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part 2: Agricultural Extension Research

Oromia Agricultural Research Institute
Regional Review Workshop on Completed Research Activities

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Part 2: Agricultural Extension Research

Editors
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Participatory Demonstration and Evaluation of Durum Wheat Technologies in Bale Zone: The Case of Gololcha, Ginir and Goro districts

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Abstract

The research activity was carried out to identify the most suitable varieties for specific locations together with active participation of farming communities and respective subject matter specialist of the area. The trial was executed at Gololcha, Ginir and Goro districts of Bale zone for one year (2013/2014) main season using two new varieties released from Sinana Agricultural Research center namely Dire, Toltu and local check (Ejersa). The variety demonstration and evaluation process were carried out using farmers’ own selection criteria along utilization, marketing and agronomic field performance. The major selection criteria of the farmers in the three districts were almost similar. In general, such utilization and market characteristics as seed color, seed size, market demand as well as field performance including yield, maturity period and tolerance to disease were identified as important farmers selection criteria’s. Accordingly, variety that suite their respective location were identified. As a result, farmers in all site showed special preference to Dire variety based up on their selection criteria seated by themselves. The yield advantage of the preferred variety Dire over Toltu and local check is 11.58% and 22.35% respectively. Extension events, such as mini-field days were organized at each respective site in which different stakeholders ware participated and experience shared. In the most case farmers preferred improved varieties based up on their yield potential and resistance to disease and market demand. As a result, Dire variety was selected by farmers’ selection criteria indicated in all site of the districts and recommended for further pre-scaling activity in similar agro-ecology of the zone.

Key words: Participatory, demonstration, evaluation, Durum wheat

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). It has been selected as a target crop for the strategic goal of national food self-sufficiency. Wheat (bread and durum) occupies over 1.5 million of land annually, primarily as mid-altitude and highland rain fed crops, ranks 4th in area next to teff, maize & sorghum, and 2nd in productivity among the cereals (CSA, 2013). At national level, during 2011/12 cropping season 1,553,239.89 ha of land was covered by wheat (bread and durum) and over 28,556,817.43 quintals produced from this land annually (Crop Variety Registry Book, 2012). In 2012/13 cropping season, wheat annual production in Ethiopia was 3.43 million tons cultivated on 1.63 million ha land (CSA, 2013).
The cultivation of wheat reaches far back into history. It is number one cereal of temperate region. Also substantial amount is grown by subsistence farmers under rain fed conditions in tropical and sub-tropical environments. It is one of the major cereal crops grown within the range of 1500 to 2800masl in Bale, Arsi, West Arsi and Shewa zones, Oromia National Regional State, Ethiopia. These areas have reliable rainfall and are considered as “the wheat belt area of the country” (Bekele, 2011). Wheat is number one cereal crop grown in Bale zone both in terms of area coverage and production (CSA, 2013). It is produced by smallholder and commercial farmers, private investors and the former state farms (now Oromia Seed Enterprise-Bale Branch) in the study zones.

Durum wheat has been cultivated in Ethiopia for thousands of years, though it is gradually being displaced by bread wheat (Chiari et al., 2012). It is produced in highland vertisols of Ethiopia mainly for food and industrial purposes (Dessalegn, 2006). Durum wheat is mainly used as raw materials for pasta and macaroni industries. However, due to low volumes and poor quality of national wheat production, Ethiopian pasta industries are obliged to import the required raw material mainly hard wheat (Chiari et al., 2012). Effort has been made by Sinana Agricultural Research Center in collaboration with Ethio-Italian Development Cooperation Project “Agricultural Value Chains in Oromia” in promoting durum wheat as viable business opportunities for farmers through involvement of farmers’ cooperatives. In the last few years, durum wheat production dramatically increased from 500tonnes during 2012 production year to over 30000tonnes in 2014/15 (Seifudin and Genene, 2015). Ejersa, Bakkalcha, Ilani, Obsa, Ude, Tate and Toltu are among the varieties widely grown by farmers in Bale zone.

However, it was clearly seen from field observation that durum varieties under production specifically Ejersa, Obsa, Tate and Toltu are losing their genetic potential for disease (esp. stem rust). As a result, Sinana Agricultural Research Center had proposed participatory evaluation and demonstration of improved durum wheat varieties (Dire, Ejersa & Toltu) were undertaken at Goro, Ginnir and Gololcha districts in 2014/15 bona season of mid altitude of Bale zone.

Objectives

- To demonstrated and evaluate improved durum wheat technologies in the mid altitude of Bale zone.
- To recommend the best & widely selected improved durum wheat varieties for further pre-scaling activity.

Materials and Methods

Participatory improved durum wheat technology demonstrations were conducted at three potential districts of Bale zone (Gololcha, Ginnir and Goro) in 2013/14 main season. Purposive sampling methods were employed to select three representative districts based on their production potential for durum wheat. From each district two representative kebele were also selected purposefully based on their accessibility and production potential of the crop. Similarly, two trial hosting farmers were selected with active participation of development agents.

Two promising durum wheat varieties (Dire and Toltu) released by Sinana Agricultural Research were used in this participatory durum wheat varieties demonstration. At each location, the improved varieties along with local check used comparison were planted and managed by researchers. The trails were replicated on farmers’ field across the district in Randomized Complete Block Design. These trails managed by the researchers, were visited by the farmers at different stages. The data were collected and selections of best performing variety were made by farmers of the area, DAAs and invited subject matter
specialists form district agricultural office. The farmers were asked to select the variety (ies) which fulfilled their requirements.

All recommended agronomic management practices were applied except chemical application for disease management. Continuous supervision and follow up of the activity were undertaken in collaboration with DA of the study area and research extension team of Sinana Agricultural Research Center. Participatory extension approaches were also used in the demonstration of durum wheat technologies. Furthermore, mini field days were organized in all districts where evaluation and ranking of the varieties with farmers own criteria, prior to moving to the field trial took place. The field day was conducted in a way both male and female farmers can debate, interact and reach consensus on the rating of the varieties against indicated parameters.

Data collection

The types of data collected include yield data, farmers’ perception and their variety selection criteria.

Method of data analysis

In this research simple descriptive statistical methods were used to describe the qualitative and agronomic data collected using table and graphs.

Results and Discussion

Agronomic evaluation

The average grain yield per plot indicated that dire variety has a yield advantage of 11.58% and 22.35% over local respectively. Although dire was ranked 1st in terms of disease resistance, adaptability to the environment, early maturity and seed quality etc. The variability on the average grain yield also imply that the potential benefit for dire (38.25kg/p) and Toltu (33.8kg/p) remains positive as compared to that of local one (29.7.2kg/p).

Figure 1: Average grain yield in kilogram per plots across six sites
Farmers' preference

Mini field day and participatory varieties demonstration, assessment and evaluation were organized at crops maturity stage at all trial sites (Golocha, Ginir and Goro districts). During field day and variety evaluation and assessments, a total of 78 farmers, 12 DA and 6 SMS were participated. According to farmers' assessment and selection criteria, Dire variety captured the interest mainly because of its field performance (seeds per spike, disease resistance, uniformity of the crop, tillering capacity etc...). Varieties were selected by the participants as their second option at all site by its seed color, adaptability to the area and early maturity. During field days and farmers' assessments, Dire variety was selected by all participants of the area based up on their selection criteria (Seeds per spike, disease resistance, Uniformity, tillering capacity).

Conclusions and recommendations

Conclusions

Participatory durum wheat technology demonstration and evaluation was undertaken at three potential districts of Bale zone (Gololcha, Ginir and Goro) successfully with active participation and collaboration of relevant stakeholders' at all respective trial site. In new technology demonstration and evaluation, clear identification of farmers' selection criteria was very important which will be used in identifying appropriate technologies for end users. As a result here, appropriate site and hosting farmers' selection was done carefully with active participation of those development agents of the site. The trials were well managed and treated with full agronomic practices.

In this participatory demonstration and evaluation of durum wheat varieties participant farmers and development agents of the study area got firsthand observation and information on the actual performance and benefit of those improved durum wheat varieties. Using different extension events awareness was created and confidence was developed on the durum wheat variety (Dire) that paves the way for further pre-scaling up activities in the same agro-ecologies of the zone. In participatory technology demonstration and evaluation ensuring active participation of relevant stakeholders like; farmers, development agents (DAs), respective district agricultural officers and multi-disciplinary team of researchers through formal and informal arrangement is critical in sustaining the out puts of participatory extension approaches.

As group discussion result and practical field observation shows that, there is a knowledge gap on appropriate agro-chemicals application (utilization) by those smallholder farmers in the study area and also preserving and exchange of quality seeds they got from different formal and informal seed suppliers. Moreover, the participant farmers highly emphasized the constraint of row planter, seed supply shortage (in quantity, quality, with reasonable price and at required time), mono-cropping problem due to growing of wheat after wheat and emerging big challenge of wheat rust disease epidemics in the study zones.

Farmers' preference to a variety does not necessarily depend on yield per se rather other criteria such as resistance to disease, tillering capacity, grain quality, market demand were of high importance as recognized from the activity in all districts. In fact, the order of variety importance was found to be dynamic in relation to the market conditions. Extension can be more productive, should it duly consider farmers' preference in new technologies evaluation and promotion. Therefore, technology promotion through participatory extension approach is the mandatory. Finally, based up on farmers assessment and agronomic data result Dire variety was recommended for further pre-scaling activity for the same agro-ecologies.
Recommendations

In general, the on farm participatory technology evaluation and transfer with well organized farmers groups working together with research and extension has proved a valuable interactive approach for quick technology evaluation and dissemination. So that, in technology development and promotion working with a group of farmers and relevant stakeholders is very crucial. This is because of the fact that, research and extension activities need to capitalize on farmers’ group approach as it ensures an appropriate coverage of local socioeconomics situations, offers reflective learning environment for all actors involved and helps to exert influence to reach out more farmers sharing similar experiences and crate strong demand pull on institutions to make most preferred technologies accessible.

Training is the catalyst for improving farmers’ innovative capacity for enhancing wider diffusion of the proven impacts of improved technologies to the other areas. Women and male-headed households, and house-wives should be provided with continuous technical trainings on production technologies, post-harvest handlings. Moreover, those participatory training organized for farmers should be consider the convenience of the training for those women farmers in terms of time and distance.

Effective and efficient delivery of technical advices and support to smallholder farmers is highly required to enhance wheat production and productivity, and strengthening the linkage of those relevant stakeholders in promotion of best-bet durum wheat varieties under farmers’ condition is important to make our research more demand-driven. Strengthening the linkages among relevant actors and key potential stakeholders (research-extension-farmers-private service providers as well as processors and exporters) can facilitate the adoption of improved chickpea technologies and improve the income of small scale farmers.

References


Participatory Demonstration and Evaluation of Bread Wheat Technologies in Bale and West Arsi Zones

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Abstract

The paper presents the result of participatory demonstration, evaluation and validation of recently released 4 improved bread wheat varieties (Danda’a, Huluka, Hidase and Shorima) with joint participation of farmers, agricultural experts, development agents, researchers and other stakeholders in Sinana and Agarfa districts of Bale and Dodola district of West Arsi zones of Oromia National Regional State, Ethiopia in the year 2012/13 through the support of East African Agricultural Productivity Project. The objectives were to demonstrate, evaluate and validate the productivity of improved bread wheat technologies under farmers’ condition in the target areas, to improve farmers’, development agents’ and agricultural experts’ capacity (knowledge, skill and attitude) through training on wheat production techniques and management packages, to establish farmers research groups/farmers research-extension groups, to enhance better linkage among the relevant stakeholders and to recommend the best-bet improved bread wheat varieties for further pre-scaling up activity. Three wheat growing potential kebeles were selected from each participant districts and a total of nine kebeles were selected for the study. A total of 180 farmers (with the composition of men, women and youth farmers) were participated in the activity. Three trial farmers at each kebele (a total of 27 hosting farmers in three districts) were selected with the help of group members and development agents. Farmers were considered as replications. A total of 225 individuals (87.56% male and 12.44% female) from the three districts were participated on both theoretical and practical training on wheat production and management packages. To show the performance of demonstrated varieties, mini field day was jointly organized in collaboration with other stakeholders at each district and about 300 participants were participated on this event. A total of 688 participants were participated on participatory assessment and evaluation of the varieties. Uniformity in germination, good tillering capacity (> 10 is preferable), disease resistant (especially yellow and stem rusts), good spike length, number of seeds per spike (> 60 is preferable), good grain yield (> 6 tons/ha) and ease for mechanization (medium size) were the best criteria identified by the evaluators for selecting the best performing varieties. Bread wheat variety, Danda’a, were selected in the first place, whereas Hidase is preferred for its good yield with the availability of fungicides. In this activity, farmers were identified as reliable partners in the participatory plant breeding program.

Key Words: Bread wheat, Demonstration, Technology, Farmers’ preferences, FRGs/FREGs, Linkage

Introduction

Ethiopia is the second largest producer of wheat in Sub-Saharan Africa next to South 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). It has been selected as a target crop for the strategic goal of national food self-sufficiency. Wheat (bread and durum) occupies over 1.5 million of land annually, primarily as mid-altitude and highland rain fed crops, ranks 4th in area next to teff, maize & sorghum, and 2nd in productivity among the cereals (CSA, 2013). At national level, during 2011/12 cropping season 1,553,239.89 ha of land was covered by wheat (bread and durum) and over 28,556,817.43 quintals produced from this land annually (Crop Variety Registry Book, 2012). In 2012/13
cropping season, wheat annual production in Ethiopia was 3.43 million tons cultivated on 1.63 million ha
land (CSA, 2013).

The cultivation of wheat reaches far back in to history. It is number one cereals of temperate region. Also
substantial amount is grown by subsistence farmers under rain fed conditions in tropical and sub-tropical
environments. It is one of the major cereal crops grown within the range of 1500 to 2800mals in Bale,
Arsi, West Arsi and Shewa zones, Oromia National Regional State, Ethiopia (SARC, 2014). These areas
have reliable rainfall and are considered as “the wheat belt area of the country” (Bekele, 2011). Wheat is
number one cereal crop grown in Bale zone both in terms of area coverage and production (CSA, 2013).
It is produced by smallholder and commercial farmers, private investors and the former state farms (now
Oromia Seed Enterprise-Bale Branch) in the study zones. Smallholder farmers in Bale and West Arsi
zones preferred producing wheat because of the following reasons. Conducive agro-ecology, comfortable
plain farmland for wheat production & ease for mechanization, availability of improved agricultural
technologies and associated packages (improved production techniques), availability of private service
providers (agro-chemicals, mechanization services such as tractors, row planters, combine harvesters,
etc.), increased demand for wheat (home consumption and food processors) and its comparative
advantage (attractive market price).

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). For Bale
zone, emmer wheat (Triticum dicoccum L.) is also very important (SARC, 2014). Bread wheat is of recent
introduction; durum wheat is indigenous to the Ethiopia, which is considered as ‘the secondary center of
diversity for tetraploid wheat’. Nevertheless, the on-going efforts to improve access to and use of
available improved wheat technologies to smallholder farmers is below the requirements in terms of area
coverage and number of beneficiaries. This is not because of government policy, the environment/agro-
ecology, or not because of the potential high yielding varieties, rather due to lack of well prepared plan,
coordination and linkage in a sustainable way (multi-stakeholder approach). Furthermore, sustainable
improvements in production and productivity depend on an efficient system of channeling demand-
driven; need and interest based improved agricultural technologies to the end users.

Developing high yielding, disease resistant and stable varieties that can meet increasing food demand of
the growing population are very important. Thus, generating, demonstrating, evaluating, validating,
popularizing and disseminating improved bread wheat technologies to smallholder farmers are vital in
facilitating adoption of these technologies. Consequently, the research system have been making
continuous and unreserved endeavors in varietal development and seed/variety replacement to ensure the
sustainability of early generation seed source for both formal and informal seed multipliers and
Distributors. In this endeavor, more than sixty (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. Of
these, Tusie, Madda Walabu and Sofumar are relatively resistant to diseases, commercial and in
production.

Nevertheless, the recent wheat rusts epidemics in Ethiopia is among the major wheat yield reducing
factors and currently becoming the major threat for wheat production in the study zones as well as in the
country. Among the bread wheat varieties widely grown by farmers in the study area, however, it was
clearly seen from field observation that 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). To tackle this problem, 4 improved bread varieties (Danda’a, Huluka, Hidase and
Shorima) recently released by research centers in 2010 and 2011 with full recommended packages for
production and farmers have to select the best performing variety/ies by comparing with the existing
commercial varieties. Farmers’ low or lack of participation and failure to select the appropriate varieties is
a costly mistake. Besides, its potential productivity is limited by moisture stress (moisture stress/drought
and water logging), lack of improved wheat varieties (resistant/tolerant to wheat rusts disease epidemics),
low soil fertility, severe weed infestation (esp. grassy weeds), low crop management practices, diseases and insect problems. Moreover, low use of recommended full packages is also another yield limiting factor. Therefore, undertaking participatory demonstration, evaluation and validation of improved wheat technologies with joint participation of farmers, agricultural experts, development agents, researchers and other stakeholders in the study area is highly important.

General objective

➢ To demonstrate and recommend the best selected variety/ies, and enhance the knowledge, skill and attitude of the end users towards the improvement of bread wheat production and productivity.

The specific objectives

➢ To demonstrate, evaluate and validate the productivity of improved bread wheat technologies under farmers’ condition in the target areas.
➢ To improve farmers’, development agents’ and agricultural experts’ capacity (knowledge, skill and attitude) through training on wheat production techniques and management packages (packages approach).
➢ To establish Farmers Research Groups/Farmers Research-Extension Groups (FRGs/FREGs) in order to make the farmer to be central to agricultural research and technologies dissemination
➢ To enhance better linkage among the relevant stakeholders
➢ To recommend the best performing improved bread wheat variety/ies for further pre-scaling up activity.

Methodology

Description of the study area

The research was carried out in Sinana and Agarfa districts of Bale Zone, and Dodola district of West Arsi zone of Oromia National Regional State (ONRS), Ethiopia. Bale and West Arsi zones are among the 18 administrative zones of the ONRS located in southeastern Ethiopia.

Sinana district

Sinana district is among the eighteen (18) districts of Bale zone, which is located at 430 km southeast of Addis Ababa. It is one of the largest and potential district of Bale zones with a total land area of 1168km² (116,800 hectares). It is divided into twenty (20) Kebeles and four (4) small rural towns. About 99% 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, linseed, maize, hot pepper, potato, cabbage, banana, sugar cane, orange and papaya. Cattle, equines, sheep, goats and chickens are important livestock species reared by farmers in the district (SDADO, 2014).

The agro-ecological zones of the district are highland (90%) and midland (10%). The altitude ranges from 1650m to 3650 m.a.s.l. The annual average temperature is 16.5°C with minimum and maximum temperatures of 10°C and 23°C, respectively. The annual average rainfall is 1105mm where as the minimum and maximum rainfall is 1060mm and 1150mm, respectively. The dominant soil type is loamy clay and pellic vertisols. Sinana district is bounded by Agarfa district in the North, Dinsho district in the
West, Barbare and Goba districts in the South, Gassara district in North-east and Goro in the East and the administrative center of the district is Robe town (SDADO, 2014).

**Agarfa district**

Agarfa district is among the eighteen (18) districts of Bale zone, which is located at 460 km southeast of Addis Ababa. It is one of the largest and potential district of Bale zones with a total land area of 1343 km² (134,300 hectares). It is divided into twenty (20) Kebeles and two (2) 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, linseed, maize, hot pepper, potato, cabbage, banana, sugar cane, orange and papaya. Cattle, equines, sheep, goats and chickens are important livestock species reared by farmers in the district (ADADO, 2014).

The agro-ecological zones of the district are highland (83%), midland (11%) and lowland (6%). The altitude ranges from 1250m to 3855 m.a.s.l. The Mean Annual temperature of the district is 17.5°C. The maximum and minimum temperatures are 25°C and 10°C, respectively. The mean annual rain fall is 800mm where as 1200mm and 400mm Maximum and Minimum annual rain fall recorded in the district, respectively. The dominant soil type is loamy clay and vertisols (ranges from well-drained fertile to waterlogged vertisols). Agarfa is bounded by Sinana and Dinsho districts in the South, Arsi zone in the North, Adaba district in the West and by Gassara district in East and the administrative center of the district is Agarfa town (ADADO, 2014).

**Dodola district**

Dodola district is among the twelve (12) districts of West Arsi zone, which is 75 km far away from Shashamanne and located at 326km southeast of Addis Ababa. It is divided into twenty three (23) Kebeles and four (4) rural 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), tef, maize, sorghum, field pea, faba bean, chickpea, linseed, lentil, enset, potato and cabbage. Cattle, equines, sheep, goats and chickens are important livestock species reared by farmers in the district (DDADO, 2014).

The agro-ecological zones of the district are Dega (91%), Woynadega (8%) and Kolla (1%). The altitude ranges from 1500m to 3655 m.a.s.l. The annual average temperature is 18.5°C with minimum and maximum temperatures of 12°C and 25°C respectively. The annual average rainfall is 1109.5mm where as the minimum and maximum rainfall is 800mm and 1419mm respectively. The dominant soil type is loamy clay and pellic vertisols. The district shares bounder line with Gadab Hasasa in the north, Kokosa and Kofale in the west, Adaba in the East, and Nensebo in the south and the administrative center of the district is Dodola town (DDADO, 2014).

**Site and farmers’ selection**

One district from West Arsi zone (Dodola) and two districts from Bale zone (Sinana and Agarfa) were selected purposively for the implementation of the activity. In collaboration with development agents (DAs) and agricultural experts, three wheat growing potential kebeles were selected from each district (Salka, Nano Robe and Walta’i Barisa kebeles from Sinana district; Ali, Elabidu and Ilanni kebeles from Agarfa district and Barisa, Dannaba and Kachama-Chare from Dodola districts) making a total of nine (9) kebeles selected for the study.
Interest of farmers in bread wheat production and potential land they have, their ability and willingness to perform cultural practices as per recommendation, social status in the community (that can influence his/her community in decision making) and gender equality issues (at least 25%) were considered as farmers’ selection criteria. A total of 180 farmers were selected and grouped into FRG/FREG. In each kebele, each FRG/FREG had 20 members with the composition of men, women and youth farmers. Under FRGs/FREGs members other farmers were organized as follower farmers to share knowledge, skill and experience for further promotion mechanism. Thus, a total of 720 follower farmers (1 farmer has 4 follower farmers) were participated in the activity (directly or indirectly).

Trial farmers were selected based on ownership of suitable and sufficient land to accommodate the trials, willingness to contribute the land, vicinity to roads so as to facilitate the chance of being visited by many farmers, initiatives to implement this activity in high-quality, good in field management and willingness to explain the technologies to others. Accordingly, three representative trial farmers from each FRG/FREG were selected at each kebele (with the help of group members and DAs) making a total of twenty seven (27) hosting farmers in all the three districts. Farmers were considered as replications i.e. the demonstration activity was replicated on three farmers per kebele. Farmers (FRG/FREG members and other follower farmers) were encouraged to participate in the physical activities from the beginning up to the end and at each stage of the demonstration activity.

**Trial design**

Sinana Agricultural Research Center (SARC) was the source of all agricultural inputs (seed of improved varieties, fertilizers-DAP and UREA, herbicides-Pallas 45 OD). Four improved bread wheat varieties (Danda’a, Huluka, Shorima and Hidase) and one standard check (Madda Walabu) were planted on selected farmers’ land with simple plot design (10m X 10m) in 202/13 main cropping (Meher) season. The varieties were treated with full recommended wheat production and management packages. Row planting method and other crop management practices were used during the research work. The spacing of 20cm between rows was used. The recommended seed rate of 150 kg/ha was used by drilling in the prepared rows. Shallow planting of 5cm depth was used in the presence of ample soil moisture. The recommended inorganic fertilizer rate 50/100 kg/ha UREA/DAP was applied with split application of nitrogen: 1/3 at planting time and 2/3 at tillering stage of the crop. Depending on weed infestation, two effective weeding were done; the first at one month after sowing and the 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.

**Approaches Followed**

Participatory and multidisciplinary approaches were used during demonstration activity. For the sake of enhancing efficiency and effectiveness, integration and cooperation (synergy) were institutional innovation tool implemented for the achievements of the strategy. Joint Planning: organizing stakeholder forum for consultation meeting with responsible and collaborative participants to have a common understanding of demonstration activities; establishing stakeholder platforms at zone and district levels and establishing FRG/FREG at each participant kebeles were undertaken and done successfully.

Training on capacity building (on knowledge, skill and attitude): for farmers, agricultural experts (zonal and district levels) and DAs on bread wheat production and management packages (from site selection to post harvest handling), on roughing and informal seed dissemination mechanisms were given. Packaging and distribution of wheat technologies and other agricultural inputs (inorganic fertilizers, agro-chemicals-herbicides). Improved bread wheat varieties with their recommended packages distributed to selected zones, districts and farmers. Farmers (FRG/FREG members and follower farmers) were encouraged to participate in the physical activities from the beginning up to the end and at each stage of the
demonstration activity. Participatory/joint monitoring and evaluation: regular field visit by extension agents i.e. demonstration field was regularly visited by extension counterparts; joint field visit and supervision at different crop stage were done. Mini field day and demonstration were organized at crop maturity stage to popularize and create more awareness for the local communities.

Data collection

Both qualitative and quantitative data were collected using appropriate data collection methods such as direct field observation/measurements, household/participant interview, focused group discussion (FGD) and knowledge test. The types of data collected include:

- Agronomic data such as days to heading, days to maturity, plant height, spike length, seed per spike, stand, thousand seed weight and grain yield per plot were recorded.
- Total number of farmers participated on training, field visits, mini field days, demonstration and evaluation by gender,
- Numbers of farmers become aware of the relative advantage of the demonstrated improved bread wheat technologies by gender.
- Role of farmers and other stakeholders in technology demonstration and evaluation,
- Change in level of knowledge and skill of farmers and development agents,
- Farmers, DAs, agricultural experts and researchers assessment (feedback assessment)
- Farmers’ preferences (likes and dislikes, which is the base for plant breeding process and perceptions towards the performance of the technologies)
- The farmers’ opinions, ideas, interests and views that need consideration in plant breeding program were collected.

Data analysis

SPSS was used as statistical package (descriptive statistics was used to analyze the data). Pair wise ranking matrix was used to rank the varieties in order of their importance.

Results and Discussion

Training for farmers and extension workers

In this activity, training on knowledge, skill and attitude were the main approaches that used to create awareness about improved bread wheat technologies among farmers, to capacitate the farmers’, DAs’ and experts’ knowledge and skill about wheat production and management packages. Consequently, multidisciplinary team consists of seven SARC researchers were organized to deliver the training in capacity building and facilitating extension efforts of bread wheat technologies. The team was composed of socio-economist, agricultural research-extensionist, breeder, pathologist, agronomist, weed scientist and seed scientist from SARC.

A total of 225 individuals (87.56% male and 12.44% female) from the three districts (180 farmers, 15 agricultural experts, 27 development agents & 3 supervisors) participated on both theoretical (in-room) and practical (on-spot) training on wheat production and management packages (Table 1). The trainings focused on available improved bread wheat technologies (varieties, agronomic recommendations and practices/packages, etc.); input utilization (type, quantity required and application methods); weeds, diseases, insect pests and their controlling ways; agro-chemicals applications and safety precautions; the importance of crop rotation to
break mono-cropping problem and quality seed production techniques and post harvest handling. The softcopy of training materials were provided in CD and flash disk to the concerned body.

