil test based crop response phosphorus recommendation

Graph 1: Graphical representation of maize grain yield at Bedele district in 2016 cropping season



Training was given to FREG members, DA and woreda experts; moreover field day was conducted for the woreda's community including stack holders in the district.

Conclusion and Recommendation

The study revealed that, STBCRPR is superior to both farmers' practices and control, Hence STBCRPR is selected for the recommendation on maize at Bedele district. Therefore awareness should be created for farmers through demonstration.

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Pre-extension Demonstration of Soil Test Based Crop Response Phosphorus Recommendation on Teff at Chora District, Western Oromia,

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Abstract

On-farm demonstration of soil test based crop response calibrated phosphorus was conducted at Chora district, Buno Bedele Zone of Oromia, during the main cropping seasons of 2016. The aim of the study was to demonstrate P-critical value and P- requirement factor for Phosphorus recommendation of improved teff, Kuncho variety for the district. The results of the study revealed that the soil reaction pH (H_2O) were strongly acidic ranged from 4.20 to 4.71, Very low available P from 0.530 to 1.649 ppm. Nitrogen fertilizer 46 kg N $ha^{-1}$was selected as N fertilizer recommended for the area. The study also showed that P-critical value (4 ppm) and P- requirement factor (11.71) were determined for phosphorus recommended for the area. Economic analysis was performed to compare treatments advantages. The validity of critical value and economic evaluation showed that STBCRPR would yield 1.37 Ethiopian birr for every birr invested. Thus, farmers in the Chora area might be advised to use soil test based crop response phosphorus recommendation to increase the productivity of teff

Keywords: *Pre-extension, demonstration, soil, Phosphorus, recommendation, Teff*

Introduction

Teff [*Eragrostistef* (Zucc.) Trotter] is an annual C4 grass that belongs to the family *Poaceae* (Kebede *et al*., 1989).It is an indigenous cereal crop in Ethiopia. Ethiopia is the origin and the first domesticator of this unique crop (Vavilov, 1951).The straw of teff is used as a very important source of animal feed, especially during the dry season (Seyfu, 1997). Highland soils of Ethiopia indicated that phosphorus is potentially limiting element in crop production (Desta, 1982; Tekalign and Haque, 1987).

Soil test based fertilizer recommendation plays a vital role in ensuring balanced nutrition to crops. It is widely believed that economic and optimum fertilizer application can only be achieved by developing appropriate fertilizer recommendation that takes into consideration the nutrient status of a specific field. Currently there are no site-specific fertilizer recommendations for the different soil-crop climatic conditions.

Chora district was selected for pre-extension demonstration of soil test based crop response phosphorus recommendation. Research activity was carried out with the objective to evaluate and create awareness on Phosphorus critical value and Phosphorus requirement factor for Teff based on soil test crop response; with this experiment optimum level of Nitrogen, Pc (phosphorus critical level), Pf (phosphorus requirement factor) and verification trial were completed.

Pre extension demonstration activity was conducted before further popularization in order to evaluate and create awareness in the community. Therefore the objectives of this research activity were: 1) to evaluate soil test based crop response calibrated Phosphorus recommendation on Teff, 2) to create awareness on site specific crop response fertilizer recommendation

Materials and methods

The research activity was conducted on farmers' fields at Chora district. Three PAs per district were selected based on their willingness, initial soil test value and purposively from previous verification trials had been under taken. One FREG per PA and six host/test farmers per district were organized. More over under each FREG 15 farmers among which (40%) female farmers were organized through FREG and trained. A total of six sites (host/test farmers) were selected.

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 (Kuncho) 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 svailable Phosphorus

The pH (H_2O) of the soil samples collected before planting was ranged from (**4.20 to 4.71**) (Table 1). Accordingly, the soils were strongly acidic in reaction (FAO, 2008). Continuous cultivation and long-term application of inorganic fertilizers lower soil pH and aggravate the losses of basic cations from highly weathered soils (Mokwunye *et al*. 1996). The result showed that soil pH affects Teff production which is less than the Teff requirement proposed (FAO, 2006).