Table 1. Training given for farmers and extension workers (2012/13)

<table>
<thead>
<tr>
<th>Districts</th>
<th>Male</th>
<th>Female</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sinana</td>
<td>52</td>
<td>8</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Agarfa</td>
<td>54</td>
<td>6</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>-</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>2</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Dodola</td>
<td>55</td>
<td>5</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>2</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td><strong>Grand Total</strong></td>
<td><strong>197</strong></td>
<td><strong>28</strong></td>
<td><strong>225</strong></td>
</tr>
</tbody>
</table>

Input supply

A total of 202.5 kg seeds of the five demonstrated bread wheat varieties, namely, Danda’a, Huluka, Hidase, Shorima and Madda Walabu (40.5 kg of each variety) were distributed to twenty seven (27) trial farmers for demonstration purpose. A total of 67.5 kg UREA and 135 kg DAP (inorganic fertilizers) were distributed to twenty seven (27) trial farmers for demonstration purpose. In addition to this, one (1) liter Pallas 45 OD herbicide was used for demonstration purpose on 1,814 ha (18144 m²) land of twenty seven (27) trial farmers. Area

Supervision

The multidisciplinary team jointly conducted supervisions, monitoring and evaluation of the activities among the participating districts based on the necessities and requirements. As a result, the group had offered advice based on the practical problem observed on the spot in the project areas.

Field days

To show the performance of demonstrated varieties, mini field day was jointly organized in collaboration with other stakeholders (zone and district level agriculture development offices and participant farmers) at each district and about 300 participants were participated on this event including FRGs/FREGs members and follower farmers in the three districts.

Yield performance
The overall mean yield (qt) of Danda’a and Hidase varieties on-farmers field were 66.7 and 68.3, respectively (Fig.1). This figure was competent with the potential yield of the varieties at research field since packages approach was employed during demonstration activity.

Fig. 1. Average yield of demonstrated varieties

Results of participatory assessment and evaluation

The target beneficiaries/farmers/end users 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.

In the three districts (at 9 kebeles), participatory assessment and evaluation of the varieties were undertaken with agricultural experts, DAs, farmers and researchers at maturity stage of the crop. A total of 688 participants (643 farmers, 30 DAs & supervisors and 15 experts from the three districts) & researchers were participated on evaluation of the varieties (Table 2).

Table 2. Number of participants on participatory assessment and evaluation of the demonstrated varieties

<table>
<thead>
<tr>
<th>Participants</th>
<th>Sinana</th>
<th>Districts Agarfa</th>
<th>Dodola</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farmers</td>
<td>240</td>
<td>220</td>
<td>183</td>
<td>643</td>
</tr>
<tr>
<td>Agricultural Experts</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>15</td>
</tr>
<tr>
<td>DAs</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>27</td>
</tr>
<tr>
<td>Supervisors</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>255</td>
<td>235</td>
<td>198</td>
<td>688</td>
</tr>
</tbody>
</table>

Before embarking on the actual assessment work, 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 and criteria set by them to evaluate and 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 in ranking the demonstrated varieties in order of their importance, and report through their group leader at the end.

The evaluators set and identified the best selection criteria for selecting of the best performing demonstrated improved bread wheat varieties. These were uniformity in germination, has good tillering capacity ($\geq 10$ is preferable), disease resistant (especially yellow and stem rusts), has good spike length, number of seeds per spike ($\geq 60$ is preferable), good grain yield ($\geq 6$ tons/ha), no irregular maturity because of late tillers, and not very late or early, ease for mechanization (medium size), good for consumption/bread making and marketable.

Consequently, suitable and widely accepted bread wheat varieties for the study areas were identified and ranked based on these criteria. So, Danda’a and Madda Walabu were selected in the first place, whereas Hidase is preferred for its good yield with the availability of fungicides (Table 3). This approach will not only be resource saving in terms of preferred variety promotion/dissemination, but also time saving and fast adoption.

Table 3. Overall rank of each variety based on the result of participatory evaluation

<table>
<thead>
<tr>
<th>No.</th>
<th>Variety name</th>
<th>Sinana</th>
<th>Agarga</th>
<th>Dodola</th>
<th>Perception of the evaluators</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Danda’a</td>
<td>1st</td>
<td>2nd</td>
<td>1st</td>
<td>High yielder, relatively disease resistant (but susceptible to yellow rust) and affected by cool weather during maturity</td>
</tr>
<tr>
<td>2</td>
<td>Madda Walabu</td>
<td>1st</td>
<td>1st</td>
<td>2nd</td>
<td>Relatively high yielder and disease resistant</td>
</tr>
<tr>
<td>3</td>
<td>Huluka</td>
<td>3rd</td>
<td>4th</td>
<td>3rd</td>
<td>Low yielder but disease resistant</td>
</tr>
<tr>
<td>4</td>
<td>Shorima</td>
<td>4th</td>
<td>3rd</td>
<td>3rd</td>
<td>Lacks uniformity (Different maturity level within a single plant)</td>
</tr>
<tr>
<td>5</td>
<td>Hidase</td>
<td>5th</td>
<td>5th</td>
<td>4th</td>
<td>High yielder with the availability (on time and price) of fungicides</td>
</tr>
</tbody>
</table>

Output obtained from demonstration activity

Farmers had first hand observation on the actual performance and benefit of the demonstrated varieties and Danda’a was selected for further pre-scaling up activity. Knowledge is gained, skill is acquired and attitude of the farmers is changed through intensive training especially on the importance and the dynamics of wheat rusts epidemics and on using full recommended packages (packages approach). Knowledge and skill of DAs and agricultural experts also enhanced through training. Besides, farmers access to improved bread wheat technologies increased; large number of farmers was persuaded and information was disseminated to several farmers, which might pave the way for scaling-up/out. Thus, demand driven technology transfer created.

Furthermore, the activity had popularized and identified the farmers’ opinions, ideas, perceptions, interest and views that need consideration in breeding program. Competitiveness among smallholders on technology (with full packages) utilization increased. Information on market access provided (inputs and produce). Besides, strong linkage among stakeholders (links to networks) is created that bridge further participatory effective bread wheat technology generation, demonstration, evaluation, validation and up-scaling/dissemination of the best performing technologies those fulfilling farmers’ need and interest. Moreover, adoption and dissemination of improved bread wheat technologies enhanced through farmer-to-farmer learning and information exchange mechanisms.
Conclusions and Recommendations

Conclusions

There is an opportunity to harvest high yield from commercial bread wheat variety if and only if our farmers use appropriate 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, disease resistant, good spike length, number of seed per spike, yield, no irregular maturity, ease for mechanization and marketability are the best identified selection criteria during participatory evaluation 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. 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), mono-cropping problem and emerging big challenge of wheat rust disease epidemics.

Recommendations

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. To break mono-culture problem and emerging big challenge of wheat rust epidemics, and to stay sustainable in wheat production in the study zones, our farmers must practice appropriate integrated weed/disease management practices.

Recently, farmers’ group is seen as the smallest unit of the farmers. Hence, establishing and strengthening FRGs/FREGs is one of the approaches, which make the farmer to be central to agricultural research, technology promotion and dissemination. Among the four improved bread wheat varieties, Danda’a, Huluka and Hidase (with full recommended packages) were selected and recommended for pre-scaling up activity at least 1 midde (32m X 32m) in the 2013/14 production season. The standard check, Madda Walabu, had already popularized and widely disseminated especially in Sinana and Agarfa districts because of its wider adaptation to the environment. Though it requires commitment and facilities, the prevalence of wheat rust epidemics in the country, especially in the wheat belt areas, calls for a shift from classical/conventional breeding to molecular/gene targeting breeding program. Generally, strengthening the linkages among key potential stakeholders (research-extension-farmers-private service providers as well as agro-industries/food processors) is indispensable to attain the goal.

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Participatory On-farm Demonstration and Evaluation of Improved Chickpea varieties in Goro District of Bale zone

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Abstract

Research activity was carried out to identify the most suitable varieties for specific locations using participatory farmers’ research groups approach. It was executed at Goro district of mid-altitude of Bale zone for one year 2013/2014 preceding adaptation trial of four newly released chickpea varieties (Shasho, Ejere, Habru & Arerti). From the adaptability trial result Harbu and Ararti were well adapted and selected by the farmers of the area for further demonstration activity. Thus, demonstrations of those improved and adapted chickpea varieties with local check were conducted at two purposefully selected kebeles per district. One farmers research group (RGs) per kebele were organized in which three model farmers were used as hosting farmers. The demonstrations were conducted on 10mx10m plot size with full recommended agronomic practice. The variety demonstration and evaluation process were carried out using farmers’ own criteria along utilization, marketing and agronomic field performances. The major selection criteria of the farmers in all sites were almost similar. In general, utilization and market characteristics as seed color, seed size, market demand as well as field performance including yield, maturity period and tolerance to disease were identified as important farmers selection criteria’s. Accordingly variety that suite their respective location were identified. As a result farmers in all site showed special preference to Harbu variety. The yield advantage of the preferred variety Harbu over Ararti and local check is 8.58% and 25.35% respectively. Extension events, such as mini-field days were organized at each respective site in which a total of 68 farmers, 6 DAs and 2 SMS were participated and experience shared. Finally, Harbu variety was selected by farmers’ selection criteria and average grain yield data collected and recommended for further pre-scaling in similar agro-ecologies of Bale zone.

Key words: Participatory, demonstration, technology evaluation, chick pea

Introduction

Chickpea is a less labor-intensive crop and its production demands low external inputs compared to cereals. In Ethiopia, chickpea is widely grown across the country and serves as a multi-purpose crop (Shiferaw et al., 2007). First, it fixes atmospheric nitrogen in soils and thus improves soil fertility and saves fertilizer costs in subsequent crops. Second, it improves more intensive and productive use of land, particularly in areas where land is scarce and the crop can be grown as a second crop using residual
moisture. Third, it reduces malnutrition and improves human health especially for the poor who cannot afford livestock products. It is an excellent source of protein, fiber, complex carbohydrates, vitamins, and minerals. Fourth, the growing demand in both the domestic and export markets provides a source of cash for smallholder producers. Fifth, it increases livestock productivity as the residue is rich in digestible crude protein content compared to cereals.

Chickpea production works well in rotation with cereals such as wheat and teff widely grown in relatively well-drained black soils. Globally, chickpea is adapted to black soils in the cool semi-arid areas of the tropics, sub-tropics as well as the temperate areas. It is the third most important pulses growing in the world after dry bean and pea and constitutes 20% of the world’s pulse production (Joshi et al., 2001). There are two types of chickpea produced globally, namely desi and kabuli chickpeas. Kabuli chickpeas have a larger cream-colored seed with a thin seed coat whereas the desi type has a smaller, reddish brown-colored seed with a thick seed coat. On average, world production consists of about 75% of desi and 25% of kabuli types (Agricultural and Agri-food Canada, 2004).

Chickpea, locally known as shimbra, is one of the major pulse crops (including faba bean, field pea, haricot bean, lentil and grass pea) in Ethiopia and in terms of production it is the second most important legume crop after faba beans. It contributed about 16% of the total pulse production during 1999-2008, (CSA, 2013). For this study some newly released improved chickpea varieties (Desi and Kabuli type) were collected from national agricultural researches and tested for their adaptability at six site of Goro district. Based up on the adaptation trial result Harbu and Ararti were selected for the demonstration activity with the following specific objectives.

Objectives

☐ To demonstrated and evaluate improved chickpea technologies in the mid altitude of Bale zone.

☐ To recommend the best & widely selected improved chickpea varieties for further pre-scaling activity.

Materials and Methods

Farmers’ selection and experimental design

The demonstration was conducted at Goro district of Bale zone. For the implementation of this activity appropriate site and model farmers selection was done with active collaboration of those development agents found at respective kebeles. Therefore, a total of three representative kebeles were selected in which one farmers research groups per kebele were established and model farmers were nominated form the groups to host the trial. The trials were managed by hosting farmers and research extension team of SARC and treated with recommended agronomic practice on the plot size of 10mx10m. Participatory training was given for the member of farmers’ research groups on the principles of farmers research groups and overall production techniques and agronomic practice of pulse crops especially chickpea.

Data collection

Data were collected through own observation, focus group discussion and participant interview. The type of data collected include number of farmers participated in different extension events, grain yield and farmers’ perceptions on those improved chickpea varieties.
Method of data analysis

In this research paper simple descriptive statistical methods were used to describe the qualitative and agronomic data collected using table and graphs.

Result and Discussion

Farmers’ assessment

Mini field days and training were organized at crop maturity stage. The demonstration and evaluation and ranking of the varieties with a groups of farmers (male and women) with their own criteria, prior to moving to the field trail was done serving as unique experience where participant male and female farmers debated, interacted and reach consensus on the rating against agreed upon parameters. During field day and variety evaluation and assessments, a total of 68 farmers, 6 DAs and 2 SMS were participated. According to farmers’ assessment and selection criteria Harbu variety was capture the interest of 98/5 of the participant farmers and expertise. This is mainly because of its field performance in seeds per pod, disease tolerance, uniformity of the crop and tillering capacity. Next to Harbu, Ararti variety was also selected by the participants at all sites for its seed color, adaptability to the area and early maturity.

Agronomic evaluation

The average grain yield data shows that Harbu variety has a yield advantage of 19.5% and 43.1% over Ararti and local varieties respectively (Fig. 1). The variability around the average yield also imply that the potential benefit for Harbu (40.6kg/plot) and Ararti (32.8kg/plot) remains positive as compared to that of local one (23.2kg/plot).

![Figure 1. Average grain yield in kilogram per plots across six sites](image)

Figure 1. Average grain yield in kilogram per plots across six sites

Conclusions and recommendations

Conclusion

In mid altitude of Bale zone especially where shortage of rainfall is common, farmers’ preference to a variety does not necessarily depend on yield per hectare only, but other important selection criteria they listed such as, resistance to disease and early maturity of the crops is very crucial. In fact, the order of
variety importance is found to be dynamic in relation to the market behaviors options. In new technology demonstration and evaluation, clear identification of farmers' selection criteria was very important which will be used in identifying appropriate technologies for end users. Extension can be more productive, should it duly consider farmers’ preference in new technologies evaluation and promotion. Therefore, technology promotion through participatory extension approach is the mandatory. This chickpea technology demonstration and evaluation was undertaken successfully with active participation and collaboration of relevant stakeholders’ at all respective trial site. As a result here, the trial was well managed at all site and mini-field days were organized in which farmers of the area, DAs, SMS and researchers from Sinana Agricultural research Center were participated.

Recommendations

On farm participatory technology evaluation and transfer with well-organized farmers groups working together with research and extension have proved a valuable interactive approach for quick technology evaluation and dissemination. In addition to this, strengthening the linkages among relevant actors and key potential stakeholders (research-extension-farmers-private service providers as well as processors and exporters) can facilitate the adoption of improved chickpea technologies and improve the income of small scale farmers. Training is the catalyst for improving farmers’ innovative capacity and for enhancing wider diffusion of the proven impacts of improved technologies to the other areas. Women and male-headed households, and house-wives should be provided with continuous technical trainings on production technologies, post-harvest handlings. Moreover, those participatory training organized for farmers should be consider the convenience of the training for those women farmers in terms of time and place of training.

Appropriate technology promotion should supported by effective and efficient delivery of technical advices and support to smallholder farmers and linking with attractive market system. Finally, based up on farmers selection criteria and average grain yield data Harbu variety was selected and further recommended for pre-scaling activity in the same agro-ecology of zone.

References


Pre-Extension Demonstration and Evaluation of Improved Maize Varieties in Selected Districts of West and Kellem Wollega Zones

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Abstract

Maize is the major source of food, and an important cash crop for farmers of West and Kellem Wollega zones. The study was carried out with objectives of selecting best performed maize variety/varieties under farmers' condition in Guliso, Lalo Kile, Dale Sedi and Dale Wabera on the total of 16 farmers' field. Three improved variety of namely BH-661, BH-545 & Gibe-2 were compared with local check on 100m² for each variety. Agronomic data and grain yield were recorded by the researchers and development agents. The results of study revealed that the mean yield of BH-661 is the highest among demonstrated varieties. It gave 60.3q/ha while BHQPY-545, Gibe-2 and the local gave 48.95, 46.81 and 36.19 quintal per hectare respectively. Moreover farmers' selection criteria were considered to indicate their preference. Hence BH-661 and BHQPY-545 varieties were selected based on grain yield, cob size and grain color. Therefore, BH-661 and BHQPY-545 varieties are recommended for the study area and similar agro ecologies for further scaling up to improve production and productivity of maize.

Key words: Grain yield, Maize, Participatory approach, farmers' preferences

Introduction

In developing countries maize is the most important and widely cultivated food cereal crop. It is a major source of food, and an important cash crop for low income household farmers. Maize is not only used for human consumption, but it also used as feed for animal at different growth stage in the form of the silage at young stage. Its stalk and cobs is also very important for fuel purpose in areas where fuel woods are inadequate (Roger et al., 2013). Maize is the most important crops in terms of both total national production and productivity in Ethiopia. Maize grows in all agro-ecologies starting from lowland to 3700 meter above sea level. It is also grown in arid region receiving rainfall of 250mm to high rainfall areas of above 1500mm (Beyene et al., 1998).

Technology transfer and adoption, particularly adaptive research should be under taken in the agro ecology of within which it is produced and with the people who will consumed it. Adoption and dissemination of an innovation is influenced by members of social group and communication techniques. When some members of a group have adopted technology others will follow it (Vanden & Hawking, 1996). The dissemination of the project results can also be encouraged through different awareness creation mechanisms such as progress reports, manuals, workshops, posters, training, demonstration plots and publications.

Technology development process failed to consider the socio economics and agro ecological circumstances of the end users. Farming community is not expose to evaluate technologies under their existing system of production. As a result dissemination and adoption rates of many technologies popularized so far was not impressive. Furthermore, technologies from research station failed to fulfill farmers' technology selection criteria; hence adoption rate become low (Abera, 2004). In line with this, Haro Sebu Agricultural Research Center made some efforts to address the bottleneck of farming communities for some crop variety on adaptation trial, regardless of its good result; farmers benefit is not as such eye-catching.
Therefore, participatory research and extension approach whereby stakeholders, mainly farming community actively participate in decision making and implementation from stage of problem identification through experimentation to utilization and dissemination of research results is by far crucial in addressing those problems. Thus the study was intended to achieve the following objectives. These are:

- To evaluate and select well performed maize variety/varieties for their localities.
- To enhance the skill and knowledge of farmers in maize production and management practices.
- To create awareness on the importance of the maize technology.

**Methodology**

On farm evaluation of some selected improved varieties of maize was conducted in west and kellem Wollega zones for two consecutive cropping seasons (2013/2014 and 2014/2015) under rain fed conditions. Four districts were selected namely Guliso from west Wollega and Lalo kilo, Dale Sedi & Dale Wabera from kellem Wollega Zone. Guji Webaru and Moga Kobera kebeles from Guliso district were used while Sago from Lalo, Kombo & Keto Shen from Dale Wabera, Hawetu Birbir, Gonsidereba, Hawetu Gendaso & Kebele 19 from Dale Sedi were used for demonstration. Based on farmers' representativeness of the majority of smallholder farmers, their motivation for work and their ability to disseminate the information to other farmers by considering the gender aspect 16 farmers were selected as experimental farmers. One FRG group was established in each operational kebeles with 15-20 members. Training is also given for all FRG members regarding the proper management and monitoring required for the experiment being demonstrated in order to perform similar management practices for all varieties at the same time.

The demonstration trial was laid out using each experimental farmer's field as a replication. The maize varieties used in this study were BH-661, BHQPY-545, Gibe-2 and the local check. Each experimental plot had gross area of 100m². Spacing between plant to plant and row to row were 25 and 75 cm, respectively. The distance between plots was 1m. Two seeds per hill were sown, which were thinned to one plant per hill after three weeks. Sowing was done by hand drilling at a seeding rate of 25 kg ha⁻¹. Fertilizer in the form of urea and DAP was applied at the rate of 200 and 150 kg ha⁻¹, respectively. DAP was used all once during planting while urea was applied three times i.e. half during sowing and the one-fourth during 8-10 leaf stage and the remaining one- at silking stage. Weeding and hoeing were done as required. Data on days to teeseling and silking, maturity date, ear length (cm), number of ears per plant, plant height (cm), lodging(%) and grain yield were collected and subject to statistical analysis using SAS statistical software (SAS 9.0).
Results and Discussions

Agronomic Performance of Maize on farmers' fields

The results of the study reveal significant differences among the tested varieties in all agronomic evaluation. Accordingly, 50% days to teasing, 50% days silking, days to maturity and lodging are higher in case of local varieties as compared to BH-661, BHQPY and Gibe-2 which are second, third and fourth respectively in these specified agronomic evaluation traits. Similarly, plant height is also shows different magnitude for different maize varieties. The tallest plant were observed in BH-661 (287.02cm) followed by the local check. Gibe-2 and BHQPY-545 with a height of 272.42, 240.73 and 232.63cm respectively. Hence, according to the result of agronomic evaluation of tested maize varieties, BH-661 is the tallest whereas BHQPY-545 is the shortest plant. The ear (cob) length ranged from 15.23 to 18.40cm. The variety BH-661 with an ear length of 18.40cm had maximum cob length, which is significantly superior than BHQPY-545, Gibe-2 and local with an ear length of 17.08. 17.05 and 15.23cm respectively. BHQPY-545 had almost two (1.94) ears per plant while the remaining varieties BH-661, Gibe-2 and the local had 1.33, 1.31 and 1.07 (Table 1).

Analysis of the variance revealed significant variations among the tested varieties of maize for lodging percentage and grain yield. BH-661 gave the highest grain yield than the rest tested varieties of maize. The mean yield of BH-661 per hectare is 60.03 quintal which is far greater than other tested varieties can produce from a hectare which is 48.95, 46.81 and 36.19 quintal per hectare for BHQPY-545, Gibe-2 and the local. Generally variations occurs among these tested varieties of maize due to there is genotypic variation among them; although the same treatment and management practices were applied in the same form and at the same time.

Table 1. Combined mean grain yield and agronomic traits of maize

<table>
<thead>
<tr>
<th>Varieties</th>
<th>50% Days to Teasing</th>
<th>50% Days to Silking</th>
<th>Days to Mature</th>
<th>Plant Height (Cm)</th>
<th>Ear Length (Cm)</th>
<th>Number of Ear Plant</th>
<th>Lodging %ge</th>
<th>Grain Yield Qt.Ha¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>BH-661</td>
<td>78.62a</td>
<td>85.12a</td>
<td>156.5b</td>
<td>287.02a</td>
<td>18.4a</td>
<td>1.33a</td>
<td>13.23ab</td>
<td>60.03a</td>
</tr>
<tr>
<td>BHQPY-545</td>
<td>75.75b</td>
<td>80.25b</td>
<td>153.62c</td>
<td>232.63b</td>
<td>17.08a</td>
<td>1.94a</td>
<td>7.7b</td>
<td>48.95b</td>
</tr>
<tr>
<td>Gibe-2</td>
<td>74.06b</td>
<td>79.25b</td>
<td>151.18d</td>
<td>240.73b</td>
<td>17.05b</td>
<td>1.3lb</td>
<td>9.01b</td>
<td>46.81b</td>
</tr>
<tr>
<td>Local</td>
<td>80.43c</td>
<td>86.25c</td>
<td>157.94e</td>
<td>272.42c</td>
<td>15.23c</td>
<td>1.07c</td>
<td>16.12e</td>
<td>36.19c</td>
</tr>
<tr>
<td>LSD</td>
<td>1.8</td>
<td>1.71</td>
<td>1.23</td>
<td>23.19</td>
<td>0.80</td>
<td>0.06</td>
<td>6.82</td>
<td>1.50</td>
</tr>
<tr>
<td>CV</td>
<td>3.3</td>
<td>2.90</td>
<td>1.12</td>
<td>12.64</td>
<td>6.62</td>
<td>5.64</td>
<td>76.7</td>
<td>16.73</td>
</tr>
<tr>
<td>p-value</td>
<td>0.0001</td>
<td>0.0001</td>
<td>0.0001</td>
<td>0.0009</td>
<td>0.0001</td>
<td>0.0001</td>
<td>0.0018</td>
<td>0.0001</td>
</tr>
</tbody>
</table>

Source: Own field observation

In Guliso district, BH-661 gave high yield of 62.12qt ha¹ followed by Gibe-2, BHQPY-545 and local with the mean yield of 48.08, 47.24 and 40.64 quintal per hectare respectively. The local variety had low yield which is accompanied with high lodging percentage than other tested varieties of maize. Furthermore, in Lalo Kile district again BH-661 had high yield followed by BHQPY-545 whereas Gibe-2 and the local check indicate third and fourth respectively. Moreover, the result in Dale Sedi district revealed higher mean grain yield for BH-661 than Gibe-2, BHQPY-545 and local which indicated second,
third and the forth respectively. Finally, the result gained from Dale Wabera again revealed high yield for BH-661 followed by BHQPY-545, Gibe-2 and the local. To conclude the result obtained from these four districts of project location revealed high grain yield for BH-661 and low yield for the local check although the same treatment and management practices were applied similarly (Fig. 1).

![Mean Grain Yield of Maize Over Locations](image)

**Fig. 1. Mean grain yield of maize in all trial locations**

**Farmers' Preference and Feedback to the Varieties**

In all four districts (i.e. Guliso, Lalo Kile, Dale Sedi and Dale Wabera) where the trial was carried out farmers preferred first BH-661 among the other varieties due to its high grain yields, high grain filling capacity with no gaps on the cobs, good taste for consumption and higher biomass production which indicates its value for animal feed. Farmers preferred BHQPY-545 as second due to it is very sweet when consumed at fresh and dried as well, it bears almost two ear per plant and it also has good eye quality which is good for making porridge and enjera. Moreover, it also better tolerate to moisture stress which might encountered during planting.

**Conclusions and Recommendations**

Four varieties of maize including the local check were demonstrated on the farmers' field; these varieties were BH-661, BHQPY-545, Gibe-2 and the local check. Different agronomic traits like 50% days to teasing, 50% days to silking, days to mature, plant height, cob (ear) length, number of ears per plant, lodging and grain yield were evaluated for each variety. The result of analysis variance revealed that there was significant difference among the tested maize varieties in all agronomic traits. Accordingly, BH-661 had high yield and plant height.

The project was carried out with full participation of FRG farmers and it was conducted on 16 farmers' field. Farmers were participated in the selection of best performed maize varieties among demonstrated varieties of maize. Accordingly, farmers preferred first BH-661 in all the trial location due it has high yield and good taste. BHQPY-545 performed better than Gibe-2 and local in Lalo Kile and Dale Wabera districts; but, it had low yield than Gibe-2 in Guliso and Dale Sedi districts. However, the farmers of Guliso and Dale Sedi also preferred it next to BH-661 due it bears two ears per plant and its good eye quality which is good for bread and enjera. Since BH-661 and BHQPY-545 were preferred by the farmers both varieties are recommended for scaling up phase.
References


Pre-Extension Demonstration and Evaluation of Improved Tef Varieties in Selected Districts of West and Kellem Wollega Zones

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Abstract

The trial was carried out during 2013 and 2014 cropping seasons in Hawa Gelan and Dale Sedi districts on 14 farmers' field by selecting two peasant associations from each district based on their teff production potentials. Accordingly, Immo and Arere Gebi kebeles were selected from D/sedi district while Arere and Hawa Moi were from Hawa Gelan district. Three varieties (Quncho, Guduru and Ziquala) including local check were evaluated with the objective of selecting adaptable and best performing tef variety under farmers management. Analysis of variance was done across location and the combined analysis of the two districts was also undergone. In Dale Sedi district, the mean grain yields of Guduru and Quncho varieties were 10.43 and 8.39 qt/ha while the yield of Ziquala (6.70 qt/ha) was less than the local variety. Similarly in Hawa Gelan district the mean yields of Guduru (8.92qt/ha) and Quncho (7.76qt/ha) remained higher than the local check (6.56qt/ha). The yield of Ziquala (6.16qt/ha) was also less than the local. The combined analysis of variance revealed that the mean values of grain yield ranged from Ziquala (6.44 qt/ha) to Guduru (9.68qt/ha). Quncho and the local gave 8.07 and 7.39 qt/ha respectively. Farmers' selection criteria were grain yield and seed color. Based on their selection criteria, farmers preferred Guduru for grain yield and Quncho for grain yield plus its very white seeded color. Since, both varieties were preferred by the target community they are recommended to be scaled up.

Key words: Farmers' Evaluation, Grain Yield, Teff

Introduction

Ethiopia is the center of origin and diversity for teff. It is adapted to a wide range of environments and is presently cultivated under diverse agro climatic conditions. It is day length sensitive and flowers best during 12 hours of daylight. Teff performs well between 1700 and 2400 m; however, it can grow from sea level up to 2800 meters above sea level. Apart from other many cereal crops, teff can grow in different physiological conditions. Teff is cultivated in high rainfall areas with long growing periods. It can also grow in low rainfall and drought prone areas characterized by protracted growing seasons and frequent terminal moisture stress. Most of Ethiopian farmers motivated to cultivate teff because of its relative merits over other cereals in the use of both the grain and straw. It is primarily grown for human consumption of its grain which is used to prepare a favorite food of most Ethiopian people called Enjera. Whereas, it's straw is a valuable feed during the dry season when there is an acute shortage. It is highly preferred by cattle over the straw of other cereals and demands high prices in the markets. It also serves to reinforce mud and plaster the wall in local house construction (Engdawork, 2009).

Kellem and West Wollega zones have a high amount of annual rainfall that can enable farmers to grow twice a year and double their produce. Farmers of these areas traditionally practice double cropping using local varieties of teff after maize harvest in late August (Tadesse et al, 2011). These local varieties of teff in spite of having early maturing character, are very poor in yield, susceptible to lodging and have little biomass than recently released varieties. Haro Sebu Agricultural Research Centre was carried out adaptation trial of different teff varieties and had selected three top varieties. However, the adaptation was not seen under farmers' condition. According to Getachew et al. (2008) the two way feedback between
farmers and researchers is indeed vital component of high yielder and disease and pest resistant varietal development process.

Objectives

The project was initiated to achieve the following objectives.

☐ To evaluate and select well performed tef variety/varieties for their localities.
☐ To enhance the skill and knowledge of farmers in tef production and management practices.
☐ To strengthen linkage among farmers, researchers, development agents and other stakeholders

Methodology

The trial was carried out during 2013/2014 and 2014/2015 cropping seasons in Hawa Gelan and Dale Sedi districts on 14 farmers’ field by selecting two peasant associations from each district based their tef production potentials in collaboration with District Agricultural and Rural Development office. Before starting this demonstration trial on farmers’ field, training were given to the farmers on important management practices and monitoring required for the trial.

Three improved varieties of tef namely, Quncho, Guduru, DZ-cr- 358(Ziquala) and one local check were tested for their adaptability with full participation of farmers in the study areas. The spacing between plots and rows were 1.0m and 20cm respectively. Each experimental plot had 10m x 10m with a gross area of 100 m². Planting was done in row by drilling at seed rate of 15kg ha⁻¹. DAP was applied at the rate of 130kg/ha at sowing. UREA was also applied at the rate of 80kg/hectare. Half was applied at the time of planting while the remaining the second half was applied at the time of tillering. Twice hand weeding and other management practices were done as required. Data on plant height (cm), number of tillering, panicle length (cm), lodging(%) and grain yield on plant basis were collected and subject to statistical analysis using SAS statistical software (SAS 9.0). Farmers’ assessment feedback on the technologies (compatibility, affordability, complexity, and applicability) also collected through interacting with farmers.

Results and Discussions

The analysis of variance revealed that there is significant variation among observed agronomic traits of tested tef varieties Quncho, Guduru, Ziquala and the local check (Table 1). Guduru had the highest plant height (105.83cm) followed by Quncho, local and Ziquala with the magnitude of 105.38, 95.95 and 92.46cm respectively. There was significant difference (p<0.0001) among Guduru, Ziquala and the local. But there was no significant difference between Guduru with Quncho.

In term of tillering capacity, Guduru had the highest number of tillers (i.e. 4.46) whereas Ziquala had the smallest than other varieties (3.32). Similarly, there was significant difference between Guduru and Ziquala variety in terms of plant height and also between Guduru and Local check. But there is no significant difference between Guduru and local. Panicle length of Ziquala was 42.85 while yhat of Guduru was 47.38. The local variety had highest lodging percentage of 17%. Guduru variety gave the highest yield (9.86 quintal per hectare) while Quncho, local and Ziquala stood second, third and last with 8.04, 6.44 and 7.39 qt/ha respectively. In general Guduru performed better in yield and in all tested agronomic traits than all other tested varieties whereas Ziquala had low performance in most agronomic traits and yield in spite of having low lodging due to its short height in nature. Quncho was the second better performed variety next to Guduru.
Comparison of the performance of these varieties in Dale Sedi and Hawa Gelan districts shows higher yield in Dale Sedi than Hawa Gelan district. For example, Gudurru gave 10.43 qt/ha in Dale Sedi but, it gave 8.92 quintal per hectare whereas Quncho, Ziquala and the local variety gave relatively higher mean yield of 8.39, 6.70 and 8.16 quintal per hectare in Dale Sedi as compared to the mean yield of 7.76, 6.16 and 6.56 qt/ha respectively that of Hawa Gelan district.

Table 1 Combined mean yield and agronomic traits for tested tef varieties in Dale Sedi and Hawa Gelan districts

<table>
<thead>
<tr>
<th>Varieties</th>
<th>Plant height (cm)</th>
<th>No of tillering</th>
<th>Panicle length</th>
<th>Lodging (%)</th>
<th>Grain yield (qt/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quncho</td>
<td>105.38^a</td>
<td>4.00^ab</td>
<td>46.02^a</td>
<td>16.03^a</td>
<td>8.04^b</td>
</tr>
<tr>
<td>Guduru</td>
<td>105.83^b</td>
<td>4.46^a</td>
<td>47.38^a</td>
<td>15.25^b</td>
<td>9.68^a</td>
</tr>
<tr>
<td>Ziquala</td>
<td>92.46^h</td>
<td>3.32^b</td>
<td>42.85^b</td>
<td>9.64^b</td>
<td>6.44^e</td>
</tr>
<tr>
<td>Local</td>
<td>95.95^b</td>
<td>3.34^b</td>
<td>44.91^b</td>
<td>17.00^b</td>
<td>7.39^b</td>
</tr>
<tr>
<td>LSD</td>
<td>8.09</td>
<td>0.91</td>
<td>2.53</td>
<td>5.86</td>
<td>0.2</td>
</tr>
<tr>
<td>CV</td>
<td>10.58</td>
<td>13.42</td>
<td>7.29</td>
<td>52.88</td>
<td>13.7</td>
</tr>
<tr>
<td>p-value</td>
<td>0.0001</td>
<td>0.0001</td>
<td>0.0065</td>
<td>0.0047</td>
<td>0.0001</td>
</tr>
</tbody>
</table>

Source: On-farm demonstration data

Training

Training was given for farmers and experts on importance of tef in improving small holder farmers' livelihood and the recommended packages (rate of seed and fertilizer, recommended spacing and herbicide). The training covered a total of 80 farmers, 12 development agents and 4 subject matter specialists. Among the farmers trained 55 of them were male while 25 were female.
Mini-Field Day

Mini-field day was organized at Arere kebeles of Hawa Gelan district and Immo kebeles of Dale Sedi district. Farmers of Hawa Moi kebeles were invited and participated on mini-field day organized at Arere Kebele. Similarly, farmers of Arere Gabi kebeles were participated on mini-field day organized at Immo kebeles of Dale Sedi district. During this mini-field day around 120 farmers including non-FRG farmers and 16 experts were participated to evaluate the varieties and select best variety/varieties.

Farmers' Perception and Feedback to the Varieties

Farmers’ feedback assessment about the technologies compatibility and performance were assessed. Farmers’ selection criteria were grain yield and seed color. Based on their selection criteria in both districts (i.e. Dale Sedi and H/Gelan) farmers were preferred first Guduru among the tested tef varieties due to its high grain yields and resistant to major disease. Secondly, Quncho was preferred by the farmers due to it is very white seeded color in addition to its high yield.

Conclusion and Recommendations

In this on-farm demonstration, three varieties namely Quncho, Guduru and Ziquala were demonstrated with the objective of selecting adaptable and best performing tef variety and creating awareness on the importance and use of the technology. Different agronomic traits like plant height, number of tillering, panicle length, lodging and grain yield were considered by the researchers as evaluation criteria. Farmers’ have also suggested grain yield and seed color as important criteria for variety evaluation. Accordingly, of the three varieties, Guduru variety gave highest grain yield relative to the rest varieties in both districts followed by Quncho. However, Ziquala gave lower yield than the local check in both districts of the trail locations.

Based on their selection criteria, farmers’ have selected Guduru for grain yield and Quncho for yield plus its very white seed color. Since, both varieties were preferred by the farmers, both varieties are recommended further scaling up.

References


Participatory On-farm Evaluation and Demonstration of Improved Teff Varieties in Selected Woredas of Borana Zone
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Abstract
The research activity was carried out with the objective of evaluating and identifying adaptable and improved teff varieties and to familiarize farmers and agro-pastoralists with teff production techniques. It was executed at Abaya and Yabello woredas of Borana Zone for two years (2012/13-2014/15). A multidisciplinary team composed of breeder, pathologist, agronomist and agricultural extensionist was closely working both with the farmers and respective woreda agricultural experts and DAs. Regular visits, trainings and field days were conducted to provide for interaction among researchers, extension workers and farmers. The variety selection process was carried out from different dimensions including utilization, marketing and field performance. The major selection criteria of the farmers in the two locations were almost similar except in very few cases where they vary in level of emphasis to a particular criterion. In general, color, panicle length, taste, market demand was identified as important farmer criteria. The other important criteria were related to field performance of the variety that includes: yield and tolerance to disease and insect pest followed by maturity period. Using these criteria the farmers identified varieties that suit their respective location. Accordingly, Abaya farmers showed special interest to Tsedey and Ajord, while that of Yabello to Tsedey and Magna. The most interesting part of the finding was that most of the varieties preferred from utilization and marketing angle were also found superior to the local ones in their field performance. Side by side, with the aim of strengthening local availability of seeds of preferred varieties, farmer based seed production was launched and the seed produced thereby was distributed both in cash and kind from farmers to farmers. Moreover, by way of revolving seed it was attempted to redistribute the seed to other non participant farmers in the area. In so doing both awareness and access to the technology was improved.

Key words: Demonstration, evaluation, teff

Introduction
Teff is grown primarily as a cereal crop in Ethiopia. The word teff is thought to have been derived from the Amharic word “teffa” which means, "lost," due to small size of the grain and how easily it is lost if dropped. It is the smallest grain in the world, ranging from 1–1.7mm long and 0.6–1mm diameter with 1000 seed weight averaging 0.3–0.4 grams and taking 150 grains to weigh as much as one grain of wheat. The common English names for teff are teff, love grass, and annual bunch grass. It is intermediate between a tropical and temperate grass. (Berhe and Miller, 1976.)

Eragrostis tef is adapted to environments ranging from drought stress to waterlogged soil conditions. Maximum teff production occurs at altitudes of 1,800 to 2,100 m, growing season rainfall of 450 to 550 mm, and a temperature range of 10 to 27 °C. Teff is day length sensitive and flowers best with 12 hours of daylight. Teff can produce a crop in a relative short growing season and will produce both grain for human food and fodder for cattle. The grain is either white or a very deep reddish brown in color. Published accounts of teff in the late 1800s report that upper class consumed the white grain, the dark grain was the food of soldiers and servants, while bullocks (Anon. 1894, 1897) consumed hay made from
Teff. Late 20th century publications in the United States describes teff grain as being marketed as a health food product, or used as a late planted emergency forage for livestock (Goerge 1991, Weibye 1991).

Teff can be used as a high quality feed for livestock and horses. Forage quality has compared favorably with Timothy hay. Animal acceptance and palatability has been reported to be excellent by horse owners. Protein content of teff hay can range from 12-20% depending on maturity at cutting. To maximize yield and quality, it is recommended to cut the crop at approximately 30-40 day intervals (David, 2011). Many teff varieties were adapted by the Pastoral and Dry-land Agriculture Research Center in addressing the technology gap that fills both the market and consumption demand. Nevertheless, those technologies were not sufficiently introduced to all potential production sites. Recently adapted food type varieties (Ajord, Tsedey and Magna) were also found potential for small farmers. The varieties were good yielder (up to 1600kg/ha) compared to previous ones and also have short maturity cycle (85 days), they pose an opportunity for the farmers and agro-pastoralists who at times hardly wait too long to feed the family, especially in Borana lowlands where moisture is a limiting factor for crop production. On the other side, most of the farming community had little chance to know and make own choice from the ranges of available teff varieties adapted.

Therefore, this activity was designed to both evaluate the various improved teff varieties with and demonstrate the potential of teff varieties and seed production techniques to farmers and agro-pastoralists in major growing areas in the Borana Zone, particularly, in Abaya and Yabello woredas.

**Objectives**

The objectives of this research were:
- □ To create awareness on the available options of food and market type teff varieties
- □ To evaluate and identify the best varieties using farmers' selection criteria
- □ To improve access to seed by non-participating farmers of the best varieties selected by farmers

**Materials and Methods**

**Site and farmers’ selection**

The activity was carried out in two woredas (Abaya and Yabello) of Borana Zone of Oromia region. It was implemented for two years (2012/13-2014/15); the first year focused mainly on evaluation and identification of the best varieties for the respective sites while farmer based seed multiplication of the best (preferred) varieties was being done in the following year.

In executing the activity an already participated farmers in the respective woredas were involved early from selection of varieties using their own criteria. There were 10 and 20 participating farmers/agro-pastoralists in Abaya and Yabello, respectively. Majority of the farmers were male farmers. The number of female farmers ranged from 3 in Abaya to 8 in Yabello. The woreda agricultural office experts and Development Agents (DA) had also taken part in the implementation process. An inter disciplinary team composed of an Agricultural Extensionist, Breeder, Pathologist and Agronomist was in charge of this activity.

**Materials used**

Three different teff varieties, viz Tsedey, Magna and Ajord were used. Based on the criteria set by the farmers, these varieties were ranked in order from most to least preferred. The ranking process (described
later) was done by identifying farmers' response (from most preferred/very good (score 1) to least preferred/poor (score 3) against each one of the selection criteria.

Research design

The trial was carried out on selected farmers/agro-pastoralists fields in such a way that three varieties (two improved and one local variety) were planted side by side on equal sized plots replicated by the number of participant farmers/agro-pastoralists. The improved varieties used in each site were the ones ranked first and second by bio-physical researchers during the on-site adaptation trial process. The participating farmers/agro-pastoralists were in general given the role of carrying out the actual field activity on their own land as per the agreement reached at a joint planning stage. The trial farmers/agro-pastoralists followed up the trial and recorded their observation on the treatments.

Field visits were conducted every fortnight with a team of researchers, DAs and occasionally with Woreda agricultural office experts. Woreda experts usually participated in a scheduled meetings usually conducted at planning field activity, after planting, mid season and after harvest (evaluative meeting). Trainings were organized to orient farmers, DAs and woreda agricultural office experts about the technical and related matters of the trial to be executed. Moreover, tailor made training was also organized to meet specific needs/gaps observed in the implementation/management of the activity.

In an attempt to create wider interest and awareness field days, attended by Woreda agricultural & rural development office heads, experts, researchers. DAs and surrounding farmers in each trial sites, were organized. In addition, trial farmers and woreda agricultural office experts from Elwaya PA were taken to Darito PA where the trial farmers/agro-pastoralists performed well in implementing the trial activity.

Implementation Process

In line with the methodology described, a number of activities were conducted in the implementation process. These activities had important contribution for active participation of the actors involved.

Awareness creation: Prior to the commencement of the activity frequent visits (two times) were made to respective trial sites to introduce and explain the meaning and importance of the participatory research thereby creating awareness about the research. The points discussed include the role of each actor (farmer, DA, research, SMS) in evaluation, improvement and dissemination of technologies, requirements of being member of trial farmers (willingness and commitment), relation of the trial farmers to the surrounding farmers and planned research activities (variety selection and management practices). Awareness creation on the importance, principles and meaning of FRG (farmer participatory research and extension) was also done over the implementation period.

Introductory Training: Training was organized to introduce the available teff varieties with their nature and management practices to both trial farmers/agro-pastoralists and DAs in respective sites.

In addition, each variety was arranged and leaflet on teff technology was provided to the DA. In addition, they were further explained on the role of each actor in the demonstration activity. During the training the farmers have indicated the criteria they use to select teff varieties. These include seed color, panicle length, taste, and demand in the local market. Then, the varieties were ranked based on the total sum of score given against each of the criteria (see Table 1). Accordingly, it was agreed with the group to conduct the trial using the top three ranked varieties replicated on five farmers/agro-pastoralists from each FRG. The trial farmers were identified, depending on the site, by the DAs as well as by lottery method.
Planning field trial with farmers: discussions were held with participating farmers/agro-pastoralists and DAs on how to manage the trial, i.e., layout, record keeping, regular evaluation at different stage and so on. To this end, each one of the parties (research, DAs and farmers) were given a role to play in the process.

Site selection and land preparation: Site selection was done with the farmers/agro-pastoralists and DAs. The trial sites were identified in such a way that many other surrounding farmers would get the chance to observe the trial while passing by. The trial had two plots of the top preferred teff varieties and a check plot of local variety. The land preparation was carried out by the host (trial) farmers/agro-pastoralists with other members of the FRG farmers assisting and observing the exercise.

Planting, data collection and visits: Planting was done in the presence of trial farmers and DA in each location. Seed, fertilizer (Abaya), data entering forms were provided to host farmers/agro-pastoralists. DAs were also provided with display card of all teff varieties as well as data entry format to record various parameters as they closely monitor the trial. During each visit discussions were made with the farmers/agro-pastoralists and DAs right on the trial field in order to jointly evaluate the performance of the varieties on the field. During the visit both farmer’s and DAs’ data recording format were checked to observe how they handled the information gathering process.

Focused mid-term training: during regular visits, it was recognized that farmers had hard time identifying one disease from another, there was difference in planting pattern (row & broadcasting), weeding and other cultural practice. Accordingly, a tailored midterm training was organized for 30 farmers/agro-pastoralists, 5 DAs and 2 SMS to fill these gaps. During the training, in addition to observed field gaps, participants were divided into small groups and discussed on the following important issues: Record keeping, Group size, Farmers’ participation in FRG activity, problems and weaknesses observed and finally how to handle the task ahead.

The training was accompanied by a visit to one of the trial sites where the farmers/agro-pastoralists got better opportunity to further ask and discuss on issues which were raised during the training session: it helped farmers to get a live experience of how to distinguish between diseases and their symptoms, observe the level of management in the Yabello area and compare with that of theirs. The farmers-to-farmers interaction was also expressed as a good learning opportunity. Such experience (FRG to FRG visit) was found to be a better learning opportunity for the farmers/agro-pastoralists. Most visiting farmers/agro-pastoralists witnessed that their location is more fertile than Yabello, however, due to good management (row planting, proper weeding) Yabello farmers/agro-pastoralists are getting more out of their land. This helped them recognize the significance/value of good management practice.

Evaluative meeting: The result of the demonstration activity was analyzed, presented and discussed with the trial farmers/agro-pastoralists as well as DAs and respective Woreda SMS. Based on the discussion draft plan of what to be done in the following year was prepared.

Field Day and Visits: field days were organized at the two sites where non participant surrounding farmers/agro-pastoralists, DAs, supervisors, extension team leaders, SMS, Administrative heads of the two respective sites, researchers from YPDARC participated. Trial farmers, Extension experts from Abaya also participated the field day at Yabello. During the field day leaflet describing the purpose of the field day and the list of activities were distributed to the participants. Moreover, feedbacks were also collected. DAs also organized visits to surrounding farmers (farmer to farmer) where trial farmers had enough interaction with non trial farmers on the technologies being tried.

Training on quality seed production: Training was organized on the importance and techniques of producing quality teff seed, training was organized on quality seed production. FRG farmers/agro-pastoralists, DAs and SMS (Extension team leaders) from respective woredas participated the training.
Results and Discussions

Selection criteria of farmers/agro-pastoralists

Based on discussion with the trial farmers/agro-pastoralists the following selection criteria were identified. These include physical characteristics (color, panicle length); chemical characteristics (taste); field (agronomic) traits (yield), maturity period, tolerance/resistance to disease and insect pests, germination, growth habit (vigor) and demand in the local market which is basically a reflection of the combination of preferences for certain physical and chemical characteristics.

Based on color, taste and marketability as the first selection criteria the farmers/agro-pastoralists in each site ranked the teff varieties. During the selection process, it was recognized that color, taste as well as yield were the most important criteria of the farmers/agro-pastoralists. Market value was also another important criterion; however, it is basically a reflection of the preferences of the above criteria accordingly, Tsedey variety was ranked first in both sites while Manna was ranked 2\textsuperscript{nd} at Yabello and Ajord ranked the same at Abaya sites.

Yield Performance of the Varieties

The varieties ranked from first to second in respective sites were evaluated for their field performance. In some of the sites, the varieties selected based on physical appearance (color, size), chemical characteristics (taste) and market demand. In Abaya at Samaro PA the varieties tested with ten trial farmers as indicate earlier were Tsedey, Ajord and local variety. As shown in fig 1 below, Tsedey had the highest (45\%) yield advantage over the local followed by Ajord (36\%). There was visible variation among farmers' plot, mainly due to difference in management (ploughing frequency and weeding). The land of three of the farmers was ploughed once while that of other two farmers was not properly weeded and followed up. Only few of the varieties were known in the market that it was difficult to judge the market demand of other varieties prior to observing the demand after awareness creation to the farmers/agro-pastoralists and consumers.

Farmers' participation was not satisfactory probably due to improper farmer selection. The farmers/agro-pastoralists had more tendencies to aid (dependence) than interest in involving in group research and improvement activities. In addition, high turnover of the DAs made it hard to make smooth follow up of the activities. Though, the research team decided to reform/revise the group members in consultation with the incoming DA and woreda extension expert, the new group didn't function properly, either- one reason being the DA new to the area and unable to nominate committed farmers/agro-pastoralists. The reasons for poor involvement of the farmers/agro-pastoralists need to be further investigated either to improve the approach or reform the group otherwise.

Fig. 1. Average Yield of teff varieties, Abaya, 2012/13 and 2013/14
At Yabello, two varieties of teff preferred improved varieties viz Tsedey and Magna and one local variety were tested on twenty farmers/agro-pastoralists field in Yabello at Did-Yabello, Darito, Gagna and Elwaya PAs. The result of the trial is illustrated in figure 8. The farmers/agro-pastoralists in this location showed distinct preference to the teff varieties for market and food. The performance on the agro-pastoralists' field indicated that Tsedey had the highest yield advantage (55%) over the local followed by Magna (33%). In addition to the market value, agro-pastoralists also attached importance to the earliness of Magna. The yield potential as well as consumption preference was also clearly appreciated and exhibited towards the two varieties (Tsedey and Magna).

Comparatively, the locally produced variety was also early maturing but susceptible to disease and pests in addition to lower yield potential. It may be important to note at this point that proper cultural practices are also potential factors for differences in yield between the local varieties and improved ones.

Fig. 2. Average Yield of on farm teff varieties at Yabello, (2012/13 and 2013/14)

**Enhancing access to seeds of preferred varieties by farmer/agro-pastoralists**

Following the selection of varieties by the respective farmers/agro-pastoralists, an arrangement was made to produce the seed on farmers' field thereby improve access to the technology by the surrounding farmers. In addition, events, such as field days were organized to create awareness and interest in surrounding non trial farmers. All the varieties were multiplied by the trial farmers in respective sites. A total of 5.5 qt of Tsedey variety was produced by 9 farmers in Abaya and Yabello districts. Similarly, nearly 3 qt of Ajord and 2.3 qt of Magna varieties were produced in Abaya and Yabello districts respectively. However, it should be noted that amount of seed produced refers to what the research team had recorded in the first year, otherwise, the farmers/agro-pastoralists had produced more from the seeds they harvested in the previous year.

The seed provided for each farmer/agro-pastoralist was collected and revolved to the non trial farmers in respective sites. The information on the quantity of seed produced was also shared to the respective woreda agricultural offices to facilitate the dissemination of the technology from farmers to farmers. It was reported from farmers (Abaya) that there was a temptation on their side to sell the seed as a grain to traders due to problems associated to storage pest. On the other hand, other agro-pastoralists (Yabello) were complaining on lack of market for the seed (Tsedey and Magna) they produced. Both situations were communicated with respective woreda agricultural offices to consider arrangements (to facilitate) whereby the seeds can be passed to surrounding farmers on cash, credit or any other possible means.
Conclusions and recommendations

The trial farmers in the two locations are aware of the physical characteristics and field performance of all the food and market type adapted teff varieties. The major variety selection criteria of farmers in the two locations were almost similar except in very few cases where they vary in level of emphasis to a particular criterion. In general, color, panicle length, taste, market demand was identified as important farmer/agro-pastoralists criteria. The other important criteria were related to field performance of the variety that includes: yield and tolerance to disease and pest followed by maturity period. The farmers have identified, using the above criteria, the varieties that suits their respective location. Accordingly, Abaya farmers showed special interest to Tsedey and Ajord while that of Yabello to Tsedey and Magna.

It was recognized that farmers/agro-pastoralists had little understanding on importance of some cultural practices (row planting, weeding). Training organized to fill such gaps coupled with an on farm visit to Yabello trial farmers’ field had helped the farmers to gain knowledge on the significance of proper managing in teff production. Surrounding non trial farmers got the opportunity to observe and learn the potentials of the improved teff varieties selected by the farmers for respective woredas. Besides, seeds of the best varieties were made available to other farmers through farmer based seed production. Exchange of seed both in cash and kind has already been taking place in respective woredas.

Based on the preference showed by the farmers and field performance of the varieties Tsedey and Ajord in that order are best recommended in Abaya area and Tsedey and Magna in Yabello area. It is believed that the order of importance may change depending on the behavior of the market, nevertheless, fitness to the target environment and preference by the farmers remains in this activity as a proof for significance of the varieties in the respective locations. Despite the high yield potential of preferred varieties in respective woredas, absence of enough market information system leaves no option for incentive to continue production. Thus there need to be a mechanism put in place to provide market information for the farmers. The trial farmers have now developed a better capacity in identifying best varieties and management practices of teff, thus they should be given the opportunity to share their experience to other farmers thereby strengthen farmer to farmer extension. As the preference of the farmers in each sites have already been identified, it will be productive if the extension service consider farmers’ preferences in varietal promotion activity.