Available Phosphorus (Olsen method) collected before planting were ranged from (0.530 to 1.649) 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 results reported by (Mesfin, 1998; Yihenew, 2002; Dagne, 2016) who reported that the Ethiopian agricultural soils particularly the Nitisols 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, pH and EC) before planting at Chora district in 2016 cropping season

Sites	Ava.P (ppm)	pH (H_2O)	E C mmhos/cm
Site 1	0.689	4.38	0.033
Site 2	1.649	4.42	0.047
Site 3	0.958	4.26	0.065
Site 4	0.788	4.71	0.038
Site 5	0.958	4.20	0.063
Site 6	0.530	4.20	0.024

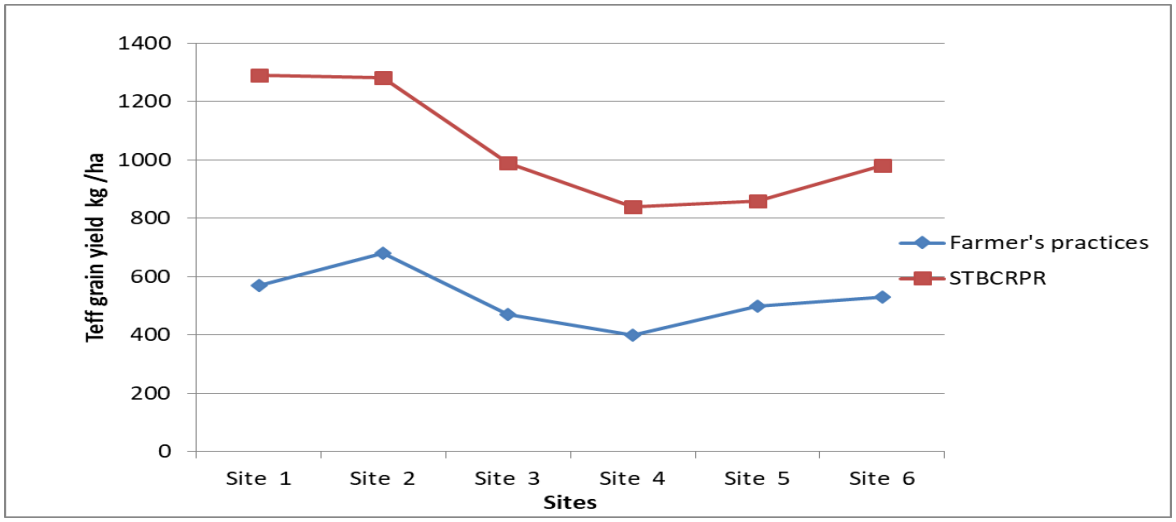
Teff grain yield at Chora district

The maximum Teff grain yield (1290 kg ha^{-1}) was recorded from the application of STBCRPR (soil test based crop response phosphorus recommendation whereas the lowest (400 kg ha^{-1}), was recorded from the control plot (Table 2). STBCRPR is maximum in all sites, it ranged from 840 to 1290 kg/ha, while farmer's practices ranged from 400 to 680 kg/ha.

Table 2: Teff grain yield at Chora district in 2016 cropping season

Sites	Farmer's practices Yield /ha (kg)	STBCRPR Yield /ha (kg)
Site 1	570.00	1290.00
Site 2	680.00	1280.00
Site 3	470.00	990.00
Site 4	400.00	840.00
Site 5	500.00	860.00
Site 6	530.00	980.00

STBCRPR = soil test based crop response phosphorus recommendation,



Graph 1: Graphical representation of teff yield at Chora district in 2016 cropping season

Field day and awareness creation in the community

Training was given to FREG members, DA and woreda experts; moreover field day was conducted for the woreda's community including stakeholders in the district.

Conclusion and recommendation

STBCRPR was superior to both farmer' 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 Recommendation on Teff Crop In Girar Jarso District of North Shewa Zone, Oromia.

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Abstract

*Pre-extension demonstration of soil test based crop response phosphorous calibration was carried out in Girar-Jarso District on Teff crop during the main cropping season of 2016 with the objectives of evaluating the response of teff to different rates of phosphorus fertilizer, creating awareness on soil test based crop response phosphorus recommendation on teff and to improve farmers knowledge and skill of application of the technology. A total of 18 P and N treatments combinations with two k-satellite were used as treatments. The trial was laid down in a completely randomized block design (RCBD) in two replications on plot size 8 m by 5m. Fertilizer rate application findings (18-Pi)*3.04) was developed for Girar-Jarso Districts in 2016. Using this equation, verification trial was conducted on farmer's field of land unit 10m by 10m in the same district with the objectives to verify research finding obtained from P-fertilizer calibration study on teff crop and to provide site specific soil test based P-fertilizer recommendation in 2015. Soil test based P calibration result, farmers' practice in the area and the control were the treatments used during pre-extension demonstration. The trial was laid out in RCBD considering farmers as replications. Analysis of variance indicated that there was highly significant difference ($P<0.001$) and ($P<0.05$) for the treatments tested as fertilizer rates for the Girar-Jarso district. The highest mean grain yield (1802 kg ha^{-1}) was recorded with soil test based P calibration result (STBPCR) which was not significantly higher than farmer's practice (1638 kg ha^{-1}) and followed by the control for Girar-Jarso district. MRR ranges from 199% in farmer practice to 471% in STBPCR for Giras-Jarso district. Therefore, it is concluded that for obtaining aimed yield target and profit with sustenance of soil fertility, test based fertilizer recommendation is economically feasible for tef production in the study area.*

Keywords: *Pre-extension Demonstration,* soil test based fertilizer recommendation

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).