References


Participatory On-farm Evaluation and Demonstration of Improved Haricot Bean Varieties in Selected Woredas of Borana Zone
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Abstract
The research activity was carried out with the objective of identifying the most suitable varieties for respective location together with farmers and agro-pastoralists. It was executed at Abaya and Yabello woredas of Borana Zone for two years (2012/13-2014/15). A multidisciplinary team composed of breeder, pathologist, agronomist and agricultural extensionist was closely working both with the farmers and respective woreda agricultural experts and DAs. Regular visits, trainings and field days were conducted to provide for interaction among researchers, extension workers and farmers. The variety selection process was carried out from different dimensions including utilization, marketing and field performance. The major selection criteria of the farmers in the two locations were almost similar except in very few cases where they vary in level of emphasis to a particular criterion. In general, color, size, cookability (easiness to cook), taste, market demand were identified as important farmer criteria. The other important criteria were related to field performance of the variety that includes: yield and tolerance to disease and insect pest followed by maturity period. Using these criteria the farmers identified varieties that suit their respective location. Accordingly, Abaya farmers showed special interest to Hawassa-Dume and Omo-95, while that of Yabello to Hawassa-Dume, Omo-95 (for food) and Batu (for early maturity and market). The yield advantage of the preferred varieties over the local ones ranged from 7.8% in Yabello to 32.8% in Abaya compared to the local checks 19.4 and 34.8 q/ha respectively. The most interesting part of the finding was that most of the varieties preferred from utilization and marketing angle were also found superior to the local ones in their field performance. Side by side, with the aim of strengthening local availability of seeds of preferred varieties, farmer based seed production was launched and the seed produced thereby was distributed both in cash and kind from farmers to farmers. Moreover, by way of revolving seed it was attempted to redistribute the seed to other non participant farmers in the area. In so doing both awareness and access to the technology was improved.

Key words: participatory, evaluation, demonstration, haricot bean, varieties

Introduction
Haricot bean (Phaseolus vulgaris) is one of the lowland pulse crops produced in various parts across Ethiopia including central, southern, eastern, western, north western and northern regions. It is predominantly grown for cash in central rift valley and for food, supplementing the protein source of poor farmers, in most other parts of the country. Haricot bean is extensively consumed in traditional dishes. The commonest forms of preparations of dry beans are “Nifro”, mixed with sorghum or maize or with “wasa” and “wot” - a curry. It is also consumed as vegetable in some parts of the country. Early maturity and double cropping often make beans the first food to become available after the annual “hunger gap” and sometimes the only crop to survive in a short growing season (Habtu, 1995). The dietary importance of the crop is, especially, high in southern Ethiopia where “enset” and other starch root crops require adequate additions of concentrated protein sources. Apart from this, the fresh leaves, straw and pod, are used as high protein supplement to grass fodder (Lowland Pulse Research Strategy, 2000).

The significance of haricot bean as a cash crop for small farmers cannot be overemphasized. Farmers sell dry beans, fresh beans, immature pods and dry bean flour in food markets throughout Ethiopia. Almost all
export production comes from small farmers especially, in Central Rift Valley followed by Southern, Eastern and Western parts of the country. In 1973, 10% of Ethiopia’s total export earnings came from sales of haricot beans. Even in 2005 the country earned USD 60 million from export market (Ethiopian Custom Authority, 2006).

Many haricot bean varieties were adapted by the Pastoral and Dry-land Agriculture Research Center in addressing the technology gap that fills both the market and consumption demand. Nevertheless, those technologies were not sufficiently introduced to all potential production sites. Recently adapted food type varieties (Hawassa-Dume, Omo-95 and Batu) were also found potential for small farmers. The varieties were good yielder (up to 3480kg/ha) compared to previous ones and also have short maturity cycle (89 days), they pose an opportunity for the farmers who at times hardly wait too long to feed the family, especially in Borana lowlands where moisture is a limiting factor for crop production. On the other side, most of the farming community had little chance to know and make own choice from the ranges of available haricot bean varieties adapted.

Therefore, this activity was designed to both evaluate the various improved haricot bean varieties with and demonstrate the potential of haricot bean varieties and seed production techniques to farmers in major growing areas in the Borana Zone, particularly, in Abaya and Yabello woredas.
Objectives

The objectives of this research were:

- To create awareness on the available options of food and market type haricot bean varieties
- To evaluate and identify the best varieties using farmers' selection criteria
- To improve access to seed by non-participating farmers of the best varieties selected by farmers

Materials and Methods

Site and farmers selection

The activity was carried out in two woredas (Abaya and Yabello) of Borana Zone of Oromia region. It was implemented for two years (2012/13-2014/15): the first year focused mainly on evaluation and identification of the best varieties for the respective sites while farmer based seed multiplication of the best (preferred) varieties was being done in the following year.

In executing the activity an already participated farmers in the respective woredas were involved early from selection of varieties using their own criteria. There were 14 and 16 participating farmers in Abaya and Yabello, respectively. Majority of the farmers were male farmers. The number of female farmers ranged from 3 in Abaya to 4 in Yabello. The woreda agricultural office experts and Development Agents (DA) had also taken part in the implementation process. An inter disciplinary team composed of an Agricultural Extensionist, haricot bean breeder, Pathologist, Entomologist and Agronomist was in charge of this activity.

Materials used

Three different haricot bean varieties, viz Hawassa-Dume, Omo-95 and Batu were used. Based on the criteria set by the farmers, these varieties were ranked in order of their preference. The ranking process (described later) was done by identifying farmers' response (from most preferred/very good (score 1) to least preferred/poor (score 3) against each one of the selection criteria.

Research design

The trial was carried out on selected farmers' fields in such a way that four varieties (three improved and one local variety) were planted side by side on equal sized plots replicated by the number of participant farmers. The improved varieties used in each site were the ones ranked first, second and third by biophysical researchers during the on-site adaptation trial process. At Abaya, Hawassa-Dume and Omo-95 varieties were demonstrated with local (check) on 12 farmers’ fields. Where as, in Yabello, Hawassa-Dume, Omo-95 and Batu varieties were evaluated and demonstrated along with local (check) on 16 farmers’ fields. The participating farmers were in general given the role of carrying out the actual field activity on their own land as per the agreement reached at a joint planning stage. The trial farmers followed up the trial and recorded their observation on the treatments. Other participating farmers were given a chance to evaluate the performance of all other varieties than those preferred within ranks from first to third. They also took part in multiplication of best preferred varieties.

Field visits were conducted every fortnight with a team of researchers, DAs and occasionally with Woreda agricultural office experts. Woreda experts usually participated in a scheduled meetings usually conducted at planning field activity, after planting, mid season and after harvest (evaluative meeting). Trainings were organized to orient farmers, DAs and woreda agricultural office experts about the technical and related matters of the trial to be executed. Moreover, tailor made training was also organized to meet specific needs/gaps observed in the implementation/management of the activity. In an
attempt to create wider interest and awareness field days, attended by Woreda agricultural & rural development office heads, experts, researchers, DAs and surrounding farmers in each trial sites, were organized. In addition, trial farmers and woreda Agricultural office experts from Elwaya PA were taken to Darito PA where the trial farmers performed well in implementing the trial activity.

Implementation Process

In line with the methodology described, a number of activities were conducted in the implementation process. These activities had important contribution for active participation of the actors involved.

Awareness creation: Prior to the commencement of the activity frequent visits (two times) were made to respective trial sites to introduce and explain the meaning and importance of the participatory research thereby creating awareness about the research. The points discussed include the role of each actor (farmer, DA, research, SMS) in evaluation, improvement and dissemination of technologies, requirements of being member of FRG (willingness and commitment), relation of the FRG to the surrounding farmers and planned research activities (variety selection and management practices). Awareness creation on the importance, principles and meaning of FRG (farmer participatory research and extension) was also done over the implementation period.

Introductory Training: Training was organized to introduce the available haricot bean varieties with their nature and management practices to both trial farmers and DAs in respective sites.

In addition, each variety was arranged and leaflet on haricot bean technology was provided to the DA. In addition, they were further explained on the role of each actor in the demonstration activity. During the training the farmers have indicated the criteria they use to select haricot bean varieties. These include seed color, size, taste, cooking time, demand in the local market.

Variety Selection process before planting: The trial farmers in each site were provided with few kilos of seed (3-4kg) from each variety to do evaluation using their selection criteria. The farmers were asked to rate each variety: as Very good (score 1); Good (score 2); Poor (score 3), against each criterion based on the group consensus. Then, the varieties were ranked based on the total sum of score given against each of the criteria. Accordingly, it was agreed with the group to conduct the trial using the top three ranked varieties replicated on four farmers from each FRG. The trial farmers were identified, depending on the site, by the DAs as well as by lottery method.

Planning field trial with farmers: discussions were held with participating farmers and DAs on how to manage the trial, i.e., layout, record keeping, regular evaluation at different stage and so on. To this end, each one of the parties (research, DAs and farmers) were given a role to play in the process. PRA exercises such as seasonal calendar was also prepared with the trial farmers to understand the seasonal flow of activities in the respective sites and plan our activities accordingly.

Site selection and land preparation: Site selection was done with the farmers and DAs. The trial sites were identified in such a way that many other surrounding farmers would get the chance to observe the trial while passing by. The trial had three plots of the top preferred bean varieties and a check plot of local variety. The land preparation was carried out by the host (trial) farmers with other farmers assisting and observing the exercise.

Planting, data collection and visits: Planting was done in the presence of trial farmers and DA in each location. Seed, fertilizer, data entering forms were provided to host farmers. DAs were also provided with display card of all haricot bean varieties as well as data entry format to record various parameters as they closely monitor the trial. Based on a pre-informed visit it was attempted to follow up the trial on average.
every two weeks. During each visit discussions were made with the farmers and DAs right on the trial field in order to jointly evaluate the performance of the varieties on the field. During the visit both farmer’s and DAs’ data recording format were checked to observe how they handled the information gathering process.

**Focused mid-term training:** During regular visits, it was recognized that the farmers had hard time identifying one disease from another, there was difference in planting pattern (row & broadcasting), weeding and other cultural practices. Accordingly, tailored mid-term training was organized for 22 farmers 5 DAs and 2 SMS to fill these gaps. During the training, in addition to observed field gaps, participants were divided into small groups and discussed on the following important issues: Record keeping, Group size, Farmers’ participation in FRG activity, problems and weaknesses observed and finally how to handle the task ahead. The following was summary of the discussion in each group:

- **Record Keeping:** both farmers and DAs need to be properly trained on how to record data and the record sheet needs to be provided timely. Moreover, the interval with which data has to be recorded should be clearly explained so that timely and proper weight would be given to the recording activity.

- **Group Size:** it was suggested that while maintain existing group size, creating sub groups under different trials, as already practiced, would facilitate follow up and discussion.

- **Farmers participation:** it was suggested that to improve level of participation the awareness level on the activity has to be raised, farmers’ selection should be done carefully in collaboration with DAs and woreda SMS, the follow up by the DAs as well as farmer to farmer communication and cooperation should be strengthened.

- **Other issues:** the issue of farmer selection and low awareness level on the nature of the activity were most critically mentioned as the reason for low farmer participation. Moreover, it was also suggested that if a regular meeting forum can be created for FRGs to meet and discuss among them and learn from one another. It was also suggested to organize a prize for well performed FRGs as well as DA to increase their work motivation.

The training was accompanied by a visit to one of the trial sites where the farmers got better opportunity to further ask and discuss on issues which were raised during the training session: it helped farmers to get a live experience of how to distinguish between diseases and their symptoms, observe the level of management in the Yabello area and compare with that of theirs. The farmers-to-farmers interaction was also expressed as a good learning opportunity. Such experience (farmer to farmer visit) was found to be a better learning opportunity for the farmers. Most visiting farmers witnessed that their location is more fertile than Yabello, however, due to good management (row planting, proper weeding) Yabello farmers are getting more out of their land. This helped them recognize the significance/value of good management practice.

**Evaluative meeting:** The result of the FRG trial activity was analyzed, presented and discussed with the FRG farmers as well as DAs and respective Woreda SMS. Based on the discussion draft plan of what to be done in the following year was prepared.

**Research team meeting:** The research team conducted totally three (one ad-hoc and two planned) meeting for planning the whole activity, organize mid-term training and prepare for presenting and discussing the final result with the farmers and DAs thereby design the action plan for the following year together with the group.

**Field Day and Visits:** field days were organized at the two sites where non participant surrounding farmers, DAs, supervisors, extension team leaders, SMS, Administrative heads of the two respective sites,
researchers from YPDARC participated. FRG farmers. Extension experts from Abaya also participated in the field day at Yabello. During the field day leaflet describing the purpose of the field day and the list of activities were distributed to the participants. Moreover, feedbacks were also collected. DAs also organized visits to surrounding farmers (farmer to farmer) where FRG farmers had enough interaction with non FRG farmers on the technologies being tried.

Cross visits to each one of the two sites were also arranged for the respective DAs for sharing of the experience among them in executing the FRG activities. This created a positive tension and learning opportunity in coordinating FRG farmers and the activities by the respective DAs. In addition, extension team leaders of the two woredas visited the FRG activities in their respective sites whereby awareness was created on the progress of the activities by respective FRG farmers and DAs.

**Training on quality seed production:** Training was organized on the importance and techniques of producing quality haricot bean seed, training was organized on quality seed production. FRG farmers, DAs and SMS (Extension team leaders) from respective woredas participated the training.

**Results and Discussions**

**Selection criteria of farmers**

Based on discussion with the trial farmers the following selection criteria were identified. These include physical characteristics (color, size/shape); chemical characteristics (cookability, taste); field (agronomic) traits (yield (pod per plant), maturity period, tolerance/resistance to disease and insect pests, germination, growth habit (vigor) and shattering habit) and demand in the local market which is basically a reflection of the combination of preferences for certain physical and chemical characteristics.

Based on color, size, cookability, taste and marketability as the first selection criteria, farmers in each site ranked the haricot bean varieties (Table 1). During the selection process, it was recognized that color, size/shape, taste as well as yield were the most important criteria of the farmers. Market value was also another important criterion; however, it is basically a reflection of the preferences of the above criteria.

**Table 1: Rank of different haricot bean varieties as evaluated by farmers at the two sites**

<table>
<thead>
<tr>
<th>Name of the variety</th>
<th>Rank given in respective sites</th>
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<tbody>
<tr>
<td></td>
<td>Abaya farmers</td>
</tr>
<tr>
<td>Hawassa-Dume</td>
<td>1</td>
</tr>
<tr>
<td>Omo-95</td>
<td>2</td>
</tr>
<tr>
<td>Batu</td>
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</table>

**Yield performance of the varieties**

The varieties ranked from first to third in respective sites were evaluated for their field performance. In some of the sites, the varieties selected just by using their physical (color, size), chemical (taste, cookability) and market also exhibited outstanding field performance. However, this was not the case in all the sites. There were certain varieties (not in the top three) which also showed conspicuous field
performance being highly appreciated by the farmers for their field performance and cheaped in the farmers' preference.

In Abaya at Samaro PA the varieties tested with twelve trial farmers as indicate earlier were Hawassa-Dume, Omo-95 and local variety. As shown in fig 1 below, Hawassa-Dume had the highest (32%) yield advantage over the local followed by Omo-95 (18%). Although Omo-95 was appreciated for being early maturing, its susceptibility to bean stem maggot (BSM) and poor germination was expressed as a concern by the farmers. Unlike Hawassa-Dume which had similar field performance and preference for food as Omo-95, the latter was highly preferred by the farmers. However, if Batu can be introduced into the existing market, it can be an additional option for the producers. The local variety was comparatively found poor both in yield and uniformity.

Disease incidence (wilt and bean stem maggot /BSM/) was more important than Insect pests, Omo-95 being the most susceptible variety. As it was during pre planting ranking, the varietal preference remained the same even after evaluation of field performance. Hawassa-Dume ranked high in the groups' preference. There was visible variation among farmers’ plot, mainly due to difference in management (ploughing frequency and weeding). The land of one of the farmers was ploughed once while that of other two farmers was not properly weeded and followed up.

Though maize is a dominant crop followed by bean the latter is recognized as a security crop in time of moisture stress, i.e., when farmers face a problem of planting maize due to late onset of rain, bean becomes the only alternative. Only few of the varieties were known in the market that it was difficult to judge the market demand of other varieties prior to observing the demand after awareness creation to the farmers and consumers.

At Yabello, three preferred improved haricot bean varieties viz Hawasa-Dume, Omo-95, Batu and one local variety were tested on sixteen farmers field in Yabello at Did-Yabello, Darito and Elwaya PAs. The result of the trial is illustrated in figure 2 below. The farmers in this location showed distinct preference to haricot bean varieties for market (Batu) and for food (Hawasa-Dume and Omo-95). The performance on the farmers' field indicated that Hawasa-Dume had the highest yield advantage (33%) over the local followed by Omo-95 (16%) and Batu (7%). In addition to the market value, farmers' also attached importance to the earliness of Batu. The yield potential as well as consumption preference was also clearly appreciated and exhibited towards the two varieties (Hawasa-Dume and Omo-95).

There was an observed minor incidence of shattering on Hawasa-Dume as reported from one of the trial farmer; nevertheless, the farmers had already developed interest in producing the varieties due to the mentioned potentials. Comparatively, the locally produced variety was also early maturing but susceptible to disease and pests in addition to lower yield potential. It may be important to note at this point that
proper cultural practices are also potential factors for differences in yield between the local varieties and improved ones.

Fig. 2. Average Yield of on farm haricot bean varieties at Yabello. (2012/13 and 2013/14)

Generally in Yabello, Batu and another white bean variety - Local were preferred for market (color) whereas Hawasa-dume and Omo-95 for food consumption purpose. The yield potential of Hawasa-dume and Omo-95 was an indication of the potential yield that the farmers can gain with better and improved management (weeding, land preparation, row planting). The varieties (Hawasa-dume and Omo-95) captured the interest of the farmers mainly because of their field performance (disease and insect pest tolerance and potential yield) as well as taste in the local recipe. In the beginning, there was almost no interest shown to this varieties (due to their red color) until the farmers got the chance to see the performance on the field and realized the taste.

**Enhancing access to seeds of farmer preferred varieties**

Following the selection of varieties by the respective farmers, an arrangement was made to produce the seed on farmers' field thereby improve access to the technology by the surrounding farmers. In addition, events, such as field days were organized to create awareness and interest in surrounding non trial farmers. All the varieties were multiplied by the trial farmers in respective sites. Accordingly, a total of 4.4 qt seed of Hawasa-Dume variety was produced by 7 farmers in abaya and Yabello districts. Similarly, 4.8 qt of Omo-95 variety was produced in Abaya and Yabello districts and 1.45 qt of Batu variety produced by two farmers in Yabello district. However, it should be noted that the figure indicated on the quantity of seed produced refers to what the research team had followed up, otherwise, the farmers had produced more from the seeds they harvested in the previous year.

The seed provided for each farmer was collected and revolved to the non trial farmers in respective sites. The information on the quantity of seed produced was also shared to the respective woreda agricultural offices to facilitate the dissemination of the technology from farmers to farmers. It was reported from farmers (Abaya) that there was a temptation on their side to sell the seed as a grain to traders due to problems associated to storage pest. On the other hand, other farmers (Yabello) were complaining on lack of market for the seed (Hawasa-Dume and Omo-95) they produced. Both situations were communicated with respective woreda agricultural offices to consider arrangements (to facilitate) whereby the seeds can be passed to surrounding farmers on cash, credit or any other possible means.
Conclusion and Recommendations

Based on agro-pastoralists' preference and field performance of the varieties, Hawasa-Dume and Omo-95 recommended for Abaya areas and Hawasa-Dume, Batu and Omo-95 for Yabello areas. It is believed that the order of importance may change depending on the behavior of the market. Nevertheless, fitness to the target environment and preference by the farmers remains as a proof for significance of the varieties in the respective locations. Based on the result of study, the following points were recommended:

- Ensuring active involvement of the respective woreda agricultural offices is critical in sustaining the activity. Accordingly, they should take active part from planning through evaluation of demonstration activities. This can fill up the gap that may possibly arise due to change of DAs or any extension staff from operation site and also due to capacity limitation from the side of research institutes.

- In order to ensure and sustain availability of seeds of the preferred varieties through farmer based seed production, there should be a viable storage technology/facility.

- It would be of high importance to develop manuals/guidelines on features and control mechanisms of important haricot bean disease and pests as well as on features of different haricot bean varieties.

- It was observed that there is a better scope to improve productivity by improving the management practices which were less practiced by most farmers specially, in Yabello area. Therefore, it would be necessary that follow up activities need to emphasize on improving cultural practices such as weeding, land preparation, row planting.

- Despite the high yield potential of preferred varieties in respective woredas, absence of enough market information system leaves no option for incentive to continue production. Thus there need to be a mechanism put in place to provide market information for the farmers.

- The FRG farmers have now developed a better capacity in identifying best varieties and management practices of haricot bean, thus they should be given the opportunity to share their experience to other farmers thereby strengthen farmer to farmer extension.

- As the preference of the farmers in each sites have already been identified, it will be productive if the extension service consider farmers' preferences in varietal promotion activity.

References


Demonstration of Improved Highland Maize varieties in Bule Hora District of Borana Zone

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Abstract

The research activity was carried out with the objective of evaluating and identifying adaptable and improved maize varieties and to familiarize farmers with maize production techniques. It was executed at BuleHora woreda of Borana Zone for two years (2012/13-2014/15). A multidisciplinary team composed of breeder, pathologist, agronomist and agricultural extensionist was closely working both with the farmers and respective woreda agricultural experts and DAs. Regular visits, trainings and field days were conducted to provide for interaction among researchers, extension workers and farmers. The variety selection process was carried out from different dimensions including utilization, marketing and field performance. The major selection criteria of the farmers in the trial sites were almost similar except in very few cases where they vary in level of emphasis to a particular criterion. In general, biomass production, cob size, seed size, grain color, palatability of stover, suitability for Injera and bread, market demand were identified as important farmer criteria. The other important criteria were related to field performance of the variety that includes: yield and tolerance to disease and insect pest followed by maturity period. Using these criteria the farmers identified varieties that suit their respective location. Accordingly, trial farmers showed special interest to Jibat and Wenchi. The yield advantage of the preferred varieties over the local ones ranged from 48.83% to 67.44% compared to the local checks 64 and 72 q/ha respectively.

Key words: Demonstration, Maize, Variety

Introduction

Maize (Zea mays, L., Poaceae family), also known as corn, is the world's third most important cereal grain after wheat and rice. Cultivated maize may have originated from the pod corn indigenous to low land of southern America. However, De Wet et al (1972) suggested that teosinte like grass could be the world wild progenitor, although known extinct. Enchilana mexicana (teosinte) is the closest wild relative of maize. In Ethiopia maize is produced for food, especially, in major maize producing region mainly for low-income groups, it also used as staple food. Maize is grown in almost all the agro-ecology ranging from arid to highly humid areas, from very cold region of altitude to warm temperature of Sahara desert in the soil that range from purely sandy to heavy clay and from flat to land to the steep slope of hill. This is attributed to the availability its ability of enormous genetic variability within the specious and its ability to yield new genotype adaptable to varied and contrasting environment (Beyene et al, 1998).

Maize is grown primarily for grain and secondarily for fodder. All parts of the crop can be used for food and non-food products. In industrialized countries, maize is largely used as livestock feed and as a raw material for industrial products. Maize accounts for 30–50% of low-income household expenditures in Eastern and Southern Africa. A heavy reliance on maize in the diet, however, can lead to malnutrition and vitamin deficiency diseases such as night blindness and kwashiorkor. (CGIAR, 2009) Common warm weather cereal crops in Ethiopia are maize, sorghum, and millet, where they are cultivated mostly at lower altitudes along the country's western, southwestern, and eastern peripheries. These three grains are the staple foods for a large part of the population and are major items in the diet for pastoralists. Maize is...
Maize is characterized by more resistant to drought. The crop can recover from early season drought. Maize is sensitive to freezing temperature except in very early stage and can recover from the effect of frost if it occurs if the plant is less than 15 cm height. (Leonard and Martin 1963). From this finding it is evident that maize can recover from early adverse climatic condition during early stage. Hence, early sowing of maize with onset of rains, even at the risk early drought due to late onset of regular rains recommended. Similarly early sowing to avoid pest and disease may be resorted to even at the risk of freezing temperature during early crop periods.

In most parts of Borana highland small scale maize production gradually become permanent activity for different purpose. However, the production and productivity is very low. Therefore, there is strong interest from farmers to replace the currently growing low yielding variety by improved maize variety. To achieve this demonstration and evaluation of released highland maize variety for their adaptability and agronomic performance is essential to tackle the problem which cause lack of food security. Therefore, this activity was designed to both evaluate the various improved maize varieties with and demonstrate the potential of maize varieties to farmers in major growing areas in the Borana Zone, particularly, in Bule-hora woreda.

Objectives

The objectives of this activity were:

- To create awareness on the available options of maize varieties
- To evaluate and identify the best varieties using farmers' selection criteria

Materials and Methods

Site and farmers selection

The activity was carried out in Bule-hora woreda of Borana Zone of Oromia region. It was implemented for two years (2012/13-2014/15). In executing the activity an already participated farmers (12 male and 3 females) in the woreda were involved early from selection of varieties using their own criteria. The woreda agricultural office experts and Development Agents (DA) had also taken part in the implementation process. An inter disciplinary team composed of an Agricultural Extensionist, Breeder, Pathologist, Agronomist was in charge of this activity.

Materials used

Two different maize varieties, viz Jibat and Wenchi were used. Based on the criteria set by the farmers, these varieties were ranked in order from most to least preferred. The ranking process (described later) was done by identifying farmers' response (from most preferred/very good (score 1) to least preferred/poor (score 3) against each one of the selection criteria.
Research design

The trial was carried out on 15 farmers' fields in such a way that the two improved varieties; Jibat and Wenchi were planted side by side with the local variety on equal sized plots replicated by the number of participant farmers. The improved varieties used in each site were the ones ranked first and second by bio-physical researchers during the on-site adaptation trial process. The participating farmers were in general given the role of carrying out the actual field activity on their own land as per the agreement reached at a joint planning stage. The trial farmers followed up the trial and recorded their observation on the treatments.

Field visits were conducted every fortnight with a team of researchers, DAs and occasionally with Woreda agricultural office experts. Woreda experts usually participated in a scheduled meetings usually conducted at planning field activity, after planting, mid season and after harvest (evaluative meeting). Trainings were organized to orient farmers, DAs and woreda agricultural office experts about the technical and related matters of the trial to be executed. Moreover, tailor made training was also organized to meet specific needs/gaps observed in the implementation management of the activity.

In an attempt to create wider interest and awareness field days, attended by Woreda agricultural & rural development office heads, experts, researchers, DAs and surrounding farmers in each trial sites, were organized. In addition, trial farmers and woreda Agricultural office experts from Gerba 01 and Gerba 02 PA were taken to Hera lephitu PA where the trial farmers performed well in implementing the trial activity.

Implementation Process

In line with the methodology described, a number of activities were conducted in the implementation process. These activities had important contribution for active participation of the actors involved.

**Awareness creation:** Prior to the commencement of the activity frequent visits (two times) were made to respective trial sites to introduce and explain the meaning and importance of the participatory research thereby creating awareness about the research. The points discussed include the role of each actor (farmer, DA, research, SMS) in evaluation, improvement and dissemination of technologies, requirements of being member of FRG (willingness and commitment), relation of the FRG to the surrounding farmers and planned research activities (variety selection and management practices). Awareness creation on the importance, principles and meaning of FRG (farmer participatory research and extension) was also done over the implementation period.

**Introductory Training:** Training was organized to introduce the available maize varieties with their nature and management practices to both trial farmers and DAs in respective sites.

In addition, each variety was arranged and leaflet on maize technology was provided to the DA. In addition, they were further explained on the role of each actor in the demonstration activity. During the training the farmers have indicated the criteria they use to select maize varieties. These include Biomass production, cob size, seed size, grain color, palatability of stover, suitability for Injera and bread, demand in the local market.

**Planning field trial with farmers:** discussions were held with participating farmers and DAs on how to manage the trial, i.e., layout, record keeping, regular evaluation at different stage and so on. To this end, each one of the parties (research, DAs and farmers) were given a role to play in the process. Seasonal calendar was also prepared with the trial farmers to understand the seasonal flow of activities in the respective sites and plan our activities accordingly.
Site selection and land preparation: Site selection was done with the farmers and DAs. The trial sites were identified in such a way that many other/surrounding farmers would get the chance to observe the trial while passing by. The trial had two plots of the top preferred bean varieties and a check plot of local variety. The land preparation was carried out by the host (trial) farmers with other members of the FRG farmers assisting and observing the exercise.

Planting, data collection and visits: Planting was done in the presence of trial farmers and DA in each location. Seed, fertilizer, data entering forms were provided to host farmers. DAs were also provided with display card of all maize varieties as well as data entry format to record various parameters as they closely monitor the trial.

Based on a pre-informed visit it was attempted to follow up the trial on average every two weeks. During each visit discussions were made with the farmers and DAs right on the trial field in order to jointly evaluate the performance of the varieties on the field. During the visit both farmer’s and DAs’ data recording format were checked to observe how they handled the information gathering process.

Focused mid-term training: During regular visits, it was recognized that farmers had hard time identifying one disease from another. There was also difference in planting pattern, weeding and other cultural practices. Accordingly, tailored midterm training was organized for 15 farmers, 3 DAs and 2 SMS to fill these gaps. During the training, in addition to observed field gaps, participants were divided into small groups and discussed on the following important issues: Record keeping, Group size, Farmers’ participation in FRG activity, problems and weaknesses observed and finally how to handle the task ahead.

The training was accompanied by a visit to one of the trial sites where the farmers got better opportunity to further ask and discuss on issues which were raised during the training session: it helped farmers to get a live experience of how to distinguish between diseases and their symptoms, observe the level of management in the Hera lephitu area and compare with that of theirs. The farmers-to-farmers interaction was also expressed as a good learning opportunity. Such experience (FRG to FRG visit) was found to be a better learning opportunity for the farmers. Most visiting farmers witnessed that their location is more fertile than Hera lephitu, however, due to good management (row planting, proper weeding) Hera lephitu farmers are getting more out of their land. This helped them recognize the significance/value of good management practice.

Evaluative meeting: The result of the demonstration activity was analyzed, presented and discussed with the trial farmers as well as DAs and respective Woreda SMS. Based on the discussion draft plan of what to be done in the following year was prepared.

Field Day and Visits: Field days were organized at the three sites where non participant surrounding farmers, DAs, supervisors, extension team leaders, SMS, administrative heads of the respective sites, researchers from YPDARC participated. During the field day leaflet describing the purpose of the field day and the list of activities were distributed to the participants. Moreover, feedbacks were also collected. DAs also organized visits to surrounding farmers (farmer to farmer) where FRG farmers had enough interaction with non FRG farmers on the technologies being tried.
Results and Discussions

Selection criteria of farmers

Based on discussion with the trial farmers the following selection criteria were identified. These include biomass production, cob size, seed size, grain color, and palatability of stover, suitability for Injera and bread, and demand in the local market which is basically a reflection of the combination of preferences for certain physical and chemical characteristics. Based on these selection criteria the farmers in each site ranked the maize varieties. Accordingly, Jibat variety was ranked first while Wenchi was ranked 2nd by farmers in the study sites. During the selection process, it was recognized that color, size, taste as well as yield were the most important criteria of the farmers. Market value was also another important criterion; however, it is basically, a reflection of the preferences of the above criteria.

Yield performance of the varieties

In this study, the two preferred varieties; Jibat and Wenchi were evaluated for their field performance on fifteen trial farmers. Accordingly, the field performance result shows Jibat had the highest (67%) yield advantage over the local followed by Wenchi (48%)(Fig 1). Although both varieties were appreciated for being high yielder, its susceptibility to leaf rust was expressed as a concern by the farmers. The local variety was comparatively found poor both in yield and uniformity. There was visible variation among farmers’ plot, mainly due to difference in management (ploughing frequency and weeding). The land of two of the farmers was ploughed once while that of other three farmers was not properly weeded and followed up.

Farmers’ participation was not satisfactory; this was assumed to be a reflection of improper farmer selection. The farmers had more tendencies to aid (dependence) than interest in involving in group research and improvement activities. In addition, high turnover of the DAs made it hard to make smooth follow up of the activities. Though, the research team decided to reform/revise the group members in consultation with the incoming DA and woreda extension expert, the new group didn’t function properly, either- one reason being the DA new to the area and unable to nominate committed farmers. The reasons for poor involvement of the farmers need to be further investigated either to improve the approach or reform the group otherwise.

![Performance Graph](image)

Fig. 1. Average Yield of maize varieties, Bule-Hora, 2012/13 and 2013/14
Conclusion and Recommendations

The major variety selection criteria of farmers in the trial sites were almost similar except in very few cases where they vary in level of emphasis to a particular criterion. In general, color, size, cookability (easiness to cook), taste, market demand were identified as important farmer criteria. The other important criteria were related to field performance of the variety that includes: yield and tolerance to disease and pest followed by maturity period. Farmers have identified, using the above criteria, the varieties that suits their respective location. Accordingly, the trial farmers showed special interest to Jibat and Wonchi.

It was recognized that farmers had little understanding on importance of some cultural practices (row planting, weeding). Training organized to fill such gaps coupled with an on farm visit to Hera lephitu FRG farmers’ field had helped the farmers to gain knowledge on the significance of proper weeding and row planting in maize production. Based on the preference showed by the farmers and field performance of the varieties Jibat and Wonchi in that order are best recommended in Bule-hora area. It is believed that the order of importance may change depending on the behavior of the market, nevertheless, fitness to the target environment and preference by the farmers remains in this activity as a proof for significance of the varieties in the respective locations.

It was observed that there is a better scope to improve productivity by improving the management practices which were less practiced by most farmers specially, in Gerba 01 area. Therefore, it would be necessary that follow up activities need to emphasize on improving cultural practices such as weeding, land preparation, row planting. Despite the high yield potential of preferred varieties in respective sites, absence of enough market information system leaves no option for incentive to continue production. Thus there need to be a mechanism put in place to provide market information for the farmers.

The trial farmers have now developed a better capacity in identifying best varieties and management practices of maize, thus they should be given the opportunity to share their experience to other farmers thereby strengthen farmer to farmer extension. As the preference of the farmers in each sites have already been identified, it will be productive if the extension service consider farmers’ preferences in varietal promotion activity.

References


Participatory On-farm Evaluation and Demonstration of Groundnut Varieties in Abaya Woreda of Borana Zone

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Abstract

The research activity was carried out with the objective of evaluating and identifying adaptable and improved groundnut varieties and to familiarize farmers with groundnut production techniques. It was executed at Abaya woreda of Borana Zone for two years (2012/13-2014/15). A multidisciplinary team composed of breeder, pathologist, agronomist and agricultural extensionist was closely working both with the farmers and woreda agricultural experts and DAs. Regular visits, trainings and field days were conducted to provide for interaction among researchers, extension workers and farmers. The variety selection process was carried out from different dimensions including utilization, marketing and field performance. In general, color, size, market demand were identified as important farmer criteria. The other important criteria were related to field performance of the variety that includes: yield and tolerance to disease and insect pest followed by maturity period. Using these criteria the farmers identified varieties that suit their respective location. Accordingly, Abaya farmers showed special interest to Tole-1, Fayo and NC4x. The most interesting part of the finding was that most of the varieties preferred from utilization and marketing angle were also found superior in their field performance. Side by side, with the aim of strengthening local availability of seeds of preferred varieties, farmer based seed production was launched and the seed produced thereby was distributed both in cash and kind from farmers to farmers. Moreover, by way of revolving seed it was attempted to redistribute the seed to other non participant farmers in the area. In so doing both awareness and access to the technology was improved.

Key words: Participatory, Evaluation, Demonstration, ground nut, Variety

Introduction

Ground nuts are grown as oil crops and grain legume crops. It is a major cash crop and widely grown in all in all tropical and subtropical region of the world for direct use as food, oil and high protein meal. Ground nuts are a warm season crop and need abundant sunshine and warm climate for their normal growth. They are adaptable to a wide range of climatic conditions, that completely intolerant to frost at any growth stage and require relatively high temperature throughout it’s growing seasons. Although the plant requires adequate moistures during its growing seasons followed by distinctive dry seasons during pod ripen and maturity. As fruiting and pegging periods are critical times, adequate moistures should be available at these periods. Excessive moistures and high temperatures reduce the yield. (Bell and Cruickshank, 1996). On the other hand ground nuts may have substantial beneficial effects relative to non legume crops on immediately subsequent non legume crops, which may ascribed to soil nitrogen difference (Philips and Norman, 1962). Ground nuts are extremely soil exhausting when nuts and entire top growth are harvested. Where the top growth is buried in to the soil after removing the nuts, the effect on the soil is less harmful.

Many groundnut varieties were adopted by the Pastoral and Dryland Agriculture Research Center in addressing the technology gap that fills both the market and consumption demand. Nevertheless, those technologies were not sufficiently introduced to all potential production sites. Recently released groundnut varieties (Tole-1, Fayo and NC4x) were also found potential for small farmers. The varieties
were good yielder (up to 3890kg/ha) compared to previous ones and also have short maturity cycle (146 days), they pose an opportunity for the farmers who at times hardly wait too long to feed the family, especially in Borana lowlands where moisture is a limiting factor for crop production. On the other side, most of the farming community had little chance to know and make own choice from the ranges of available groundnut varieties adapted.

Therefore, this activity was designed to both evaluate the various improved groundnut varieties with and demonstrate the potential of groundnut varieties and seed production techniques to farmers in major growing areas in the Borana Zone, particularly, in Abaya woreda.

Objectives

The objectives of this activity were:

- To create awareness on the available options of food and market type groundnut varieties
- To evaluate and identify the best varieties using farmers' selection criteria
- To improve access to seed by non-participating farmers of the best varieties selected by farmers

Materials and Methods

Site and farmers selection

The activity was carried out in Abaya woreda of Borana Zone of Oromia region. It was implemented for two years (2012/13-2014/15): the first year focused mainly on evaluation and identification of the best varieties for the respective sites while farmer based seed multiplication of the best (preferred) varieties was being done in the following year.

In executing the activity an already participated farmers (12 male and 4 females) in the woreda were involved early from selection of varieties using their own criteria. The woreda agricultural office experts and Development Agents (DA) had also taken part in the implementation process. An inter disciplinary team composed of an Agricultural Extensionist, Breeder, Pathologist, and Agronomist was in charge of this activity.

Materials used

Three different groundnut varieties, viz Tole-1, Fayo and NC4x were used. Based on the criteria set by the farmers, these varieties were ranked in order from most to least preferred. The ranking process (described later) was done by identifying farmers’ response (from most preferred/very good (score 1) to least preferred/poor (score 3) against each one of the selection criteria.

Research design

The trial was carried out on selected farmers’ fields in such a way that three varieties were planted side by side on equal sized plots replicated by the number of participant farmers. The improved varieties used in each site were the ones ranked first, second and third by bio-physical researchers during the on-site adaptation trial process. The participating farmers were in general given the role of carrying out the actual field activity on their own land as per the agreement reached at a joint planning stage. The trial farmers followed up the trial and recorded their observation on the treatments. They also took part in multiplication of best preferred varieties.

Field visits were conducted every fortnight with a team of researchers, DAs and occasionally with Woreda agricultural office experts. Woreda experts usually participated in a scheduled meetings usually
conducted at planning field activity, after planting, mid season and after harvest (evaluative meeting). Trainings were organized to orient farmers, DAs and woreda agricultural office experts about the technical and related matters of the trial to be executed. Moreover, tailor made training was also organized to meet specific needs/gaps observed in the implementation/management of the activity. In an attempt to create wider interest and awareness field days, attended by Woreda agricultural & rural development office heads, experts, researchers, DAs and surrounding farmers in each trial sites, were organized.

**Implementation Process**

In line with the methodology described, a number of activities were conducted in the implementation process. These activities had important contribution for active participation of the actors involved.

**Awareness creation:** Prior to the commencement of the activity frequent visits (two times) were made to the trial sites to introduce and explain the meaning and importance of the participatory research thereby creating awareness about the research. The points discussed include the role of each actor (farmer, DA, research, SMS) in evaluation, improvement and dissemination of technologies, requirements of being member of FRG (willingness and commitment), relation of the FRG to the surrounding farmers and planned research activities (variety selection and management practices). Awareness creation on the importance, principles and meaning of FRG (farmer participatory research and extension) was also done over the implementation period.

**Introductory Training:** Training was organized to introduce the available groundnut varieties with their nature and management practices to both trial farmers and DAs in the trial sites.

In addition, each variety was arranged and leaflet on groundnut technology was provided to the DA. In addition, it was agreed with the group to conduct the trial using the top three ranked varieties replicated on four farmers from each FRG. The trial farmers were identified, depending on the site, by the DAs as well as by lottery method.

**Planning field trial with farmers:** discussions were held with participating farmers and DAs on how to manage the trial, i.e., layout, record keeping, regular evaluation at different stage and so on. To this end, each one of the parties (research, DAs and farmers) were given a role to play in the process. Seasonal calendar was also prepared with the trial farmers to understand the seasonal flow of activities in the trial sites and plan our activities accordingly.

**Site selection and land preparation:** Site selection was done with the farmers and DAs. The trial sites were identified in such a way that many other/surrounding farmers would get the chance to observe the trial while passing by. The trial had three plots of the top preferred groundnut varieties. The land preparation was carried out by the host (trial) farmers with other members of the FRG farmers assisting and observing the exercise.

**Planting, data collection and visits:** Planting was done in the presence of trial farmers and DA in each location. Seed, data entering forms were provided to host farmers. DAs were also provided with display card of all groundnut varieties as well as data entry format to record various parameters as they closely monitor the trial. Based on a pre-informed visit it was attempted to follow up the trial on average every two weeks. During each visit discussions were made with the farmers and DAs right on the trial field in order to jointly evaluate the performance of the varieties on the field. During the visit both farmer's and DAs' data recording format were checked to observe how they handled the information gathering process.
Focused mid-term training: During regular visits, it was recognized that farmers had hard time in identifying one disease from another. There was also difference in planting pattern, weeding and other cultural practices. Accordingly, tailored midterm training was organized for 24 farmers, 5 DAs and 2 SMS to fill these gaps. During the training, in addition to observed field gaps, participants were divided into small groups and discussed on the following important issues: Record keeping, Group size, Farmers’ participation in demonstration activity, problems and weaknesses observed and finally how to handle the task ahead. The training was accompanied by a visit to one of the trial sites where the farmers got better opportunity to further ask and discuss on issues which were raised during the training session: it helped farmers to get a live experience of how to distinguish between diseases and their symptoms, observe the level of management in the area and compare with that of theirs. The farmers-to-farmers interaction was also expressed as a good learning opportunity. Such experience (farmer to farmer visit) was found to be a better learning opportunity for the farmers.

Evaluative meeting: The result of the demonstration activity was analyzed, presented and discussed with the trial farmers as well as DAs and respective Woreda SMS. Based on the discussion draft plan of what to be done in the following year was prepared.

Research team meeting: The research team conducted totally three (one ad-hoc and two planned) meeting for planning the whole activity, organize mid-term training and prepare for presenting and discussing the final result with the farmers and DAs thereby design the action plan for the following year together with the group.

Field Day and Visits: field days were organized at the trial sites where trial farmers, non participant surrounding farmers, DAs, supervisors, extension team leaders, SMS, administrative heads of the trial sites, and researchers from YPDARC participated. During the field day leaflet describing the purpose of the field day and the list of activities were distributed to the participants. Moreover, feedbacks were also collected. DAs also organized visits to surrounding farmers (farmer to farmer) where trial farmers had enough interaction with non trial farmers on the technologies being tried.

Results and Discussions

Selection criteria of farmers

Based on color, size, taste and marketability as the first selection criteria farmers in the trial sites ranked the groundnut varieties. Accordingly, Tole-1, Fayyo and NC4x varieties were ranked 1st to 3rd respectively. During the selection process, it was recognized that color, size/shape, taste, yield and market demand were the most important criteria considered by farmers.

Yield Performance of the Varieties

In Abaya at Samaro PA the varieties tested with sixteen trial farmers as indicated earlier were Tole-1, Fayy and NC4x variety. As shown in figure 1 below, Tole-1 had the highest (37 Qt/ha) yield followed by Fayo (35 Qt/ha) and NC4x (34 Qt/ha). There was visible variation among farmers’ plot, mainly due to difference in management (ploughing frequency and weeding). The land of one of the farmers was ploughed once while that of other two farmers was not properly weeded and followed up. Only few of the varieties were known in the market that it was difficult to judge the market demand of other varieties prior to observing the demand after awareness creation to the farmers and consumers.

Farmers’ participation was not satisfactory; this was assumed to be a reflection of improper farmer selection. The farmers had more tendencies to aid (dependence) than interest in involving in group research and improvement activities. In addition, high turnover of the DAs made it hard to make smooth
follow up of the activities. Though, the research team decided to reform/revise the group members in consultation with the incoming DA and woreda extension expert, the new group didn’t function properly, either- one reason being the DA new to the area and unable to nominate committed farmers. The reasons for poor involvement of the farmers need to be further investigated either to improve the approach or reform the group otherwise.

Figure 1. Average Yield of groundnut varieties, Abaya, 2012/13 and 2013/14

Enhancing Access to Seeds of Farmer Preferred Varieties

Following the selection of varieties by the trial farmers, an arrangement was made to produce the seed on farmers’ field thereby improve access to the technology by the surrounding farmers. In addition, events, such as field days were organized to create awareness and interest in surrounding non trial farmers. All the varieties were multiplied by the trial farmers in respective sites. Accordingly, 98 kg, 87kg and 85 kg seed of Tole-1, Fayo and NC4x varieties were produced. However, it should be noted that the figure indicated on the quantity of seed produced refers to what the research team had followed up, otherwise, the farmers had produced more from the seeds they harvested in the previous year.

The seed provided for each farmer was collected and revolved to the non trial farmers in respective sites. The information on the quantity of seed produced was also shared to the respective woreda agricultural offices to facilitate the dissemination of the technology from farmers to farmers. It was reported from farmers (Abaya) that there was a temptation on their side to sell the seed as a grain to traders due to problems associated to storage pest. The situation was communicated with respective woreda agricultural office to consider arrangements (to facilitate) whereby the seeds can be passed to surrounding farmers on cash, credit or any other possible means.

Conclusion and Recommendations

The major variety selection criteria of farmers in the trial sites were almost similar except in very few cases where they vary in level of emphasis to a particular criterion. In general, color, size, taste, market demand was identified as important farmer criteria. The other important criteria were related to field performance of the variety that includes: yield and tolerance to disease and pest followed by maturity period. Farmers have identified, using the above criteria, the varieties that suits their respective location. Accordingly, the farmers showed special interest to Tole-1, Fayo and NC4x.

Based on the preference showed by the farmers and field performance of the varieties Tole-1, Fayo and NC4x are the first three recommended Ground nut varieties for mid altitudes and moisture sufficient areas
of Borana lowlands. Ensuring active involvement of the respective woreda agricultural offices is critical in sustaining the activity. Accordingly, they should take active part from planning through evaluation of demonstration activities. This can fill up the gap that may possibly arise due to change of DAs or any extension staff from operation site and also due to capacity limitation from the side of research institutes.

It is essential to ensure, from the beginning, clear understanding of extension approach to actors (farmers, extension workers, researchers and others) involved. This is believed to have a strategic implication for sustainability of the intervention. The idea of cost sharing and capacity development should have a clear and strong footing early in the beginning to facilitate psychological preparation against the notion of free gift and dependency. Designing a mechanism whereby the extension workers’ contribution in the demonstration activity would be recognized is also central to motivate the extension staff’s involvement. In this line, creating a sense of competition between DAs, Experts, trial farmers (among and within groups) and open recognition via reward to outstanding groups/individuals can be one of the potential means. In order to ensure and sustain availability of seeds of the preferred varieties through farmer based seed production, there should be a viable storage technology/facility.

Despite the high yield potential of preferred varieties in respective woredas, absence of enough market information system leaves no option for incentive to continue production. Thus there need to be a mechanism put in place to provide market information for the farmers. The farmers have now developed a better capacity in identifying best varieties and management practices of groundnut, thus they should be given the opportunity to share their experience to other farmers thereby strengthen farmer to farmer extension. As the preference of the farmers in the trial sites have already been identified, it will be productive if the extension service considers farmers’ preferences in varietal promotion activity.

References


Demonstration of Soya bean Technology in Borana Lowlands of Southern Oromia
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Abstract
The research activity was carried out with the objective of identifying the most suitable varieties for respective location together with farmers and agro-pastoralists. It was executed at Abaya and Yabello woredas of Borana Zone for two years (2012/13-2014/15). A multidisciplinary team composed of breeder, pathologist, agronomist and agricultural extensionist was closely working both with the farmers and respective woreda agricultural experts and DAs. Regular visits, trainings and exchange visits were conducted to provide for interaction among researchers, extension workers and farmers/agro-pastoralists. The variety selection process was carried out from different dimensions including utilization, marketing and field performance. The major selection criteria of the farmers in the two locations were almost similar except in very few cases where they vary in level of emphasis to a particular criterion. In general, color, size, cookability (easiness to cook), taste, market demand were identified as important farmer criteria. The other important criteria were related to field performance of the variety that includes; yield and tolerance to disease and insect pest followed by maturity period. Using these criteria the farmers identified varieties that suit their respective location. Accordingly, Abaya farmers showed special interest to Chari, AFGAT and Clark- 636, while that of Yabello to Williams, Crawford and Nova (for early maturity).

Key words: Demonstration, soya bean, technology

Introduction
Soy bean (Glycine max L.). Soybean is an internationally known important pulse for different pulse crop. It is used for different purposes. The by product is cheap and an important source of proteins for both human consumption and animal feed. Soy beans has great potential for Ethiopia as it has been duly recognized by many researchers and research centers for its economic importance and chemical compositions (Martin, 1970). Soybeans is generally adapted to high rainfall, medium altitude and lowland region with elevation of 1300-2100masl. Soybeans uses are numerous as human food and animal feed. Due to its versatile uses of soybean is known in many parts of the world as complete food plant, golden beans, miracle beans, crops of planets, the cow of china, the meats of fields, protein hope of future and God’s golden beans (Hintle, 1975).

Soybeans or beans are considered as low status food, “meat of poor”. It is an important and cheap source of proteins in diet of many people in tropical country and used as a supplement for food rich in carbohydrates such as maize and other cereal. Planting of soybeans variety with varying maturity can reduced the risk associated with weathers. So it is urgent to develop this crop type to the prevailing environmental condition of Borana lowlands to support the resource farmers who cannot afford animal products.

Objectives

➢ To demonstrate and introduce the improved varieties
To evaluate the productivity and profitability of the technology under farmers' condition

To improve the livelihood of the agro-pastorals/farmers from technology demonstrated

Materials and Methods

The study was conducted in Yaballo and Abaya districts of Borana zone. Yaballo district located on Moyale tarmac road 563kms from Addis Ababa and characterized by bi-modal rainfall in which long rainy season March to May and short rainy season from September to October is dominant. Abaya district also located on 363kms from Addis Ababa and is different from Yaballo only by some of the areas where mid-high lands are present.

Materials used

The varieties we used for demonstration were Chari, AFGAT, Clark, Williams, Crawford and Nova. Chari, AFGAT and Clark were demonstrated in Abaya whereas Williams, Crawford and Nova were demonstrated in Yaballo. Those varieties were selected for demonstration purpose based on early maturity, flowering, yield and market. Thus, Chari, AFGAT and Clark were selected for demonstration in Abaya in recommendation and Williams, Crawford and Nova were selected for demonstration in Yaballo.

Inputs Used

The technology that presented for extension requires full packages in terms of fertilizer, all agronomic practices, and tools used for land preparation to threshing. 0.5kgs of UREA and 1kg of DAP fertilizer application was used in its recommendation in Abaya. The tools we used for land preparation were hoe, yoke, 50 meters material; for monitoring and Evaluation note book, paper, and bags for carrying those materials and pesticides while the disease emergences happened; for threshing thick stick, shera, sack and 100kg weight material.

Sampling Design

The Districts Abaya and Yaballo were selected purposively because of accessibility of the road, representativeness of the rest districts. The farmers were selected by community discussion, with key informants and community leaders participation meeting because all communities were interested to implement the technologies without considering that the technology has promise or not but the farmers category in the adoption rate technology is different we used the above methods. Thus, the communities, key informants and community leaders had selected model farmers/pastorals residents from their ollas. As a result of these sixteen pastoralists/farmers were selected from both Yaballo and Abaya districts that is 8 pastoralists/farmers from each district.

Training

Training is one of the extension approaches used for technology promotion and demonstration. From this point of view the technology we tried to demonstrate in the required training then. We trained 16 farmers/agro-pastoralists and 2 DAs and 2 experts from total of two districts. On the training the agronomic practices, technology utilization, and home consumption and market arena are the issues covered through training for trainees.

Site selection

The first implementation step is site selection that is very crucial in any demonstration study since a number of bodies can learn from the lessons present with that demonstration design to landscape
selection. The sites were carefully selected by considering water lodge, road accessibility, center of the community, nearby farmers/pastorals and nearest to road from the direction of the local one which sown nearby for comparison.

**Land preparation**

Site preparation is second step which qualify the selected land for its purpose. Accordingly, land was prepared with farmers/pastorals early prior to two months of the main rainy season by clearing unnecessary forbs and residues then plough at least four times to control some diseases remain like for example rust.

**Research design**

The standard design we used was 10m*10m for improved varieties by comparing the local one unfortunately there was no local varieties. For the first two or three varieties 10m*10m land was prepared for by faring one meter long distance among each that road was used for management simply without disturbing the plants in its germination and stand time. Thus, the improved varieties were compared nearby to compare each and the communities can learn something from that difference in order to have lesson in care method. 0.6kg seed and 0.8kg fertilizer (0.1kg DAP and 0.5kg UREA) was applied in Abaya but no fertilizer applied in Yaballo.

**Results and discussions**

Six soya-bean varieties namely Chari, AFGAT, Clark; Williams, Crawford and Nova were used for the purpose of demonstration and Evaluation. In Abaya wereda, Chari variety had higher in yield than AFGAT and Clark (figure 1). It also had more pod per plant.