According to CSA (2014/15), teff covers cultivated land of 3.02 million hectares with average average yield of 1.58t ha^{-1}. From the above figure, one can conclude that there is low tef yield in Ethiopia. The low yield is mainly due to the 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). Hence, in order to step up the productivity of tef, soil test based crop response fertilization is essential.

Soil test based fertilizer recommendation plays a vital role in ensuring balanced nutrition to crops. Therefore, fertilizer application schedules should be based on the magnitude of crop response to applied nutrients at different soil fertility levels (Santhi *et al*., 2002). As in all other regions of the country, fertilizer recommendations are not based on soil test results in Girar-Jarso district. Hence, this research was conducted in Girar-Jarso districts of North Shewa Zone of Oromia with the following objectives

- To evaluate the response of tef to different rates of phosphorus fertilizer
- To evaluate the productivity and profitability of the technology under farmer's management.
- To create awareness on soil test based fertilizer recommendation.

Materials and Methods

Soil test based crop response fertilizer recommendation studies was conducted in Girar-Jarso districts of North Shewa Zone Oromia on tef crop during 2014, 2015 and 2016 main cropping season respectively. These field experiments studies were under taken in three different phases viz: Soil test based crop response Phosphorus calibration study; Verification of soil test based crop response phosphorus recommendation study; and demonstration of soil test

based phosphorus recommendation study in which the last year activity was funded by AGP-II program.

Description of the study areas

Girar-Jarso has an altitude range from 2400-2700m a.s.l, and longitude of 38.60968-38.87360 ^{0}E and 9.98302-9.64783 ^{0}N. Annual rain fall is800-1200mm and the temperature range of 15-22 ^{0}C and the soil is pellic vertisol.

Experimental and design

The experiment was conducted on improved teff variety '*Kuncho'* and local variety '*Bora'* in four treatments at Girar-Jarso district in 2016 on five farmers' field with 10 m x 10 m experimental plot size for each treatment considering farmers as replication.

Experimental procedure

To select the experimental site, 26 soil samples were collected from different farmers of the district following the standard procedures. Soil chemical analysis was done for available phosphorus, and then five (5) farmers' fields with initial phosphorus concentration categories below critical p-concentration for the district were selected. Then Phosphorus fertilizer rate was calculated by using the formula given below.

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

Where; Pc- critical phosphorus 18ppm for Girar-Jarso; Pi-Initial available Phosphorus; Pf-phosphorus requirement factor 3.04 for the District.

Training

Training was arranged for farmer's, agricultural experts and DA's with the aim of creating awareness on the soil test based fertilizer application technology and improve farmer's knowledge and skill on technology application. The trained farmer's was selected based on the criteria of their willingness to attain the training and attitude to promotes the knowledge they have get to other farmer's community in vast.

Results and Discussions

Pre-extension demonstration of soil test based phosphorus recommendation

The finding of soil test based crop response phosphorus calibration study was demonstrated along with farmer practice and the control on farmers' holding. The improved teff variety (Kuncho) and local teff variety (Bora) was used as a test crop. The result indicated that the soil test based phosphorus recommendation on improved teff variety performed the best followed by local teff variety and the lowest was observed under farmers' practice.

Mini-field day and Training

Mini-field day was prepared for farmers, DA'S, agricultural experts and others farmer's closest to the experimental field. Training was provided for farmers, development agents, experts from zone and districts on soil fertility, crop production and soil test based fertilizer recommendation for 38 men and 12 female farmer's,5 DA's as well as 1 men and 1 female agricultural experts from zone and district total of 57 participants attended the training and mini field day.

In addition, field visit was arranged to observe experimental site, participants observed different experimental site and appreciate performance of technologies. Participants reflect their feedback during the field visit conducted as the fertilizer application based on soil test promotes increased and efficient use of fertilizer for improving teff production in the future, and they request technical support to be befitted from technologies.

Partial budget analysis for Girar-jarso district

To estimate the economical impact of the different fertilizer rates, partial budget analysis (CIMMYT,1988) was employed to calculate the Marginal rate of return(MRR). Partial budget analysis was done to identify economically feasible fertilizer recommendation rate between farmers' practice and soil test based fertilizer rates.