![Fig. 1. Field performance (average yield) of soya bean in Abaya, 2013/14](image)

In Yabello district, William variety was higher in yield than Crawford and Nova (Fig.2). It has shown good results than Crawford and Nova varieties in all farmers’ fields because of its more number of pods per plant.
Fig. 2. Average yield of soya bean in Yabello, 2013/14

Conclusion and Recommendations

The soya-bean improved varieties (Chari, AFGAT and Clark, and Williams, Crawford and Nova) demonstrated in the selected districts Abaya and Yaballo respectively were new for the agro-pastoralists/farmers we introduced for. In Abaya Chari was highest in yield to AFGAT and Clark. Since these improved varieties were introduced in new form the farmers in Abaya focused on yield to select it first to AFGAT and Clark, second Clark and third AFGAT so that they need all varieties with their consumption methods, market areas, training again and again on protection, management from sowing to store. In Yaballo Williams was first in yield and agro-pastorals selected it first, second Crawford and third Nova. In Yaballo almost the communities have the same attitude with Abaya towards these varieties. Therefore, from this conclusion we recommend that: Provision of the supply source, training on home consumption methods, market issues, its agronomic management from sowing to store are indispensable for farmers/agro-pastoralists.

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Participatory Evaluation and Demonstration of Improved Tomato Variety in East Hararghe Zone, Oromia Region, Ethiopia

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Abstract
The activity was conducted in two districts of East Hararghe namely Babile and Fedis districts during 2013 and 2014 cropping season. Participatory on farm demonstration and evaluation of improved variety of tomato was carried out on six farmers’ fields located in Erer Ibada PA of Babile district and Nagaya Umer Kulle PA of Fedis district with purpose of demonstrating and evaluating the improved tomato variety and create awareness on the availability and importance of the technology. Improved tomato variety (Melka-Shola) was planted along with local variety on six farmers’ fields. The result of on-farm demonstration and evaluation work revealed that Melka-Shola variety produced the highest fruit yield of 24910.00 kg ha⁻¹. The variety provided 52.8% higher fruit yield ha⁻¹ as compared to local variety. Assessment of farmers’ preference also indicated that Melka-sholla is highly preferred by farmers due to its high fruit yield, resistance to disease and insects, frequency of harvest and market preference, and thus the variety can be further scaled-up to address more farmers in the target areas.

Keywords: Participatory, demonstration, evaluation, farmers’ preferences, improved tomato variety

Introduction
In Ethiopia, tomato is one of major vegetables grown by smallholder farmers for home consumption and marketing. The crop is a high value commodity which has the potential for improving the incomes and livelihoods of smallholder farmers in Ethiopia and diversifying and increasing Ethiopia’s agricultural export exchange earnings (Lemma, 2001). It constitutes a major source of cash income for smallholder farm households and traders, and an opportunity to increase smallholder farmers’ participation in the production and marketing system. Currently, tomato mainly recognized as quality product for both local and export markets and providing a route out of poverty for small scale producers who live in developing countries in general and in Ethiopia in particular (Tewodros & Asfaw, 2013).

In Eastern Hararghe Zone of Oromia region, tomato is one of the major cash crops grown by smallholder farmers in the area, which is produced two times per year using rain water and irrigation for marketing and then generate income from the tomato production. The area has suitable climate condition and market opportunities for tomato production. However, for many years, tomato production in the area was highly limited by the lack of improved varieties, inadequate knowledge on production and management, and harvest and post harvest handling problems. Besides, there is a high fruit loss due to disease, insects’ attack and sunburn, and poor access to biocides to control diseases. Hence, farmers produce local varieties which are low yielding with poor quality and less demanded by buyers at local markets and the product hardly competes with those tomato varieties brought from central parts of the country.

To address these problems, and enhance productivity and income generation capacity of the tomato producers, adaptation of tomato varieties have been conducted by Fedis Agricultural Research Center and one improved tomato variety (Meklashola) was found to be high yielding, disease resistant, and good
market attributes. Hence, this activity was initiated for participatory demonstration and evaluation of the variety with farmers, and creates awareness to farmers in tomato growing areas of East Haraghe Zone.

Methodology

Description of study area

The study was conducted in Babile and Fedis districts of East Hararghe zone of the Oromiya region. Agro-climatically, Babile district has dominated by lowland. The altitude varies between 950 to 2000 masl. Livestock-crop mixed farming is the major livelihood activity. The main crops grown are khat, maize, and sorghum, groundnut, and vegetables while cattle, sheep, goats, camels, chickens and donkeys are the major livestock species kept. Fedis has midland and lowland which account for 39% and 61% of the total area, respectively. The altitude varies between 500 to 2100 masl. Agriculture is the major source of livelihood of the community. The farming system of the district is subsistence type dominated by smallholder farmers. The main crops grown in the area include sorghum, maize, groundnut and vegetables crops. Livestock husbandry includes cattle, goats, chicken, camel and donkey are common.

Site and farmers’ selection

The activity was implemented in Babile and Fedis districts of East Hararghe by involving farmers, Development agents (DAs), experts and different stakeholders (offices of agriculture). For the intended purpose, representative sites were purposively selected based on potential area in tomato production, access to irrigation water, accessibility for field monitoring and follow up, and field visits were considered while sites selection. Accordingly, Erer Ibadci Kebele from Babile district and Nagaya Umer Kulle Kebele from Fedis district were selected based on accessibility in collaboration with districts offices of agricultural.

Similarly, farmers’ selection was conducted in collaboration with experts and development agents. Participating farmers was selected based on their willingness/interest, access to irrigation water, ability to risk taker and ability to allot land for the intended purpose. Once the selection of sites and farmers is accomplished, the selected farmers from the sites were organized as FRGs (Farmers Research Groups), and a total of two FRGs having 30 farmers were organized for the intended purpose. Finally, a total of six (6) farmers were selected as trial farmers to conduct the trials.

Research design

The improved tomato variety (Melka-Shola) was planted along with the local variety to establish demonstration and evaluation trials on the selected farmers in the target kebeles. The variety was planted along with recommended agronomic practices (seedling rate, spacing, fertilizer applications, weeding) was implemented on farmers’ fields in the target area. The trial for evaluation and demonstration of improved tomato variety was implemented on the farmers’ fields in the target area, and this variety was planted along with the local variety. The trials were conducted on six (6) farmers’ fields following the procedure of simple plot design and where farmers are used as replication. The tomato was planted on a plot size of 10 m x 10 m with spacing 100 cm x 30 cm were used, and all recommended agronomic practices applied.

The evaluation and demonstration of the variety was followed process demonstration approach by involving FRG farmers as well as other stakeholders at different growth stage of the crops. All recommended agronomic practices were applied for the trials. The activity was jointly monitored and followed up by FRG farmers, researchers, experts and development agents.
Technology evaluation and demonstration methods/techniques

For the effective implementation of the activity, farmers, DAs and experts were trained on improved tomato production technologies, agricultural marketing extension, and post harvest handling technologies. Moreover, field visit was organized to enhance farmer to farmer learning and experience sharing among farmers and other stakeholders. Furthermore, training was provided for farmers and DAs on tomato seed maintenance and seedling preparation technique for wider dissemination of the technologies in the target area. A result demonstration method was used to clearly show the superiority of improved tomato variety over the local one.

Method of data collection and analysis

Qualitative data such as farmers’ perception, and quantitative data such fruit yield per plant and fruit yield per hectare were collected using checklist developed for the intended purpose through field observation, group discussion and individual interview, and then analyzed using descriptive statistics and narrative.

Results and discussions

Training of farmers and other stakeholders

Prior to implementation, training was provided to farmers, development agents and experts on improved tomato production and management practice, harvest and post harvest handling, tomato seed maintenance for enhancing their knowledge and skill. Accordingly, a total of 30 farmers (24 male and 6 women), 5 DAs and 2 experts attended the training.

Farmers’ and other stakeholders’ participation in demonstration

The demonstration and evaluation of the improved tomato variety was implemented by involving farmers, development agents, and experts. Experts from Office of Agriculture, development agents and farmers are involved in the demonstration and evaluation of the improved tomato varieties. District Office of Agriculture has been actively involving from selection of site and trial farmers as well as demonstration and evaluation processes. In addition, experts and DAs played important role in mobilizing farmers during training and field visits. In collaboration with experts from office of agriculture provided trainings for the farmers and DAs, on the objectives of demonstration and evaluation trials, technological packages of the variety of the crop and importance of farmers’ involvement in the evaluation processes. In the process of demonstration and evaluation of the trials, the FRG farmers and DAs were actively participated starting from land preparation up to harvesting. The FRG farmers were managed the trials and closely evaluating growth performances of the varieties at different crop growth stages.

For demonstration and evaluation of the trials, field visit was organized by involving farmers, DAs and experts for exchange knowledge among the participants in the area. Accordingly, a total of 36 farmers (29 women and 7 men), 12 DAs and 6 experts were participated. Agronomic data, yield, and farmers’ evaluation of the performances of the varieties and their preferences were recorded by researchers.

Yield of tomato varieties

Improved tomato variety (Melka-shola) was demonstrated and evaluated on six farmers’ fields during 2013 and 2014 cropping seasons in the target area. The variety produced significantly higher yields per hectare as compared to local variety, and also highly preferred by the farmers due to it high yielding, tolerance to disease and insect pests, tolerance to moisture stresses and market attributes in the target area.
The result of yield evaluation for fruit yield ha$^{-1}$ indicated significantly higher yield potential of variety Melka-Shola as compared to local. As shown in Figure 1 Melka-shola produced the highest total fruit yield of 24910.00 kg ha$^{-1}$. Compared with the local, Melka-shola variety provided 52.8% higher fruit yield ha$^{-1}$.

![Figure 1. Yield performance of improved and local varieties](image)

**Farmers' preference**

During demonstration and evaluation process of the tomato varieties, farmers evaluate the performances of the varieties using their own criteria under their management practices in the area. Accordingly, Melka-shola variety was highly preferred by farmers due to its fruit yield, resistance to disease and insects, frequency of harvest, fruit color and market preference. In addition, its shape and size fits to the market attributes required by traders and the fruits are not easily damaged during transportation to market centres.

Nowadays, some farmers are able to maintain seeds, raise seedling and producing the variety using rainfed and irrigation and they transfer the technologies to other farmers. As a result, some farmers have highly benefited from the variety and improved their livelihoods. For instance, some farmers have earned about Birr 7000 to 13000 per season from 185 to 720 m$^2$ of land.

**Conclusions and recommendations**

This study was demonstrated that the improved tomato variety which is vital to produce better tomato yield in the study area. The demonstration and evaluation of improved variety for tomato has shown high yield potential variety which created opportunity for increased yield and income of smallholder farmers of study the area. As evaluated by the farmers' evaluation and yield data, the Melka-Shola produced highly desirable yield as compared to local variety. The results of the study indicated that variety high yielder and also most preferred variety by farmers in the study area. The fruit yield advantage of the variety was 52.8% as compared to local variety. This indicating that farmers can be improved their tomato production in the study area by using improved tomato variety. Therefore, based on this finding, Melka-Shola can be recommended for promotion and up scaling to address more farmers of lowland districts of East-Hararghe Zone in collaboration with other stakeholders especially with seed producers and suppliers.
References


Participatory Demonstration and Evaluation of Improved Rice Technology in Ilu-Harar district of Ilu-Ababora Zone

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Abstract

This participatory demonstration and evaluation of improved rice technology, was carried out in Ilu-Harar district, Jagan PA on four (4) farmers and on 100 m² plots of land. The purpose was to demonstrate & evaluate improved rice technologies with FRGs, to create awareness on the importance of the commodity, to make better linkage with target beneficiaries and stakeholders and finally to collect feedback on the performance of rice production technologies. The activity was conducted for one year using two varieties: Chawaka and Nerica 1 as a standard check. Accordingly, Chawaka variety beat the standard check in all of the traits except time of maturity which take longer period than the standard check. The on farm yield performance of the Chawaka and the standard check, Nerica 1 were 40.67 and 26.5 respectively and on average Chawaka had a yield advantage of 53.47% than Nerica. Hence, Chawaka should be further scaled up/out to more number of farmers and on wider area in the coming years.

Keywords: Rice demonstration; Participatory variety evaluation and selection; Farmers Research Group; Chawaka and Nerica 1

Introduction

Rice (Oryza sativa L.) is the foremost staple food for more than 50% of the world's population. It is estimated that by the year 2025, farmers in the world should produce about 60% more rice than at present to meet the food demands of the expected world population at that time (Thakur et al., 2011). Rice is the world's second leading cereal exceeded only by that of wheat (Poehlman and Sleper, 1995). In terms of production, rice is the fourth most important cereal (after sorghum, maize and millet) in sub-Saharan Africa. It occupies 10 percent of the total land under cereal production and accounts for 15 percent of total cereal production (FAOSTAT, 2006). Rice has become a highly strategic and priority commodity for food security in Africa. Consumption is growing faster than that of any other major staple on the continent because of high population growth, rapid urbanization and changes in eating habits (Seck et al., 2013). It is the single most important source of dietary energy in West Africa and the third most important for Africa as a whole. Although local rice production increased rapidly after the 2007-2008 food crisis, a key problem facing the rice sector in Africa in general is that local production has never caught up with demand. The continent therefore continues to rely on importation to meet its increasing demand for rice.

Rice cultivation is a recent phenomenon in Ethiopia. The cultivation has started in a number of regions in the country and has been progressing steadily (MoARD, 2010). Generally, rice has great potential and can play a critical role in contributing to food and nutritional security, income generation, poverty alleviation and socio-economic growth of Ethiopia. Amongst of the target commodities that have received due emphasis in promotion of agricultural production, rice is considered as the “Millennium crop” expected to contribute to ensuring food security in the country.

Even though its productivity is high and lot of potential rice producing areas in Ethiopia at large and in western Oromia in particular; little has been done to demonstrate, evaluate and transfer improved upland rice varieties with their agronomic practices. Thus, this activity aimed at demonstrating, evaluating and transferring the technologies and varieties at farmers’ field there by outspreading (scaling up/out) of those
selected technologies to the end users based on farmers' selection criteria. These in turn increase household income and contribute more to food security so as to alleviate food shortage.

Objectives

This activity was mainly with the following objectives:

- To demonstrate & evaluate improved rice technologies with FRGs
- To create awareness on the importance of the commodity
- To enhance better linkage with target beneficiaries and stakeholders
- To collect feedback on the performance of rice production technologies

Methodology

Description of the study area

Ilu-Harar district is located in mid-altitude sub-humid zone in the southwestern part of Ethiopia. It is one of the administrative divisions under Illu Ababora Zone of Oromia Regional National State. It is located at 654 km from Addis Ababa and is bordered by Bedele, Diga district from East Zone and Gimbi district from West Wollega zone. The topography of the study area ranges from gently sloping to hilly lands with ridges and valleys in between. The total surface area of the district is 1,230.2 km². The Rainfall of the district is characterized by uni-modal in nature that mostly extends from May to October with highest rainfall usually recorded in August. The mean annual rainfall varies between 1300 and 2000 millimeters. The mean temperature of the study area is 25.1°C. The soil type is dark reddish brown and there is a wide area covered with vegetation.

The total population of Illu-Harar district is 311,422, out of which 157,952 (51%) are males and 153,470 (49%) are females. In terms of population density, Chawaka district stands last in Illu Ababora Zone. Population density per Km² is estimated at 20 persons. This is very low especially when it is compared with areas in southern part of the country. The district is characterized by mixed crop-livestock farming system where livestock rearing and crop production are the major occupations on which the livelihood of the vast majority is based. Maize, sorghum and finger millet are among the most common cereals where as Haricot, soybean and Sesame, are among the most common pulse & Oil crops grown in

Site and farmers' selection

Farmer-participatory approach, FRGs, was the main strategy to test and verify the technology during the first year and disseminate it in the subsequent years. The activity was carried out Jegan PA of Illu-Harar district. One FRG consisting of 15 members (taking gender balance in to consideration) was formed and managed based on their interest, land ownership, rice production experience and other important socioeconomic variables. Improved rice variety (Chawaka) was provided to FRG members for the purpose of pre- extension demonstration of the technologies. Accordingly; four farmers from Illu-Harar district (Jagan PA) were selected as our host farmer for the demonstration purpose. The demonstration plot was 10m*10m with 2 varieties Chawaka and Nerical which was used as a standard check. The spacing between rows were 20 cm. Fertilizer
rate was 100 kg/ha DAP and 50 kg/ha Urea. All recommended cultural and agronomic practices were implemented.

**Data collection and analysis**

The types of data collected include yield, farmers’ assessment/feedback on the technology compatibility, affordability, complexity, and applicability through regular interaction with farmers and rapid surveys. Simple descriptive statistics, pair-wise ranking and qualitative analysis of farmers’ assessment/feedback were used to analyze and interpret the data.

**Communication of the result**

Field days, regular monitoring and evaluation, regular visit of demonstration field with FRG and other extension partners were undertaken to enhance farmer to farmer information exchange. The result of the demonstration activity was finally evaluated jointly with FRG and other stakeholders. Extension materials such as manuals and leaflets were prepared on production and management and distributed to farmers.

**Results and Discussion**

**Farmers’ Participatory Variety evaluation and selection**

Number of tillers, plant height, disease tolerance, seed color and time of maturity were the main traits that farmers gave due attention during evaluation. Accordingly; except time of maturity, in all traits Chawaka was performed better than Nerica 1. The Nerical is also highly susceptible to bird attack.

**Table 1. Farmers’ ranking of the varieties**

<table>
<thead>
<tr>
<th>No</th>
<th>Traits</th>
<th>Rank given to varieties</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>Nerica 1</td>
</tr>
<tr>
<td>1</td>
<td>Number of tillers</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>Plant height</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>Disease tolerance</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>Seed Color</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>Early Maturing</td>
<td>1</td>
</tr>
</tbody>
</table>
Yield performance

The average yield of Chawaka variety is 40.67 Qt/Ha whereas 26.5 Qt/Ha for Nerica1. Yield of Chawaka variety exceeds that of Nerica by 14.17 Qt/ha. The yield advantage of Chewaka over Nerica1 variety as calculated by the formula Yield of new variety minus Yield of standard check divided by Yield of standard check multiplied by 100 is 53.47%. However, there is still yield difference between the the potential (on-station) and demonstration fields which is usually termed as technology gap. The technology gap which is calculated as potential yield minus yield at demonstration field for Chewaka variety was 13.3 qt. This is to mean that when planted on farmers’ field the potential of the technology was reduced by 13.33%. This difference is probably due to soil fertility status, difference in management (such as time and frequency of weeding, fertilizer rate, etc), disease, etc that consequently inhibit the variety from expressing its potential yield.

Conclusions and Recommendations

Since the Chewaka variety had 53.47% yield advantage over the standard check and preferred by farmers, the variety is recommended for further scaling up to reach large number of farmers wider areas.

References


Participatory Demonstration and Evaluation of Improved Sesame Technology in Potential Districts of western Oromia

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Abstract

This activity was conducted in Diga, Chewaka and Gnto Gida districts of western Oromia with the objective of demonstrating the newly released sesame variety, Chalesa, to the farming community in these districts. Districts were purposively selected based on potentiality for sesame production; and one potential Kebele from each district was selected on the basis of accessibility and production potential. After establishing and training of one FRG in each PA, three varieties of sesame, Chalesa (the new variety); Obsa and Dicho (as standard checks) were planted on 10m*10m adjacent plots replicated on 9 farmers' fields. A seed rate of 5 kg/ha and 50 kg DAP/ha was used with a line spacing of 40 cm between rows. The fields were closely supervised and were managed well. At maturity, the varieties were jointly evaluated with a team composed of researchers, farmers and Development Agents. Number of branches per plant, number of nodes per plant, inter node distance, height of the first branch from the ground and yield were the common selection criteria used across all locations. In almost all of the selection criteria, the new variety was found to perform better than the checks and has met the set criteria and farmers' preference. With regard to yield, the new variety showed 6% and 23.9% yield advantage over Obsa and Dicho, respectively putting Chalesa on the first rank. Since the variety has met criteria and liked by farmers, the prescaling up activity should follow in the next season.

Keywords: Sesame, Demonstration, FRG, Participatory evaluation, Chalesa, Obsa, Dicho

Introduction

The world of sesame seed market is a billion dollar industry that supports the livelihoods of millions of farmers throughout the world (USAID, 2010). Its world production gradually increased from 1.5 million tons per year in the 1960s to 3.2 million tons per year in 2005 due to an increased demand for sesame oil worldwide. Over this period, annual international trade in sesame seed increased from 150,000 tons to 800,000 tons. Africa produced an estimated 25% of the total world production and contributed nearly 40% of the world exports. Among African countries, Nigeria was the leading producer (75,000 tons year-1), followed by Ethiopia (50,000 tons year-1), Tanzania (41,000 tons year-1) and Chad (35,000 tons year-1) (Wijnands et al., 2007). In Ethiopia, the total area, production and productivity averaged for the last 11 years were 0.1 million ha, 70,000 tons and 0.60 t ha-1, respectively (CSA 1996/1997–2007/2008 as cited in Negash et al., 2011). Tigray, Oromia, Amhara and Benshangul Gumuz are
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The last 11 years data showed that the production of sesame is increasing in terms of area and total production while the productivity is much below 1.0 t ha⁻¹. (Dagnachew et al., 2011). 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). 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, and hence one way of linking them to domestic and international markets. Of the total 707,059 hectare land allocated for oil crop production in Ethiopia during 2007/2008 main cropping season, 185,912 hectare (26.294%) was mainly covered by sesame with the national average productivity 1.0 ton per hectare, and it accounts for 70% of the export value of all oil crops. During the same season, 25.66% sesame production came from Oromia, mainly from East Wollega and West Wollega (60.45% and 12.54% of the total production in Oromia, respectively).

In Ethiopia large variety of sesame seed can be produced, among which the Humera, Gondor and Wollega type are well-known in the world markets. On one hand, the Humera and Metema sesame seeds are suitable for bakery and confectionary purposes due to their white color, sweet taste and aroma. More specifically, the high oil content of the Wollega sesame gives it a major competitive advantage for edible oil production (USAID, 2010). However, the regional productivity per hectare was less than the national average, 0.62 t ha⁻¹ (CSA, 2008). The major problems of sesame production in western region were lack of adaptable high yielding and disease resistant varieties. This calls for generating and disseminating high yielding and quality sesame varieties that can make producers competitive in the today's competing markets. Cognizant of this problem, Bako Agricultural Research center has started sesame improvement activities before decades and released two promising sesame varieties named Obsa and Dicho through national variety release system in 2010. (Dagnachew et al., 2011). Two years later, the center released another improved variety called Chalessa which is more promising than the previous varieties. This activity is, therefore, initiated to demonstrate the newly released sesame variety with the following specific objectives.

**Objectives of the study**

- To demonstrate, evaluate and validate the productivity and profitability of the improved sesame technology/ies under farmers condition in the target areas
- To collect feedbacks/farmers’ opinion on the performance of the technology;
- To create awareness on the importance of the technology;
- To build farmers knowledge and skill of production and management of the enterprise;
- To enhance linkage among the relevant stakeholders.

**Methodology**

**Site and farmer selection**

This activity was conducted in Guto Gida; Diga and Chewaka districts of western Oromia. These districts were purposively selected based on their accessibility and potentiality for sesame production. From each
district one potential Kebele was selected with the assistance of Woreda experts and Development agents. These PAs were also selected based on similar criteria. In each Kebele, one FRG unit comprising of three experimenting farmers and 10 participant farmers was established. Willingness to be held as member, accessibility for supervision of activities, good history of compatibility with groups and willingness to share innovations to other farmers were the criteria used to select FRG members. Further more, 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 were additional criteria used to select the experimenting farmers.

Technology Demonstration

After training of the FRG member on sesame production and management packages/practices, FRG approach, etc. three varieties of sesame were planted on adjacent plots of 10mx10m each. Of the three varieties, Chalesa was the new variety, where as Dicho and Obsa were the standard checks. A seed rate of 5 kg/ha and 50 kg DAP/ha was used with a line spacing of 40 cm between rows. The fields were closely supervised and were managed well. At maturity, the varieties were jointly evaluated with a team composed of researchers, Farmers and DAs.

Data collection and analysis

Both qualitative and numeric data were collected and analyzed. The qualitative type of data includes farmers' feedback, and farmers' evaluation criteria. In addition yield data was collected. Finally the collected data were analyzed using descriptive statistics.

Setting evaluation criteria and participatory evaluation

Technology evaluation based only on the researchers' criterion doesn't guarantee acceptance by the end users for whom technologies are generated. Technologies, thus, should be evaluated collectively with farmers and other actors in the process. At this juncture, the farmers were oriented about objectives of the task, and were asked to set their own selection criteria. After jotting down their own selection criteria, they were assisted to put them in order of the weight they attach to each criterion. After the criteria were ordered, each variety was tested against the criteria kept in order of importance.

Results and Discussions

Yield performance of the new variety versus the standard checks

Variability in performance is inevitable between locations and even within the same location. This phenomenon might stem from difference in soil fertility status of individual fields, difference in management, rainfall intensity, distribution and disease occurrence. Despite these inevitable differences, the new variety, performed better than the two standard checks without compromising the other economically important traits that the farmers are interested in. Accordingly, Chalesa showed 31.37 % yield advantage over Dicho, one of the standard checks (Fig. 1).
The yield performance of the varieties was below what is reported by Dagne, et al. (2011). According to him, on-farm performance of Obsa was 8.7 qt/ha whereas that of Dicho was 8.1 qt/ha. Chalessa, on the other hand, performed 4.3 Qt less than its on-farm potential of 11 qt/ha. This gap might have stemmed from irregular and early termination of rain coupled with declining soil fertility. Despite the gap, however, performance of the new variety, Chalessa was greater than that of the national average 0.62 t/ha reported by CSA (2008). The yield obtained from Obsa, on the other hand, was almost similar with that reported by the same organization in 2008.

Training of farmers and other stakeholders

Training of farmers and other stakeholders before embarking on the actual demonstration is quite important. To this end, a theoretical training session was arranged for farmers, Development Agents and district agricultural experts on production and management of sesame, suitable ecologies for the crop and FRG (Farmers’ Research Group) approaches. Accordingly, 60 farmers, 9 District agricultural experts and 9 Development Agents were trained.

Farmers’ Evaluation Criteria

Despite the detailed (multiple criteria) set by farmers at Chewaka, the evaluation criteria identified by farmers of all sites were almost similar. The evaluation criteria for farmers at Chewaka were disease resistance, yield, number of branches per plant, height of the first branch from the ground, number of nodes per plant, inter-node distance, number of capsules per plant, early maturity and resistance to lodging. At Diga (Arjo Gudetu) the farmers’ criteria in order of importance was, disease resistance, height of the first branch from the ground, inter-node distance, number of branches per plant, number of capsules per plant and stem length. On the other hand, the criteria at uke was disease resistance, number of branches per plant, number of capsules per plant, height of the first branch from the ground, inter-node distance and earliness in maturity.

In all sites “distance of the first branch from the ground” was common criteria, and the logic behind was the shorter the distance from the ground, the more is the number of branches per plant and the more yielder the plant will be. Similarly, inter node distance was the common criteria across all locations despite the variation in place of the parameter in order of the weight attached to it. The common assumption was that the shorter the inter node length, the more is the number of branches per plant which is believed to have positive correlation with yield. Farmers at Uke have set few selection criteria based on context of their environment. Farmers’ ranking of the varieties differ from district to district. For instance Chalessa variety was ranked 1st at Chewaka and Diga district whereas it was ranked 2nd in Guto Gida district for its high yield, multiple branches, relatively disease resistant, short inter-node distance, multiple nodes/plant. Similarly, Obsa variety was ranked 1st in Chewaka 2nd and 3rd in Diga and Guto Gida districts respectively for its relatively high yielder and disease resistance, longer stem. Dicho variety, on the other hand, ranked 1st in Guto Gida and 2nd and 3rd in Diga and Chewaka districts respectively for its disease resistance and early maturity.
Farmers’ perception

Farmers in all of the sites (locations) liked the new variety as it met their selection criteria as better yield performance of the variety did not compromise the other economically important criteria of the farmers.