Table: 1 Partial Budget Analysis for teff crop in Girar Jarso district 2016(2008/09).

Fertilizer rate	Variable Input ($Kgha^{-1}$)	Unit price DAP/Kg(ETB)	TVC	Output($Kgha^{-1}$)	Unit price(ETB)	Gross Income	Net Income	MRR(%)
Control (Without fertilizer)	0.00	14.5	0	424.44	22	9337.68	9337.68	-
Farmers practice/blanket re.	100	14.5	1450	744.44	22	16377.68	14927.68	385.5172
Soil test based+ improved variety(Kuncho)	139	14.5	2015.5	893.33	22	19653.26	17637.76	411.8125
Soil test based+ local variety(Bora)	139	14.5	2015.5	1035.56	20	20711.2	18695.7	464.3027

Farm gate price of 22/20 ETB (Ethiopian Birr) per kg of teff as well as 14.5 and 10.4 ETB per kg of DAP and Urea respectively were used (Table 1). This is the actual unit prices during the year 2016(2008/2009) harvesting season (personal observation). The marginal rate of return were found to be 385.5% in farmers practice/blanket recommended rate, 412% in soil test based+ improved variety (Kuncho) and 464.3% in soil test based+ local variety (Bora) as indicated in Table1. MRR indicate that soil test based+local teff variety(Bora) is more economical which followed by soil test based+Improved teff variety(kuncho) and as a last option farmer's can use blanket recommendation of fertilizers.

Conclusion and Recommendation

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 information how much fertilizer to apply on different fertility status of the soils for each crop. Therefore, this research activity was carried out in Girar-Jarso district of North Shewa Zone of Oromia to address the need for fertilizer rates that are specific to the district, tef crop and for the major soil of the district. This research report compiles results from pre-extension demonstration of soil test based crop response Phosphorous calibration study on farm conditions. Based on the results reported in these findings, the following conclusions and recommendation are made:

Promising results were found from the current research so that to step up the work in other districts on major crops for developing a system for soil test based fertilizer recommendation, sufficient soil and crop information is very essential. Although, there is no significant

difference between farmers' practice and soil test based fertilizer recommendation on grain yield of tef, partial budget analysis indicated that soil test based fertilizer recommendation is economically feasible for tef production in the district. The critical available phosphorus concentration is found to be (18 ppm) for Girar-Jarso districts by Olsen Method. The P-requirement factors for major soil of Girar-Jarso districts have been established to be 3.04 by Olsen Method.

The established P-requirement factor and the Critical P concentration in conjunction with soil P-value can be applied to give site specific P fertilizer recommendation for tef in Girar-Jarso district. So, fertilizer application based on soil test promotes increased and efficient use of fertilizer for improving agricultural production. Therefore, it is concluded that for obtaining aimed yield target and profit with sustenance of soil fertility test based fertilizer recommendation is economically feasible for tef production in the district.

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Guideline for Crop Research Technology Demonstration

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Lists of abbreviations and acronyms

ADPLAC: Agricultural development partners linkage advisory council

ANOVA: Analysis of variance

DA: Development agent

FAO: Food and agriculture organization

FREG: Farmers' research and extension group

FRG: Farmers' research group

FTC: Farmers training center

GO: Government organization

IP: Innovation platform

NGO: Non-governmental organizations

PRA: participatory rural appraisal

PVES: Participatory variety evaluation and selection

SMS: Subject matter specialist

Glossary of terms and meanings

The working definitions of key terminologies are provided below.

- *Demonstration*: As an extension method, it can be defined as a method of showcasing the performance of improved technologies in actual conditions. It is a widely accepted extension method for creating awareness about a technology and raising demands by farmers for impact.
- *Farmers' research group (FRG) approach*: One of the research approaches, in which a group of farmers, extension workers and a multidisciplinary research team jointly participate in agricultural technology generation, verification, and improvement so as to meet farmers' needs and improve farmers' production and management practices.

- *Improved agricultural technologies*: improved varieties, practices, processes, methods, approaches and any other innovations generated by the research system.
- *Innovation:* Ways of doing something referring to changes in thinking, products, processes and/or organization perceived as new at least by some segment of a society.
- *Innovation plat form:* Innovation platforms are ways or forums to bring together different stakeholders whose role is crucial for effective implementation of technology transfer and popularization.
- *Pre-extension demonstration*: It can be conceived both as an entry point for show casing improved agricultural technologies and best practices via establishing demo plots under different agro-ecologies and farming systems.
- *Recommendation domain:* A specific group of farmers and geographical area with similar characteristics and to which the same technology/solution fits.

Introduction

Realizing the key role that it plays, the agricultural technology transfer program has nowadays received considerable attention of the agricultural research system of the country in general and the regional research institutes in particular. The program aims at promoting improved agricultural technologies, training of farmers and frontline extension workers and facilitating linkage between research, extension and end-users so as to enhance technology dissemination and uptake. Pre-extension demonstration of newly released/recommended of improved agricultural technologies is one of the major components of the agricultural technology transfer program.

In Oromia agricultural research institute, the research center based research-extension divisions/departments now called agricultural extension research teams have been conducting various technology transfer activities particularly pre-extension demonstrations to create awareness and demand and also to evaluate the technology under farmers' circumstances. Several improved agricultural technologies have been demonstrated in different agro-ecologies of the region. However, a close look at to the overall performance of the work indicates that there have been certain deficiencies in the achievements and quality of the

outputs, mainly due to lack of standard research methodologies and procedures for designing and implementing pre-extension demonstration activities.

This crop technology demonstration guide is therefore developed to fill the gaps related to planning, execution, data collection, data analysis and reporting of crop technology demonstration activities. The guideline is believed to provide certain guidance especially to junior researchers in designing research project proposals with clear objectives and methodologies, collect relevant data, analyze and present research results.

Purpose of developing the guideline

The guideline is prepared mainly to provide guidance to young agricultural extension researchers on how to develop quality research project proposals, collect and analyze data and present results. It is developed basically to address some of the key shortcomings witnessed in developing research project proposals, designing trials, collecting and analyzing data, writing scientific report and sharing research results to users.

Key guiding principles

Empowerment of end users: Farmers, pastoralists and agro-pastoralists are the ultimate users of on-farm demonstration activities. Hence, there is a need to engage them in the whole process of technology demonstration starting from problem identification to impact assessment.

Agro-ecology based intervention: Technology demonstration interventions should take into account resource bases, priorities and system interactions specific agro-ecologies.

Market oriented production: Technology demonstration activities need to give prime focus and priority for commodities that have high economic and social importance.

Multidisciplinary team approach: Technology demonstration activities need to be conducted by multidisciplinary team of researchers.

Multi-Stakeholders engagement: All relevant stakeholders should take their defined role and responsibilities and execute their role as desired

Innovativeness: Innovative approach is key to effectively implement technology demonstration activities

Value chain approach: Value chain approach is a holistic and widely used approach to address the whole range problems in agricultural production, processing, marketing and consumption.

Emphasis to crosscutting issues: These days, crosscutting issues such gender, nutrition and climate change are an important component of any research and development interventions.

Scientific Quality and standard: Every steps, procedures, and documentation of the research processes and results need to meet and be governed by scientific merits. In every steps technology demonstration activities scientific quality standards should not be compromised. Results obtained need to be analyzed and reported to contribute to scientific stock of knowledge.

Design and implementation of Pre-extension Demonstrations

Working definition and concepts of Pre-extension demonstration

The term pre-extension demonstration is coined from the common term 'demonstration' which is defined as a way of disseminating useful agricultural technologies through illustrating the importance and application of agricultural technologies to farmers . Pre-extension demonstration, as the term implies, is a kind of demonstration conducted by the research system before wider scale demonstration to create awareness and demand for the technology and also to evaluate the biophysical performance and economic and social feasibility of technologies under farmers' conditions. Pre-extension demonstration has some aspects of evaluation embedded in it.

Pre-extension demonstration is the technology transfer phase/step where the research-extension team of the research centers introduces the newly released variety to farmers and extension workers within the recommendation domain of the technology. Such linkage apparently takes place on the farm and can also serve to provide feedback to the researchers for further research endeavors. It is more of farmer managed as compared to earlier research/technology development trials although there are inputs from researchers as well.

The motive behind carrying out pre-extension demonstration trials is to show the peculiarity and superiority of the new technology/research output over the one being used by farmers and for collecting researchable issues and feedbacks for future technology development/improvement. In pre-extension demonstration, the experiments/technologies are evaluated using criteria that are important to farmers, and the results are used to make recommendations.

Purpose of pre-extension demonstration

As indicated earlier, pre-extension demonstration is the type of demonstration that is undertaken by the research institutions before handing over the technology to extension for wider dissemination. Such activity, on top of exposing farmers and other stakeholders to the new technologies, has the following specific objectives:

- Create awareness on the new technologies or practices
- Evaluate yield performance and socio- economic compatibility of the new technology under farmers' conditions
- Enhance farmers' knowledge and skill of application of the new technology or practice
- Assess farmers' and other stakeholders' feedbacks for further technology development/improvement

Types of demonstrations

Demonstrations typically fall into two categories: result or method demonstration. However, the distinctions between the two types are not always clear, since many demonstrations incorporate aspects of both methods (John, 1997). In general, the purpose for which the demonstration is conceived, executed, and carried through is the real test of its classification.