Conclusions and Recommendation

Conclusion

In all of the study locations, Chalessa was the first yielder followed by Obsa. This trait was also accompanied by other traits of economic importance. Hence, the new variety should be further promoted.

Recommendation

As the new variety has met the farmers’ selection criteria, it can be promoted in wider scale.

References


Diga Wereda Agriculture and Rural Development Office documents (2011), Ifa


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On-farm demonstration and evaluation of improved plastic milk churner in West Arsi zone of Oromia regional state, Ethiopia

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Abstract

The study was conducted in two districts of West Arsi zone with an objective of demonstrating and evaluating improved plastic milk churner there by reducing women's workload in churning activity. 17 improved plastic milk churners were distributed and evaluated by participating women farmers grouped in farmer's research groups (FRGs). The results showed a significant difference in time of churning at (p<0.05) resulting in 0:39± 0.01hrs for the improved plastic milk churners and 1:05±0.01 hr. for the traditional clay pot churners. However, there was no statistically significant difference on butter yield between the churners in the study areas. Nevertheless, the improved plastic churner were found to be more time saving than the traditional clay pot churners and are recommended for further scaling up works.

Key words: Milk Churner, FRG

Introduction

Milk production and processing is an important activity of small holder farmers in Ethiopia. However, a fraction of total milk production enters the formal processing channel. Thus most of the milk produced in the country is either sold as fluid milk or processed using traditional practices using traditional clay pot churners. In many households, milk is accumulated in the clay pot and kept at room temperature for several days by adding fresh milk in to the already accumulated until is sour for processing. Because the small holder traditional milk processing is based on sour milk. A clay pot is then used to churn the sour milk to get butter and other products. Processing milk in to such stable and marketable product generates cash income for smallholders' producer in the rural areas and enables them to conserve milk solids as butter for sale and consumption (Lemma, 2004).

Yet, the clay pot churners are not efficient either in their butter production, in saving time and labor. Studies indicated that the traditional method of churning is time consuming, perhaps, taking more than an hour (O’Connor et al.,1993, Feyisa et al., 2009 and Yilma et al., 2007). O’Connor et al. (1993) reported that in on-farm trails in the Debre Birhan areas, Ethiopia, an average churning time of 139 minutes. Likewise, Yilma et al. (2007) reported 191 minutes for traditional clay pot churner while Feyisa et al (2009) reported 65 min on average when using the traditional clay pot churners in central rift valley areas of the country. Mahony and Peters (1987) also reported that traditional clay pot churners give low yield butter per unit of sour milk and require high labor input. Similarly the amount of butter obtained from traditional milk churner is lower than the yield obtained from improved churner as reported by (Lemma, 2004).

Nevertheless different on farm participatory type research activities were conducted by different institutions to try new types of churners by comparing their time saving potential and butter yield along with traditional clay pot churners. Studies conducted by O’Connor et al (1993) reported as 57 minutes was obtained with the agitator fitted into the traditional clay pot churner. In a related research conducted by Alganesh (2002), using the internal agitator reduced churning time by 22% from an average of 28
minutes to 23 minutes. The same author reported that the average butter obtained the internal agitator was 359.7 grams and 376.9 grams per 6 liters of sour milk, respectively. Yilma et al. (2007) also reported that 475g of butter was obtained using clay pot with the churning time of 191 minutes (3.7hr) whereas 492g of butter was obtained from internal wooden made agitator which is developed by International Livestock Research Institute (ILRI) with the churning time of 80 minute (1.3hr). The milk was churned after 62hr of fermentation and ten (10) litters of milk were used for both butter making methods (Yilma et al., 2007).

In on farm trial made around Adami Tulu area of central rift valley of Ethiopia the average time taken by traditional milk churner was reported as 65min and the modified milk churner which was wooden made was reported to be 43.54±5.06 (Tesfaye et al.,2008). In the same place, but using different improved churner made from plastic (developed by Adami Tulu Agricultural Research) Feyisa et al (2009) reported reduced churning time by 58.89% from the average 80.97min to 33.29 using traditional and plastic milk churner respectively. In all the above research activities promising results have been found by using the improved milk churners. At Adami Tulu Agricultural research center the plastic milk churner evaluated by farmers also showed a promising result on Adami Tulu areas as reported by Feyisa et al. (2009) and Tesfaye et al. (2008). Yet, these milk churners were not evaluated and demonstrated under farmers circumstances in milk producing areas of West Arsi zone. Therefore, this research and extension activity is proposed with an objective of demonstrating and evaluating improved plastic milk churner there by reducing women farmers’ workload in churning activity in west Arsi zone.

Objectives

- To demonstrate and evaluate improved plastic milk churner technology with women farmers in West Arsi zone
- To reduce time spent and women farmers work load in churning activity

Material and Methods

Description of the study area

The study was conducted in Shashamane and Kofele Districts of Oromia Regional State. Shashamane is located in West Arsi Zone, Oromia Regional State about 240km south of Addis Ababa lying on the main way road to Hawasa. Geographically, the area is located at 7° 11' 33" N altitudes and 38° 35' 33" E longitudes. The area has an annual average temperature ranging from 12°C to 28°C. The rainfall ranges from 1500-2000ml (OFEDO, 2009).

Kofele is also located in West Arsi Zone of the Oromia Regional State. The area has an altitude and longitude of 7° 00" N 38° 45 E/ 7 N 38.750 E. The annual average rainfall of area is about 1232 ml with a mean monthly rainfall of 102.6ml. The mean monthly minimum and maximum temperatures are about 5.4°C and 19.8°C, respectively (OFEDO, 2009).

Farmers' selection and group formation

The demonstration and evaluation of the churners used Farmers Research Group (FRG) approach. FRG approach is a participatory research approach whereby multidisciplinary team of researchers, extension workers, group of farmers and other pertinent actors jointly conduct research on farmers’ field on selected topics (Bedru et al., 2009).

Thus, Fifty three (53) and twenty nine (29) women farmers were selected for group formation or as a member of Farmers Research Groups (FRG) from Kofele and Shashemene districts respectively. The
selection of kebeles was done purposively in collaboration with district experts from respected livestock and fishery development offices basing potential of the kebeles for their milk production potential. Among 53 (fifty three) women farmers of Kofele district, three FRGs were established and from 29 twenty nine women farmers of Shashemenne two FRG’s were established. From the established FRG’s selected 10 and 7 farmers who had lactating cows during the study were selected as experimental or trial farmers from both districts respectively.

Training

Training was given to all participating women farmers to create awareness about improved plastic milk churners, the intended objective of the activity and to improve efficiency and quality of milk and dairy products production, handling and processing. The training was organized in both Shashamane and Kofale districts respectively at on-farm level for all FRG members and respective site development agent (DAs) and district extension agents.

Extension material development

A simple manual illustrating how to use the technology was developed by local language and distributed for each experimental farmer.

Materials used

The materials used or compared were traditional clay pot churner which farmers have on their own hands and improved plastic milk churner produced by the project for the evaluation and demonstration purpose. Total of 18 improved plastic milk churner with 10 volumetric were produced at Guddina micro enterprise. Among those 18 milk churners 10 were distributed for kofale and 7 seven was also distributed for shashamane experimental farmers and one is left for Adami Tulu Agricultural research center as a sample. Experimenting farmers were advised on methods of installation and operation of the newly designed plastic milk churner.

Data collection

Data collection sheet was prepared and distributed to the trial or experimental farmers and orientation was also given for farmers and DAs on data recording methods. The data sheets include amount of milk for each churning, time taken for agitation, time taken for churning, amount of butter obtained as well as types cow. The data collected included the type of churner used, amount of sour/fermented milk used, starting time of churning, ending time of churning, time taken to churn and butter yield

Data Analysis

For data analysis Excel worksheet and SPSS version 20 were used.

Results and discussions

Seventeen (17) experimenting farmers from two Kebeles of kofale and shashamane districts, organized in farmer research group (FRG), were participated in the evaluation of improved plastic milk churner and traditional clay pot churner. Milk from both cross breed and local cows was used compositely for evaluations of the milk churners by the farmers after the milk was accumulated and fermented. The FRGs used time required for churning and butter production as criteria/parameters to compare the two churners. The capacity of the improved churners distributed was 10lt while the traditional clay pot churners could accommodate 5lt. Nonetheless, the average amount of milk used by the farmers for both milk churners
was not more than 5lt. The following tables shows the results of the evaluation based on the data gathered from the farmers who evaluated both the churners comparatively.

Table 1. Difference in time taken to churn and butter yield among churners

<table>
<thead>
<tr>
<th></th>
<th>Improved</th>
<th>Traditional (clay pot)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>TT (hr)</td>
<td>BY (gm)</td>
</tr>
<tr>
<td>Mean</td>
<td>0.39±0.01</td>
<td>180.5484±6.46</td>
</tr>
<tr>
<td>N</td>
<td>62</td>
<td>62</td>
</tr>
<tr>
<td>Std. Deviation</td>
<td>0.12</td>
<td>50.90772</td>
</tr>
</tbody>
</table>

TT= time taken (in hr)
BY= Butter Yield (in gm)
AMCh= Amount of milk churned (in lt)

As can be seen from table 1 above, using improved plastic milk churner reduced the time required for butter making by 26 minutes for the same volume of milk with a statistically significance difference in churning time (p<0.05) between the two churners. The time taken for churning using improved churner was recorded as 0.39±0.01 hr while the traditional clay pot churner took 1.05±0.01 hrs. Using the improved plastic milk churner was found to be improving the time efficiency up to 40% as compared to the traditional clay pot. This finding is comparable but slightly higher than with the finding of (Feyisa et.al., 2009) which reported an average time of 20 minutes on the same type of churner with an efficiency of 58.89% at Adami Tulu area. The difference could be justified by the difference in environmental temperature, the hotter the environmental temperature the shorter the time taken for butter making.

Furthermore the churning efficiency could also be affected by the amount of milk. Feyisa et.al., 2009 reported that filling more than half of the volumetric capacity of the improved milk churner increases churning time recommending the optimum amount of milk to be used as 6.5lt for better efficiency of improved plastic milk churners. However, the max amount of milk used by the farmers in this study was 5lt. Nevertheless, the two churners didn’t show a statistically significant difference (p<0.05) in terms of their butter yield. The butter yield recorded for improved and traditional clay pot churners was 180.5484±6.4 and 174.7742±8.07 respectively.

Comparative evaluation of the two churner types across the districts indicate that the time taken to churn using improved churner as 0.40±0.01hr and 0.37±0.02hr in Kofele and Shashemenne districts respectively while the traditional clay pot churner took 1.06±0.01hr and 1.05±0.03hr in Kofele and Shashemenne respectively. In terms of butter yield the improved churner yielded 185.87±11.84gm and 175.22±5.27gm in kofele and Shashemenne respectively, while the traditional clay pot yielded 185.87±11.84gm and 162.97±7.2gm in Kofele and Shashemenne districts respectively with no differing amount of milk. As a result, both churners have shown no statistically significance difference (p<0.05) across districts in time taken and their butter yield.

Even though the results are not statistically significant across districts, the time efficiency difference between the two churners and butter yield with equal amount of milk could be associated with the cattle breeds, temperature differences among the districts which can differ the degree of agitation.

Farmers’ response and feedback
In many districts of Ethiopia, milk processing is the sole responsibility of females. Men don’t process and/or involve in processing and marketing of milk and milk products. Study by Nicholson et al. (1999) indicated that more than 70% of the time spent in processing dairy products is covered by women or the female headed household. Lemma (2004) also reported that milk is mostly processed by women and girls and rarely by boys.

In the districts where this demonstration work took place, similar to the studies quoted above, churning is the responsibility of females and it can take from one and half hours to two hours depending upon their daily chores. Adult males in the study area do not churn as a result of the gender division of labor, the suitability of the churner and different cultural issues. However, as the demonstration took place with the presence of male household members including the husband, participating female farmers have showed interest on the improved churner especially in Kofele district as it was found to be helpful in reducing the time of churning and its suitability to be used by men and boys.

Conclusions and recommendations

Conclusions

The study set out to demonstrate and evaluate improved plastic milk churners (improved churner and traditional clay pot churner). For the study, 17 trial female farmers grouped in FRG in two districts of the west Arsi zone of Oromia regional state were involved. The improved plastic churners were produced in advance and the traditional clay pot churners already available on the farmers hand were used. Trainings were also prepared for all the trial farmers and other non-trial farmers including their husbands. Milk from both cross breed and local cows was used compositely for evaluations of the milk churners by the farmers after the milk was accumulated and fermented. The FRGs used time required for churning and butter production as criteria/parameters to compare the two churners.

The result indicated that a significant difference in churning time at \( p<0.05 \) among the two churners. But there was no statistically significant differing in butter yield with equal amount of fermented milk between the two churners in both districts. Furthermore the study has created demand as the participating female farmers have showed interest on the improved churner. However, the study lacked in analyzing how women farmers spent their saved time which was previously consumed through churning by traditional clay pot churner. Nevertheless, based on the results, it can be concluded that the improved churner was found to be more time saving than the traditional clay pot churner.

Recommendations

The following recommendations are given based on the results of the study.

- Further assessment is needed to analyze analyzing how women farmer spent their saved time which was previously consumed through churning by traditional clay pot churner

- The perception of our farmer especially in Kofele districts regarding to the technology is good and still there is demand for additional improved plastic milk churners. Thus, further scaling up activity is recommended. To this end, considering linkage among stakeholders for the multiplication and promotion of the technology is important
References


Evaluation and Demonstration of Improved Forages in Pastoral and Agro-pastoral Areas of Fentale District, East Shoa Zone, Oromia

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Abstract

This activity has been conducted at Fentale district with the objectives of evaluating and demonstrating of forage species suitable for livestock feed under rain fed and irrigation condition. Four kebeles were selected namely Ilala and kobo from (rain fed) and Gidara and Dire Saden from (irrigation). Forty six farmers were selected and given both practical and theoretical training throughout the experiment period for evaluation and demonstration purpose. Adaptable forage species, from herbaceous legumes, Lablab purpureous 147 and Viginea unguculata at seed rate of 20 kg/ha, tree legumes (Cajanus cajan) at 15 kg/ha and grasses (Chloris gayana cv.massaba at 15 kg/ha and Pennisetum purpureum 30,000 cuttings/ha) were evaluated. The size of each plot were 6m x 8m with spacing of 60cm by 30 for Lablab purpureous 147 and Viginea unguculata, 1m x 2 m between row and plant, for Cajanus cajan, broadcast for Chloris gayana cv.massaba and 1m x 0.5 m between row and plant for Pennisetum purpureum. Forage trials under rain fed was not succeeded due to shortage of rain fall in consecutive three years. However, in the two PAs where irrigation facilities were available forage development was succeeded. The highest dry matter yield was found for Pennisetum purpureum (18.614t/ha) followed by Chloris gayana cv.massava(11t/ha) at Gidara site. Less technology ab and technology index was found for Chloris gayana cv.massava than the other accessions. Farmers mean knowledge score had significantly increased by 55.634 after implementation of demonstration activity. Majority of the respondent farmers expressed medium (50 %) to the high (50 %) level of satisfaction for extension services and performance of technology under demonstration. Accordingly, Pennisetum purpureum, Chloris Gayana Cv. massava and Lablab purpureous 147 were recommended to pre-scaling up activity.

Key words; Evaluation, forage, irrigation, pastoral, rain fed

Introduction

Livestock production is an important economic activity in mixed crop-livestock and pastoral production systems of East Africa region in general and Ethiopia in particular. Ethiopia, with its diverse climate and topography, is a country with wide resources and traditional skill and experience in livestock rearing (Ayana,1999). The main feed resource for livestock in Ethiopia are natural pasture and crop residues, which are low in quantity and quality for sustainable production (Alemayehu, 2004). More than 90% of ruminant livestock feed on natural pastures, which vary in composition depending on the agro-ecology (Alemayehu, 2005). Natural pasture provides about 50% of total annual feed supply depend on availability of alternatives (crop residues). The natural pasture or grazing land comprises of permanent grazing land, shrub land, fallow lands, lands unsuitable for cultivation such as water logged, flooded areas, steep slopes, and road sides. In addition, some of the forested, bush lands provide some feed to browsing animals (Alemayehu, 2005). These feed sources are reported as low in digestible energy and protein content and as such do not meet requirement for livestock production (Alemayehu, 2005).
Feed for livestock in the Fentale is derived mainly from grazing natural pasture and crop aftermath and or crop residues. The rapid increase of human population has forced the farming to reserve more land for crop production, and the areas available for animal grazing is diminishing. The uses of by-products from cereal milling factories and oil processing plants are limited to urban area where it is available and quantity extracted is small and cannot be extensively used (Alemayehu, 2005). Forage production is one of the mechanism in which the poor quality of feed resources can be solved and even substitute concentrates with low cost. Similarly improved forages are new introductions in most villages of the project area. Their coverage is insignificant though there is the intention to extend them in many parts (data from livestock agency of the districts). Therefore, it is necessary to avail improved forages so as to satisfy the requirements of the animals in the area.

Objectives

- To evaluate and demonstrate forage species suitable for livestock feed under rain fed and irrigation conditions at Fentale district
- To avail improved forages in the area so that the pastoral and agro pastoral easily access feeds for their livestock.

Materials and Methods

Description of the study area

The experiment was carried out in Fentale district, East Shoa zone, Oromia regional state. Fentale is one of the districts in shortage of rain fall located in mid rift valley. The district is bordered on the South East by the Arsi Zone, on the South West by Boset, on the North West by the Amhara Region, and on the North East by the Afar Region. The area is characterized by both crop and animal production. The district was previously pastoral, but currently pastoralists started producing crops as well. Thus, livestock production is the main economic activity followed by crop production. The area receives mean annual rainfall of 550 mm, but is highly variable and with mean minimum and maximum monthly temperature of 17.4 and 32.7 °C (EMA, 2006).

Site and farmers selection

Four kebele were selected namely, Kobo, Ilala, Gidara, and Dire Saden from the 18 kebeles found in the study district at the first year of the experiment, 2009. The kebeles were selected based on the availability and absences of irrigation water to evaluate the adaptability of forage species under irrigation and rain fed conditions respectively. Accordingly two pastoral kebeles which are very close to the government irrigation project scheme and two kebeles which are very far from the irrigation project scheme were selected. Sixteen farmers and four FTCs located in Kobo, Ilala, Gidara and Dire Saden Kebeles were selected in the first year. Ten farmers from Kobo and twenty farmers from Ilala were selected again in the 2nd and 3rd year of the project to were selected the performance of forages under rain fed conditions.

Proximity of the plot to the farmers home steady to control exposure to free ranging animals, availability of enough family labor in the households, willingness of farmers, active participation/great commitments, gender and the role of model farmers so that others can learn from them were the criteria's to select the participant farmers.

Trial establishment and management

In 2009 the evaluation and demonstration was conducted on farm lands of sixteen farmers (eight from irrigation and eight from rain fed site) and four FTCs in four kebeles and on thirty farmers (ten from
Kobo and twenty from Ilala) in 2010 and 2011. Land preparation was done manually. The improved forage legumes and grass species evaluated and demonstrated were herbaceous legumes, (Lablab purpureus 147 and Viginea unguculata), tree legumes (Cajanus cajan) and grasses (Chloris gayana cv.massaba and Pennisetum purpureum). The seed rate were 20 kg/ha for Lablab purpureus 147 and Viginea unguculata, 15 kg/ha Cajanus cajan and Chloris gayana cv.massaba and 30,000 cuttings/ha for Pennisetum purpureum. Their seeds and cuttings were collected from Adami Tulu Agricultural Research Center (ATARC). The seeds/cuttings of the forages were planted on August 2009. The size of each plot used for forage evaluation and demonstration study were 6m x 8m with spacing of 60cm by 30 for Lablab purpureus 147 and Viginea unguculata, 1m x 2 m between row and plant, for Cajanus cajan, broadcasting for Chloris gayana cv.massaba and 1m x 0.5 m between row and plant for Pennisetum purpureum.

Technology evaluation and demonstration

Farmers usually evaluate a given technology based on attributes of importance to them. In this study, improved forages were evaluated using criteria jointly set by researchers and farmers. These include, biomass yield, dry matter yield, physical appearance and farmers perception. Farmer to farmer learning was used to promote the technology simply by collecting farmers from their irrigation site.

Training farmers’ and other stakeholders

Both practical and theoretical training was given for the participant farmers, DAs for each kebele and livestock expert from the district before the actual experiment was done to create awareness. Totally 46 farmers, 4 DA’s and 2 experts were trained throughout the evaluation and demonstration period.

Field day organized

Mini field day was organized with the cooperation of district Livestock Agency to evaluate the forage performances with the participating farmers and development agents.

Communication methods used for evaluation and demonstration activity

Both practical and theoretical training, farmers to farmer visit and personal observations are among the communication methods used to disseminate the technology in the area.

Data collection

Data on survival rate, biomass yield and dry matter yield were collected carefully. Harvesting of total forage yield per meter square were at its 10 - 50% flowering stage. The fresh weight was taken in the field using a top-loading field balance. Fresh subsamples were taken from each plot and each plant species separately then, weighed and chopped into short lengths (2-5cm) for dry matter determination. The weighed fresh subsample (FWss) was oven dried at 65 °C for 72 hours and reweighed (DWss) to give an estimate of dry matter yield. The dry matter yield (ton/ha) was calculated as (10 x TotFW x (DWss / HA x FWss)) (Tarawali et al., 1995).

Where: TotFW = total fresh weight from plot in kg

DWss = dry weight of the sample in grams

FWss = fresh weight of the sample in grams.

HA = Harvest area meter square and

10 = is a constant for conversion of yields in kg m\(^{-2}\) to tone/ha
To study the impact of demonstration, 8 farmers were selected as respondent through proportionate sampling. Production data for demonstrated forage accessions were collected and analyzed. The technology gap and technology index were calculated using the following formulas as given by Samui et al. (2000): Technology gap = Potential yield – Demonstration yield
Technology index = Potential yield – Demonstration yield/Potential yield ×100.

Knowledge level of the farmers about improved production practice of improved forages before demonstration implementation and after implementation was measured and compared by applying t-test. Further, the satisfaction level of respondent farmers about extension services provided was also measured based on various dimensions like training of participating farmers, timeliness of services, supply of inputs, solving field problems and advisory services, fairness of scientists, performance of variety demonstration and overall impact of demonstration activities. The selected respondents were interviewed personally with the help of a pre-tested and well structured interview schedule. Client Satisfaction Index was calculated as developed by Kumar and Vijayaragavan (2005). The individual obtained score Client Satisfaction Index = The individual obtained score/MAXIMUM score possible

Statistical analysis

Data on survival rate, fresh biomass yield and dry matter yield were analyzed by simple descriptive statistics. Impact and satisfaction levels were tabulated and statistically analyzed by SPSS to interpret the results.

Results and discussion

Technology dissemination

The technology was disseminated through giving theoretical and practical training for Livestock experts, DAs and farmers in selected kebeles on forage development and utilization in which 2 experts, 3 DA's and 67 farmers were participated and provided with seeds/cuttings of the forage. The experts and DA's were playing a great role in the dissemination by assisting the researchers during land preparation, distribution of seeds; follow up of the activity and teaching other farmers. Farmers have also contributing a lot for the dissemination of the technology through providing seeds/cuttings for other farmers nearby them. Through these farmers are initiated to further pre-scale up the forage technologies.

Yield performance of the sown forage

The result of the study showed that about 60% of the pastoralists of Kobo and Ilala kebeles were not sown the forage they were received in 2009 because of shortage of rain fall during this year. Whereas 40% of them planted, but the germinated forages were wilted and died. In contrast to rain fed areas forages sown/planted at irrigated sites of Fentale in Gidara and Dire Saden PAs were germinated and survived even though significant difference was observed between irrigated PAs of Gidara and Dire Saden in biomass yield and Dry matter yield.

The dry matter yield of forage planted at irrigation condition ranges from 9.593 to 11 t/ha for Chloris gayana cv.massaba 9.743 to 18.614 t/ha for Pennisetum purpureum and from 7.365 to 9.33 t/ha for Lablab purpureous 147 at one harvest at Dire Saden and Gidara respectively. The difference might be due to ample amount of irrigation and proper management by farmers found at Dire Saden. However under normal circumstance the above forages can produce 10.5 t/ha, 14.5t/ha and 9.3t/ha (ATARC unpublished) on station result using rain fed within one year. The dry matter yield of those forages were almost above the on station performance where 10.5 t/ha, 14.5t/ha and 9.3t/ha recorded for Chloris gayana cv.massaba,
Pennisetum purpureum and Lablab purpureous 147 respectively by using rain. This result is almost higher than the finding of (Aklilu et al., 2014, unpublished) similar works done at Amibara and Awash Fentale districts which is 7 t/ha, 12t/ha for Chloris gayana cv.massaba. Pennisetum purpureum respectively but lower for Lablab purpureous 147 which they found dry matter yield of 15t/ha. The difference is may be due to the availability of irrigation throughout the growing season, management of the field trials and soil factors.

The dry matter yield for Cajanus cajan in Gidara was higher than the on station due to the irrigation facility found there. However, at Dire Saden is 4.5t/ha which was comparatively low because of less adaptability and low irrigation facility to the area which has to be 7.5t/ha with normal circumstance (ATARC unpublished). In this study survival rate, biomass yield and DM yield of Napier grass was highest followed by Chloris gayana Cv. massava. The least survival rate, biomass yield and DM was seen with Cajanus cajan in both site of study area. The performance of Viginia unguiculata was almost nil in Gidara and totally absent in Dire Saden which might be due to excess irrigation application at establishment which makes the seed to distort and due insect borer (Table 1).
<table>
<thead>
<tr>
<th>Kebele</th>
<th>Forage species</th>
<th>Survival rate</th>
<th>Biomass t/ha/year</th>
<th>Dry matter yield t/ha/year</th>
<th>Dry matter yield t/ha/one harvest</th>
<th>Frequency of harvesting per year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gidara</td>
<td><em>Chloris gayana cv. Massava</em></td>
<td>90</td>
<td>100</td>
<td>33</td>
<td>11</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td><em>Pennisetum purpureum</em></td>
<td>95</td>
<td>380</td>
<td>130.3</td>
<td>18.614</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td><em>Lablab purpureus 147</em></td>
<td>80</td>
<td>175</td>
<td>28</td>
<td>9.333</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td><em>Cajanus cajan</em></td>
<td>70</td>
<td>40</td>
<td>16</td>
<td>8</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td><em>Vigna unguculata</em></td>
<td>70</td>
<td>7.5</td>
<td>1.7</td>
<td>1.7</td>
<td>1</td>
</tr>
<tr>
<td>Dire Saden</td>
<td><em>Chloris gayana cv. Massava</em></td>
<td>70</td>
<td>60</td>
<td>28.78</td>
<td>9.593</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td><em>Pennisetum purpureum</em></td>
<td>75</td>
<td>155</td>
<td>68.2</td>
<td>9.743</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td><em>Lablab purpureus 147</em></td>
<td>60</td>
<td>65</td>
<td>14.73</td>
<td>7.365</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td><em>Cajanus cajan</em></td>
<td>50</td>
<td>12.5</td>
<td>4.5</td>
<td>4.5</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td><em>Vigna unguculata</em></td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
</tbody>
</table>

* = absent; g = gram, ha = hectare, m² = meter square, PA= Peasant Association and t = tone
Yield of the demonstration activity and potential yield of the improved forages was compared to estimate the yield gaps which were further categorized into technology index. The technology gap shows the gap in the demonstration yield over potential yield and it was 203,321, 667, 754 and 7500 kg ha\(^{-1}\) for *Chloris gayana cv. massaba*, *Pennisetum purpureum*, *Cajanus cajan*, *Lablab purpureous 147* and *Viginea unguculata* forage accessions respectively. The observed technology gap may be attributed to dissimilarities in soil fertility, salinity and erratic rainfall and other attributes of weather conditions in the area and management practices. Hence, to narrow down the gap between the yields of on station and on farm performance proper management of the forage at farmers’ level is essential. Technology index shows the feasibility of the variety/accessions at the farmer’s field. The lower the value of technology index more is the feasibility. Table 2 revealed that the technology index values were 2.21, 8.89, 13.33, 81.07 and 81.52 for *Chloris gayana cv. massaba*, *Cajanus cajan*, *Pennisetum purpureum*, *Lablab purpureous 147* and *Viginea unguculata* forage accessions respectively. Therefore *Pennisetum purpureum* was more feasible than the rest accessions in the area. The finding of the present study is in line with the findings of (Aklilu *et al.*, 2014, unpublished)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Yield in kg ha(^{-1})</th>
<th>Technology gap (kg ha(^{-1}))</th>
<th>Technology Index (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Pennisetum purpureum</em></td>
<td>14179</td>
<td>321</td>
<td>2.21</td>
</tr>
<tr>
<td><em>Chloris gayana cv. massaba</em></td>
<td>10297</td>
<td>203</td>
<td>13.33</td>
</tr>
<tr>
<td><em>Lablab purpureous 147</em></td>
<td>8546</td>
<td>754</td>
<td>81.07</td>
</tr>
<tr>
<td><em>Cajanus cajan</em></td>
<td>6833</td>
<td>667</td>
<td>8.89</td>
</tr>
<tr>
<td><em>Viginea unguculata</em></td>
<td>1700</td>
<td>7500</td>
<td>81.52</td>
</tr>
</tbody>
</table>

ha = hectare and kg = kilogram

**Economic benefit to the farmers**

Fentale pastoralists used forage grass and legumes as cut and carry for their cattle. Furthermore they are producing cuttings from *Pennisetum purpureum* accession for further pre-scale up of the forages.