Result demonstration

Result demonstration is used to compare results of new practice or package of practices with traditional one. It compares only few and most often only two practices without replication on

the same farmers plot. Result demonstration is usually carried out with the understanding that the improved technologies are worth investing as compared to the farmers' ones.

In a result demonstration, the producer is asked to accept nothing until results are available for consideration. A result demonstration must cover a substantial period of time, include records of results and comparisons, and be conducted by a farmer under the direction of researcher and Extension agents.

Method demonstration

Method demonstration refers to situations where techniques are shown to farmers who are already convinced to use them. This could be like methods of fertilizer application, how to use farm implements, etc. The crucial point in this kind of demonstration is that farmers have to be convinced first about the innovation and be keen to learn the techniques of how to go about it. The method demonstration assumes the acceptance of a practice and focuses on teaching how to apply the technology/practice. In method demonstration, the purpose is to show how to complete a task.

Research approach

Pre-extension demonstration follows participatory research approaches such as farmers' research group (FRGs) and innovation platforms (IPs) approaches. Farmers' research groups are voluntarily established groups to take part in joint problem identification, trial designing, execution and monitoring and evaluation. An innovation platform is a forum that brings together different stakeholders (e.g. farmers, researchers, extension/advisory services, private sector or agribusinesses such as processors, traders and transporters, policy makers and civil society organisations) in agriculture to handle critical development challenges or opportunities, based on mutual interest, comparative advantage and synergies, and institutional commitments (Buruchara *et al*,2013). It comprises stakeholders and/or collaborators of diverse social and economic actors and the institutions that govern their behaviour, all working towards a common objective. Innovation plat forms are established at district levels to address production constraints along the commodity value chain. Farmers'

research groups are established at village level to conduct research on their fields and can be represented in innovation platform established at district level.

For how long should we conduct pre-extension demonstration: Duration?

Demonstration may take one season or more depending on the type of demonstration and nature of the crop. For instance, variety demonstration can be completed in one season or one year whereas fertilizer demonstration may take two seasons/years. However, cropping pattern and perennial crops demonstration may require three or more years.

Key Steps in Conducting Pre-Extension Demonstrations

The process of conducting pre-extension demonstrations consists of the following steps.

Identifying production constraints and farmers' technology needs

As indicated in earlier sections, pre-extension demonstration activities should focus on farmers' real problems and priorities. In other words, the technology to be demonstrated should ultimately be a kind of technology addressing certain production constraints. Thus, to conduct problem oriented pre-extension demonstration activity, those problems should first be well known. This can be done through conducting PRA studies and reviewing previous survey results. Formal or informal requests from farmers' organizations or relevant public institutions in charge of providing services to farmers and stakeholder forums such as ADPLAC can also be used as a base to conduct on-farm demonstration. In any case, however, it is important to get the real problem to be solved to clearly justify the need to undertake pre-extension demonstration activities.

Selecting technology to be demonstrated

Select only proven technologies which have higher potentialities in terms of yield, disease resistance, quality, and can fit in the existing farming systems and situations of the area/farmers. Be sure that the technology selected for demonstration is much superior to the technology already in use. The technologies to be demonstrated to farmers could be a single

technology/practice, package of technologies or composite/integrated technologies. However, it is usually preferable to demonstrate package of technologies or composite/integrated technologies as their effect is higher than a single technology or practice.

Selecting demonstration sites

Demonstration can be conducted on individual farmers' fields or clustered farms. Clustered farm or block demonstrations present strong visual impact and involve working with a group of 10 to 15 farmers. The size of cluster in this case could be 2 to 5 hectares.

In general, one has to consider the following while selecting demonstration sites.

- Locate the demonstration in an area accessible to farmers who need its information
- Select appropriate and representative sites
- Consider FTCs as one location for demonstration as most of FTCs are located in central place accessible to majority of villagers. Use of FTCs is also useful for establishing functional linkage at grass root level with development agents.
- Use Clustering approach to conduct pre-extension demonstrations in geographically clustered farms. This would help to clearly show impact of improved agricultural technologies in a focused area. The size of cluster could be 2 to 4 hectares.

Selecting participant farmers

In general, one has to consider the following in selecting participant farmers:

- **Select volunteer farmers:** Farmers who are volunteer are more likely to be enthusiastic and successful in their activity
- **Representativeness**: Demonstrations work best when the farmer is representative of the farmers you are trying to reach.
- **Gender consideration:** Make sure that women and youth are well considered in selection of participant farmers. The women and youth should constitute at least 30% of the participants of pre-extension demonstration.

When there is a need to use group approach, it is quite important to organize the selected farmers into FRG/FREG groups. The size of FRGs/FREGs could vary depending on the type of technology and other local circumstances. However, a group of smaller size (15-20

members) is usually recommendable for ease of management and to ensure effective group interaction.

Treatment selection and plot design

Treatment lay out: As opposed to a complex experimental research which involves large number treatments and replications, pre-extension demonstration trials involve few numbers of treatments and of course reasonable number of replications. In most cases, pre-extension demonstration consists of two treatments, the new technology and the standard/local check. The treatments are set side by side to easily observe the differences between treatments. The treatments to be compared should vary enough to detect differences visually and/ or by measuring yield.

Treatments	1	2

Example of demonstration plot lay out with two treatments

Treatment 1: Improved variety A with all its agronomic practices

Treatment 2: Improved variety under production (standard check)

Number of demonstration plots: Whether to replicate demonstrations or not usually depends on the purpose for which demonstration is conducted. If the purpose for establishing demonstration plots is simply a visual observation of differences between two or more treatments, it may not be necessary to replicate treatments. Replication becomes important when we want to collect meaningful measurements of the differences between treatments. As pre-extension demonstrations are intended to statistically compare the differences between treatments and at the same time to create sufficient awareness and demand, it is advisable to have 3 to 4 replications (individual farmers' fields) per demo sites. However, there should be more numbers of representative demonstration sites and plots accessible to farmers who need its information.

Size of demo plots: Available literatures indicate there is varying plot sizes used for on-farm demonstration. By taking into account available experiences, in this guideline, the plot size for on-farm demonstration is recommended to be 0.25 ha (50m x 50m). However, smaller size plots (i.e. less than 0.25 ha) could be used depending on the nature of the technology and availability of land and labour to conduct demonstration, For instance, for horticultural crops, the plot size can be minimized to100 m^2.

Training of farmers' and extension workers

Training is one of the keys in technology transfer activities in general and pre-extension demonstration in particular. In pre-extension demonstration, training is given to farmers and extension workers in order introduce them to the new technology/practice and how to implement it. Training should be given 2 to 3 times in the course of conducting demonstration activities preferably at the beginning, during planting and weeding and at the end on post-harvest management and marketing. To make the training more effective, it is advisable to have a training plan with clear objectives, outputs, method of training, trainers and schedule. Farmer training is ideally carried out on farmers' field and/or FTCs unless there is a special necessity to conduct it in the research center.

Establishment and Management of demonstration trials

Establishing a demonstration involves the actual planting of demonstration plots and/or field trials in the fields of representative farmers. Such field demonstrations examine a small number of new variables, test possible solutions, verify recommendations, and demonstrate recommendations to farmers. Demonstration fields should be managed properly. Hosting farmer should be well trained on how to manage the trial fields.

It is important to mark demonstration boundaries by placing permanent stakes. Marking demonstration boundaries is a small task, but it is a very important part of any successful demonstration. Treatments should be labelled at each plot so that data related to respective plots is properly recorded.

Supervision and Data collection

Regular field supervision and data collection is an important activity in conducting pre-extension demonstrations. Both qualitative and quantitative data should be collected properly

using appropriate data collection techniques such as own field observation, household interview and focused group discussion. Change in level of knowledge is measured using standard knowledge test items identified for measuring farmers' level of knowledge. The type data to be collected include:

- Yield data
- Cost and revenue/income related data
- Total number of farmers (by gender) participated in training, field visits and field days
- Number of farmers (by gender) who became aware of the availability and importance of the technology in the locality
- Change in level of knowledge and skill of farmers
- Role of farmers and other stakeholders in technology demonstration
- Farmers' opinion

Organizing field visits and field Days

Field day and field visits are important extension methods for creating wider awareness and facilitating farmer-to-farmer information/experience sharing. Field day is usually organized towards the end of the trial (at crop maturity stage) to create wider awareness of farmers and other stakeholders. However, field visit could be arranged 2 to 3 times in a production season to create an opportunity for trial and surrounding farmers learn from each other.

Data analysis and report writing

Different data analysis techniques ranging from simple descriptive statistics to parametric and non-parametric tests could be used to analyze data. The choice of statistical tests depends on the research question and the type and nature of data collected. T-tests and ANOVA is for instance used to see the mean yield difference between treatments. Mean knowledge score of participant farmers before and after demonstration is compared using independent t-test. Cost benefit analysis can be done using partial budget analysis, marginal rate of return and other appropriate techniques.

Rereferences

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Additional Reading Materials

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Appendix

Contents of pre-extension demonstration research proposals

1. Title

2. Background and justification

Try to mention the following points in justifying your proposal.

- How important is that crop/enterprise in that particular agro-ecology and farming system
- The perceived production problems or gaps which are supposed to be addressed through pre-extension demonstration
- The relative advantage (in terms of yield, quality, market value or other benefits) of the proposed technology as compared to the already existing ones
- The purpose of conducting the activity

3. Objectives of the study

The following objectives can be used commonly for pre-extension demonstration activities.

- Create awareness on the importance of the new technologies or practices
- Evaluate yield performance and socio- economic compatibility of the new technology under farmers' conditions
- Enhance farmers' knowledge and skill of application of the new technology or practice
- Assess farmers' and other stakeholders' feedbacks for further technology development/improvement

4. Expected out puts (deliverables) when the activity is completed

The expected out puts of pre-extension demonstration activities can be expressed in terms of:

- Recommendations made (e.g Improved variety X will be recommended for wider scaling up)
- Feedbacks for future technology generation/improvement
- Number of farmers participated(hosted) pre-extension demonstration e.g. 30 farmers are expected to participate in pre-extension demonstration
- Number of farmers attended pre-extension demonstration e.g. 150 farmers is expected to attend demonstration
- Number of farmers participated in trainings and field days
- Number of farmers who become aware of the availability and importance of the new technology
- Improved knowledge and skill of farmers

5. Research approach (This refers to participatory mechanisms such as Innovation platforms (IPs) and Farmers' research groups (FRGs) approaches used to enhance stakeholders' engagement in problem identification, joint planning, implementation, monitoring and evaluation.

6. Methodology

The methodology part should at least constitute the following sub headings under it. Each sub headings should be well described.

6.1. Description of the study area (general description of the study area)

6.2. Site and farmers' selection (including criteria used to select demonstration sites and participant farmers, FRG establishment…)

Consider the following in selecting sites and participant farmers

Site selection

- Representativeness of the field in terms of location, soil type and other issues
- Accessibility for more farmers to visit demonstration plots
- Consider FTCs as one location for demonstration as most of FTCs are located in central place accessible to majority of villagers. Use of FTCs is also useful for establishing functional linkage at grass root level with development agents.
- Use Clustering approach to conduct pre-extension demonstrations in geographically clustered farms. This would help to show the impact of improved agricultural technologies in a focused area. The size of cluster could be 2 to 5 hectares.

Farmers' selection

- Select volunteer farmers: Farmers who are volunteer are more likely to be enthusiastic and successful in their activity
- Representativeness: Demonstrations work best when the farmer is representative of the farmers you are trying to reach.
- Gender composition: Make sure that women and youth are well considered in selection of participant farmers. The women and youth should constitute at least 40% of the participants of pre-extension demonstration.

6.3. Research design (includes number of treatments, number of replications and plot size)

- Treatments: At least two treatments; the improved practice/technology and the local/standard check.
- Number of demo plots/fields: At least three or four replications per demo sites (village). There should be sufficient demonstration sites and demo plots/fields to create wider awareness and demand.
- Plot size: 0.25 ha or less depending on availability of land and nature of the technology.

6.4. Role of different stakeholders in technology demonstration

6.5. Farmers' training (number of trainings to be given, number and diversity of participants, topics/areas on which trainings are going to be given etc…)

6.6. Field visits/tours and field days (When to conduct field visits and field days, participants etc)

6.7. Data type and method of data collection

6.7.1. Method of data collection (includes both qualitative and quantitative methods)

Appropriate method/s of data collection should be selected and described in view of the objectives. The following are some of the data collection methods.

- Observation: gathering primary data through field observation/measurements
- Household interview
- Focused group discussion(FGD)

6.7.2. Data types

- Yield data
- Input costs and economic return
- Total number of farmers participated in training, field visits and field days by gender
- Numbers of farmers become aware of the availability and importance of the technology by gender
- Role of farmers and other stakeholders in technology demonstration
- Change in level of knowledge and skill of farmers
- Farmers' opinion/feedbacks

6.8. Method of data analysis (statistical and econometric tools)

- Statistical tools/techniques: descriptive statistics, parametric tests such asT-test, ANOVA etc..
- Econometric tools/techniques: Partial budget analysis, marginal rate of return (MRR) etc…

7. Location

8. Duration
9. Beneficiaries
10. Initiator:
11. Responsible persons:
12. Log frame matrix
13. Monitoring and evaluation matrix
14. Work plan and budget
15. References