**Change in level of knowledge and skill of participating farmers**

Knowledge level of respondent farmers on various aspects of improved forage production technologies before conducting the demonstration and after implementation was measured and compared by applying dependent 't' test. It could be seen from the table 3 that farmers mean knowledge score had increased by 55.634 after implementation of demonstration activity. The increase in mean knowledge score of farmers was observed significantly higher. As the computed value of 't' (49.099) was statistically significant at 5 % probability level (Table 3). It means there was significant increase in knowledge level of the farmers due to demonstration activity. This shows positive impact of demonstration activity on knowledge of the farmers that have resulted in higher adoption of improved forage. The results so arrived might be due to the concentrated educational efforts made by the researchers. Here in general sense farmers are able to learn about improved forages, produce green forages and cuttings from *Pennisetum purpureum* accession.
Table 3: Comparison between knowledge levels of the respondent farmers about Improved forage demonstration (n=8)

<table>
<thead>
<tr>
<th></th>
<th>Mean score</th>
<th>Computed 't' value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before demonstration implementation</td>
<td>After demonstration implementation</td>
<td>Mean difference</td>
</tr>
<tr>
<td>24.6785</td>
<td>80.3125</td>
<td>55.634</td>
</tr>
</tbody>
</table>

* Significant at 5% probability level.

Farmers satisfaction and feedback

The extent of satisfaction level of respondent farmers over extension services and performance of demonstration variety/accessions was measured by Client Satisfaction Index (CSI) and results presented in table 4.

Table 4: Extent of farmers satisfaction of extension services rendered (n=8)

<table>
<thead>
<tr>
<th>Satisfaction level</th>
<th>Number</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Medium</td>
<td>4</td>
<td>50</td>
</tr>
<tr>
<td>High</td>
<td>4</td>
<td>50</td>
</tr>
</tbody>
</table>

It is observed from table 4 that all of the respondent farmers expressed medium (50%) to the high (50%) level of satisfaction for extension services and performance of technology under demonstration. Whereas, none of the respondents expressed lower level of satisfaction. The medium to higher level of satisfaction with respect to services rendered, linkage with farmers, and technologies demonstrated etc. indicate stronger conviction, physical and mental involvement in the demonstration activity which in turn would lead to higher adoption. This shows the relevance of demonstration activity. Farmers are really impressed to this forage development and this type of activity has go to further to pre-scaling up activity. Farmers are in need of the pre-scaling up activity of *Pennisetum purpureum*, *Chloris gayana Cv.massaba* and *Lablab purpureous* 147.

Monitoring and Evaluation

The activity has been monitored majorly by researchers and Live stock and Fishery office of the districts which they represented by the DA's in the kebele. The development agents (DA's) see and monitor the activity day to day since they are near to the farmers and also give technical assistant to the farmers.

Conclusions and recommendations

Conclusions

Forage development at Fentale district under rain fed condition was very difficult and not recommended for legumes and perennial grasses such as *Lablab purpureous* 147, *Cajanus cajan*, *Cowpea*, *Chloris gayana cv. massaba*, and *Pennisetum purpureum* as they cannot with stand moisture stress. Using irrigation is the only option for establishment and development of improved forages in this area. Forage species like *Pennisetum purpureum*, *Chloris gayana cv. massaba* *Cajanus cajan* and *Lablab purpureous* have the highest yield than the rest forage species under irrigation condition.
Recommendations

Use of irrigation is highly recommendable for development of improved forages in the study area. Therefore, species of forage like *Pennisetum purpureum*, *Chloris gayana cv. massaba* and *lablab purpureus* has to be further pre-scale up to cover large area of Fentale and similar districts.

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Participatory Evaluation, demonstration and Verification of Sisal foil wrapped milk containers on Quality parameters of Camel milk marketed in Borana Zone, Southern Ethiopia

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Abstract

The research activity was carried out with the objective of evaluating and demonstrating performance of sisal foil wrapped milk containers on enhancing shelf life of the camel milk while transported long distance and create awareness about the technology. It was carried out for two years (2012/13-2014/15) in Yabello and Moyale woredas of Borana Zone. A total of 24 pastoralists (6 individual producers, 9 groups of producers and 9 middlemen/collectors) have participated in evaluation and demonstration work. 46 sisal foil wrapped milk containers were distributed for the target groups in such a way that 26, 11, 9 from the 10, 5 and 3 liter sized containers, respectively. Introductory training as well as tailor made training was organized in relation to the issues like overall objectives of the study, the merits of wholesome milk, how to produce quality milk, effectiveness of the particular technology in maintaining the quality of milk, how to handle the hygienic condition of the container and the milk transported with this particular equipment, the benefits of provision of quality milk for consumers and in the process of research activities how to provide the required information. Both sites were visited regularly and exchange visit was organized to create wider awareness and collect feedback from the pastoralists. The result of the study revealed that the camel milk samples transported with sisal foil wrapped milk containers have the lower temperature and microbial load than unwrapped milk containers and stayed negative for both alcohol and clot on boiling test at the terminal milk market, whereas, the unwrapped containers were positive for alcohol test and showed higher temperature and microbial load. In terms of cost, the only differentiating factor was sisal foil wrapping. Even if, sisal foil seems expensive, it compensates through relatively lesser loss, durability and accessibility. The pastoralists who got the opportunity to visit the wrapped milk containers were very much surprised to see milk being transported for longer period than they traditionally do with almost no loss. They have also explained that by proportionally increasing the size of the containers, more quantity of milks can be transported even for marketing purpose. According to participants' opinions, the technologies are easily manageable, cost effective and are very appropriate for improving the productivity of small scale pastoralists. However, to gain more impact from the technologies in the future, participation of pastoralists, coordination of different disciplines and reaching more target groups at larger scale should be taken as a strategy.

Keywords: Evaluation, demonstration, Sisal foil wrapped milk containers, Camel milk

Introduction

Milk is a marvel of nature and a very nutritious biological fluid. Lactating animals are producing milk to feed their offspring naturally. Throughout the world, milk and milk products are indispensable components of the food chain. In most part of the world cattle milk is consumed much than other milk sources; Goats, camel, buffalo and sheep. Milk and milk products are also used as a raw material for agro industries in the form of milk powder, concentrated milk and cream. Milk is composed of much of water and other chemicals different in their composition due to genetic and environmental factors. One of the parameters in milk quality is the accepted level of composition of these chemicals in the milk. Like the fatty acid content, protein content, the lactose, the pH level of the milk, its test and texture. The milk quality can be affected at different levels starting from the physiology of the cow, milking, collecting, transporting, processing and distribution.
Ethiopia's camel population is estimated to be one million head. This number ranks the country third in Africa after Somalia and the Sudan, and fourth in the world (India included) (Tezera and Kassa 2002). Because of its outstanding performance in the arid and semi-arid areas of south-east lowlands of Ethiopia where browse and water are limited, pastoralists rely mainly on camels for their livelihood. In these areas, camels are mainly kept for milk production and produce milk for a longer period of time even during the dry season when milk from cattle is scarce (Bekele et al 2002). The annual camel milk production in Ethiopia was estimated to be 75,000 tones (Felleke 2003). In most pastoralists, camel milk is always consumed either fresh or in varying degrees of sourness in the raw state without heat treatment thus, can pose a health hazard to the consumer. Camel milk is transported from central Borana to Kenya border using plastic containers.

Milk is a marketable commodity whereby consumers buy when they get satisfied by the quality of the product based on their perception. As milk is also highly perishable product its quality and handling will affect the market. Therefore, having a due attention to total quality aspects of milk production and consumption; quality detection and safety precautions became of paramount importance. Therefore, this study was designed to evaluate and demonstrate the effectiveness of sisal foil wrapped milk containers in reduction of microbial growth and increased shelf life of the camel milk, transported long distance exposed to sunlight in Borana pastoral area.

Material and Methods

Description of study area and site selection

The study was conducted in Borana zone of southern Ethiopia. Yabello and Moyale district were purposively selected based up on their potential. The study conducted by YPDARC (2009) on characterization of demand of dairy products identified that Yabello as major milk supply to Moyale town, and Moyale as major milk demand area in the Borana zone. From Yabello district Surupa was selected purposively based on its potential for milk supply for Moyale district, particularly Moyale town. Surupa is principal milk marketing area where milk in the local jerry can is loaded on the public vehicle exposed to sun light long distance to the Moyale town. At Moyale terminal market milk is distributed to different local consumers, snack tea and coffee house, processors of Ethio-Kenyan border.

Surupa is located about 50km from Yabello town in northern part and Moyale town is located about 200km from Yabello town in the southern part that is about 570km south of Addis Ababa. Surupa and Moyale town and the way to Moyale are found in similar weather condition of higher ambient environmental temperature. This is normally easily and shortly ferments and rise the microbial load of the milk which is transported to the terminal market on the public vehicle with the local containers.

Method of Sample collection and laboratory analysis

It was the milk of camel that was the focus of the accomplished study. Samples of the milk were taken, transported and analyzed following standard procedure (Richardson, 1985). Fresh morning camel milk samples were collected at farm level (Olfa). Pastoralists were pre-informed to prepare, as possible as, clean unadulterated milk. All the milk samples collected from the pastoralists were tested for primary quality tests (Specific gravity, Organoliptic test and Alcohol test). Those which were negative for the tests were considered as good quality milk and mixed to make homogenous milk before transferring to treatment containers that was designed as:
T1 = 4 local milk containers currently used by the community
T2 = 4 unwrapped new plastic milk containers
T3 = 4 wrapped new plastic milk container and soaked in water

Except the four local ones, other containers were fumigated and handled according to the community’s indigenous knowledge, the eight milk containers (four Sisal foil wrapped and four new plastic containers) were sterilized using hot water. Variations in terms of where the containers had been placed on the vehicle were controlled as much as possible. Therefore, care was taken on how the milk containers were placed on the vehicle and deliberate efforts were made to ensure the containers were placed systematically every time in a repeatable way so that some received more air movement and others less, as it was labeled below with regard to their placement pattern on the vehicle.

Each of the treatment was replicated two times. Mixed and homogenized 1lt milk sample was transferred to each of the container. Thermometer reading was taken from each container before transportation. Half of the containers (2 from each treatment) were kept on the upper layer of the entire container properly arranged and loaded to the car used for human transportation, in a way it was freely exposed to the sunlight. Whereas half of the containers, 6 from each treatment were loaded at the bottom of the layer of the container loaded on the car to prevent direct exposure to sun light and strong wind pressure. A sample representing the initial quality at farm level was collected in well sealed bottles and kept under the refrigerator temperature in Ice box to be utilized as a control. The sample was immediately taken to the laboratory of YPDARC.

Terminal market (Moyale) milk quality

At the terminal point where the milk is sold Plat form tests (Organoleptic, Alcohol and Clot on boiling) for each treatment sample was performed and temperature reading was also taken. For further quality test, 100ml sample of milk from each treatment was collected and kept under refrigerator temperature in Ice box and brought to aforementioned laboratory station.

Laboratory analysis

Titratable acidity

The titratable acidity of all the samples (From the farm and terminal market) was determined by the quantity of a standard alkaline solution (0.1 N NaOH) which is required to neutralize the milk in the presence of phenolphthalein.

The Resazurin Test

Resazurin solution was prepared as per the standard procedure of one ml of the solution was placed in sterile test tubes then 10ml of the milk samples were added to each test tube. The samples were incubated at 37°C and result was recorded at 10min., 1hr. and 3hrs interval.

Microbial count

Aerobic plate count was done within 12 hr of arrival of the samples at the laboratory. Enumeration of total aerobicsesophilic bacteria was done after plating 1 ml of the 10^-5 dilution of the samples onto Standard Plate Count Agar. The agar plates were incubated aerobically at 35°C for 48 hr with replications. After incubation colony was count by counter and result was expressed as colony forming unit per one ml of milk (cfu/ml).
Selection and Empowerment of Participants

The pastoral communities will be the ultimate beneficiary of the research result. Hence, the involvement of target group in the whole process of technology transfer is fundamental. One way to empower the community is to organize them into groups and monitor to achieve the designed objectives of the project. In the process they may get some knowledge and develop some skill, so that they can effectively participate in the process and decide on their matters themselves. Ahead of participant selection an open meeting will be held with the community at both the initial and terminal site so that the interested participant will be assigned as the target group for this study.

For the purpose of this study 6 individual producers and 9 groups of producers who have the potential to fill the prepared container were deliberately selected as a target group. Similarly, 9 middlemen/collectors were purposively selected. The criterion for selection of the group is mainly based on their willingness to participate in the study, and their potential to be involved until the completion of the study. The sisal foil wrapped milk container of 3, 5 and 10 liter size were distributed for the individual producer, group of producers and middlemen/collectors.

Prior to actual implementation of the study the training will be given for target group individual producers, middlemen and individuals within the groups. To have common consensus training and awareness creation will also be given for particular client those involved in milk marketing process which is transported from Surupa to Moyale terminal market. In this case list of respective target group client will be taken from target group at initial site (Surupa), so that the respective client can be easily contacted at Moyale terminal market. The training will focus on the issues like overall objectives of the study, the merits of wholesome milk, how to produce quality milk, effectiveness of the particular technology in maintaining the quality of milk, how to handle the hygienic condition of the container and the milk transported with this particular equipment, the benefits of provision of quality milk for consumers and in the process of research activities how to provide the required information. Further awareness creation will be undertaken through Participatory Integrated Community Development (PICD) methods (focus group discussion or community meeting).

It is unquestionable that only provision of training may not be sufficient for successful completion of the project. Thus, memorandum of understanding (MOU) may need to be signed between the target group and the implementer of the project, i.e., YPDARC, particularly Agricultural Extension Research team, and regular monitoring was made by researchers. The individuals around Modjo area of Eastern Shoa, who are engaged in wrapping the Sisal foil to the plastic Jerry can will be visited, check list will be prepared to discuss thoroughly on issues like, their skill of wrapped container preparation; cost of sisal foil, jerry can and completely wrapped jerry can, and time required for wrapping each container. On the top of these the discussion will include recognizing the advantage of the sisal foil wrapped plastic container for maintaining the quality of milk transported in warmer environmental condition. Finally, the agreement will be made and memorandum of understanding (MOU) will be signed between the skilled persons and the implementer of the project in providing the container in the desired order and required number for the purpose of the study.

Training and demonstration

As introduction to the principles and operation of the improved jerry can, orientation training was organized both for the pastoralists and extension workers involved in the activity. The training was followed by a field demonstration of the implement to familiarize the trial pastoralists.
Field Days and pastoralists to pastoralists exchange visits

Field days demonstrating the result and methods of using the containers and pastoralist to pastoralist visits were organized to provide for non-trial pastoralists to gain experiences of the new technology. The field days were participated by pastoralists from different kebeles and districts, heads and experts in woreda agricultural and rural development office, woreda administrations, NGOs, extension experts from neighboring districts and from the zone. In addition, the DA also organized a visit (information sharing platform) to the surrounding pastoralists thereby enhanced the level of awareness on the technology.

Feedback workshop

At the end workshop will be arranged at YPDARC meeting hall and the final result of the study will be presented to the target and non-target community group, and different stakeholders. This workshop will be held in the presence of zonal and districts’ research-extension-pastoralists-linkage advisory council (Z/DREPLAC). The workshop will involve livestock expertise, DA, veterinary health workers, public health officers and public health extension of the respective districts. This created a forum for wider consultation and consensus building on all issues that may be contentious, and for wider adoption of the milk cooling technology by the community and created an opportunity to get further feedback from participants to modify the shortcomings of this technology.

Data management and statistical analysis

The computer software Microsoft-Excel was used for data management. The SPSS statistical computer software (SPSS for windows, version 16.0, 2007) was used to analyze the data. Descriptive statistical tools were employed to analyze the qualitative data. The qualitative data from the group discussion, PRA, key informant interview and workshop feedback were analyzed partly on spot to avoid forgetting.

Results and Discussions

Quality of milk at producer (‘OLLA’) and Terminal market

The smell of milk was smoky since all the pastoralists in the study area have been smoking their milk containers for various purposes (Table 1). For instance, smoking milk containers has been reported to exert anti-microbial properties and prolong the shelf life of milk (Ashenafi, 1996). It was clearly observed from the physical derbies in the milk that pastoralists produce their milk under none hygienic environment. According to Abdurrahman (1995), poor management and unhygienic milking practices prevalent in the traditional husbandry systems, which include tying the teats with soft barks to prevent the calf from suckling, tick infestations and cauterization of the udder and skin, are few of the factors responsible for contamination of milk. At initial point (Olla) all the samples collected were negative for alcohol test that was evidence for no or very low production of acid at farm level which indicates the freshness of the milk. Significant temperature variation was observed ($p<0.01$) for the milk in the wrapped and unwrapped containers mainly due to the unwrapped containers’ absorption of the environmental temperature.

The rise in temperature was relatively lower for wrapped containers and it was possible to observe that the samples with higher temperature were positive for alcohol and clot-on-boiling test (Table 1 and Table 2). This result is in line with the report of Connor (1995) which states that temperature is the most determining factor for milk fermentation and hence quality deterioration.
### Table 1: Primary quality tests of camel milk at producers (Olla) of Borana zone

<table>
<thead>
<tr>
<th>Sample No</th>
<th>Smell</th>
<th>Color</th>
<th>Appearance</th>
<th>Specific gravity</th>
<th>Alcohol (68%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Smoked</td>
<td>Yellowish white</td>
<td>Physical Derbies</td>
<td>1.020</td>
<td>-Ve</td>
</tr>
<tr>
<td>2</td>
<td>Smoked</td>
<td>Yellowish white</td>
<td>Physical Derbies</td>
<td>1.021</td>
<td>-Ve</td>
</tr>
<tr>
<td>3</td>
<td>Smoked</td>
<td>Yellowish white</td>
<td>Physical Derbies</td>
<td>1.022</td>
<td>-Ve</td>
</tr>
<tr>
<td>4</td>
<td>Smoked</td>
<td>Yellowish white</td>
<td>Physical Derbies</td>
<td>1.021</td>
<td>-Ve</td>
</tr>
<tr>
<td>5</td>
<td>Smoked</td>
<td>Yellowish white</td>
<td>Physical Derbies</td>
<td>1.020</td>
<td>-Ve</td>
</tr>
</tbody>
</table>

### Table 2: Temperature of pooled sample of camel milk within the three treatments at the initial point (Olla)

<table>
<thead>
<tr>
<th>Type of Container</th>
<th>Code for Container</th>
<th>Temperature (26°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wrapped New Container</td>
<td>WNC</td>
<td>21°C</td>
</tr>
<tr>
<td>Unwrapped New Container</td>
<td>NC</td>
<td>24°C</td>
</tr>
<tr>
<td>Local Container</td>
<td>LC</td>
<td>25°C</td>
</tr>
</tbody>
</table>

Test for various organoleptic and temperature measurement of milk at the terminal market (Moyale town) revealed that there was some similarity and discrepancy for wrapping and not wrapping the containers. All the wrapped containers stayed negative for both alcohol and clot on boiling test at the terminal milk market (Table 3). The exposed milk containers had significantly higher temperature than less exposed containers (p<0.01).

### Table 3: Primary quality tests of camel milk at terminal point (Moyale town) of Borana zone (30°C*)

<table>
<thead>
<tr>
<th>Sample code</th>
<th>Alcohol Test</th>
<th>Clot on boiling</th>
<th>Smell</th>
<th>Color</th>
<th>Appearance</th>
<th>Milk Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>WMEC</td>
<td>-ve</td>
<td>-ve</td>
<td>Smoked</td>
<td>Yellowish white</td>
<td>Physical derbies</td>
<td>27°C</td>
</tr>
<tr>
<td>WLEC</td>
<td>-ve</td>
<td>-ve</td>
<td>Smoked</td>
<td>Yellowish white</td>
<td>Physical derbies</td>
<td>25°C</td>
</tr>
<tr>
<td>LMEC</td>
<td>Turbid/ Sediment</td>
<td>+ve</td>
<td>Smoked</td>
<td>Yellowish white</td>
<td>Physical derbies &amp; Minor curdling</td>
<td>33°C</td>
</tr>
<tr>
<td>LLEC</td>
<td>Sediment</td>
<td>+ve</td>
<td>Smoked</td>
<td>Yellowish white</td>
<td>Physical derbies</td>
<td>30°C</td>
</tr>
<tr>
<td>NMEC</td>
<td>Clear sedimentation</td>
<td>+ve</td>
<td>Smoked</td>
<td>Yellowish white</td>
<td>Viscous</td>
<td>34°C</td>
</tr>
<tr>
<td>NLEC</td>
<td>Sediment</td>
<td>+ve</td>
<td>Smoked</td>
<td>Yellowish white</td>
<td>Viscous</td>
<td>30°C</td>
</tr>
</tbody>
</table>

WMEC: Wrapped container exposed to Sun light; WLEC: Wrapped container less exposed to Sunlight; LMEC: Local container exposed to sunlight; LLEC: Local container less exposed to sunlight; NMEC: New container exposed to sunlight; NLEC: New container less exposed to sunlight.

Milk of other treatments with unwrapped was remained positive for alcohol and clot-on-boiling test. That might due to the development of lactic acid from milk fermentation because of exposure of the containers to sun light. The result was proved according to the report of O’Connor (1995) which states...
that alcohol test is an alternative method of measuring the acid accumulation of milk since it is more sensitive for acid than clot-on-boiling test.

**Laboratory sample analysis result**

**Titratable acidity**

The lactic acid secretion of milk in the wrapped containers was relatively lower than unwrapped during dry season of the study site. On the other hand, the containers with no wrapping stimulated the milk to produce extra lactic acid which strongly deteriorates the quality parameters. The secretion of lactic acid for less exposed containers was significantly lower than the most exposed ones (p<0.01). The results were in line with the report of T. Ahmed and R. Kanwal (2004) which states that when camel milk is left to stand and heated moderately, the acidity rapidly increases due to the presence of lactic acid producing bacteria.

**Table 4. Titratable acidity value of camel milk from terminal site**

<table>
<thead>
<tr>
<th>Sample code</th>
<th>N° (0.1 NaOH)</th>
<th>Lactic acid</th>
</tr>
</thead>
<tbody>
<tr>
<td>WMEC</td>
<td>2.30</td>
<td>0.230</td>
</tr>
<tr>
<td>WLEC</td>
<td>2.28</td>
<td>0.228</td>
</tr>
<tr>
<td>LMEC</td>
<td>2.38</td>
<td>0.238</td>
</tr>
<tr>
<td>LLEC</td>
<td>2.35</td>
<td>0.235</td>
</tr>
<tr>
<td>NMEC</td>
<td>2.40</td>
<td>0.240</td>
</tr>
<tr>
<td>NLEC</td>
<td>2.36</td>
<td>0.236</td>
</tr>
<tr>
<td>Control</td>
<td>2.25</td>
<td>0.225</td>
</tr>
</tbody>
</table>

WMEC: Wrapped container exposed to Sun light; WLEC: Wrapped container less exposed to Sunlight; LMEC: Local container exposed to sunlight; LLEC: Local container less exposed to sunlight; NMEC: New container exposed to sunlight; NLEC: New container less exposed to sunlight.

**Resazurin test**

The dye reduction value of the whole representative sample with three time interval was analyzed. The milk samples didn’t show any significant variation in color change during the first 10min whereas after an hour the new plastic container that was exposed to sun light was totally changed to pink (Table 5).

**Table 5. Resazurin test of camel milk from terminal site**

<table>
<thead>
<tr>
<th>Sample Code</th>
<th>10min.</th>
<th>1hr.</th>
<th>3hr.</th>
</tr>
</thead>
<tbody>
<tr>
<td>WME</td>
<td>Light purple</td>
<td>Light purple</td>
<td>Light purple</td>
</tr>
<tr>
<td>WLE</td>
<td>Light purple</td>
<td>Light purple</td>
<td>Light purple</td>
</tr>
<tr>
<td>LME</td>
<td>Light purple</td>
<td>Purple pink</td>
<td>Whitish pink</td>
</tr>
<tr>
<td>LLE</td>
<td>Light purple</td>
<td>Light purple</td>
<td>Pink</td>
</tr>
<tr>
<td>NME</td>
<td>Light purple</td>
<td>Pink</td>
<td>White</td>
</tr>
<tr>
<td>NLE</td>
<td>Light purple</td>
<td>Slightly Purple pink</td>
<td>Pink</td>
</tr>
<tr>
<td>Control</td>
<td>Light purple</td>
<td>Light purple</td>
<td>Light purple</td>
</tr>
</tbody>
</table>
After 1 hr the samples in unwrapped new containers as well as in local containers show color change which is an indication of becoming poor in quality. Even after 3 hrs incubation the samples in wrapped containers remained unchanged. In the contrary the dye was totally reduced in the sample from new plastic container that was exposed to sun light that showed bad quality milk. While, the local containers that was most exposed to sun light was changed to whitish pink after 3 hr of incubation. Whereas the local containers were in better position than new plastic containers this might be due to the fact that the containers were well smoked. Compounds released from smoking wooden trees namely Olea africana (Egeresa) and Balanites galbara during smoking of the containers may be responsible for the longer shelf life of camel milk (Eyassu, 2007).

Total microbial load

The result showed that the milk samples kept in new plastic containers most exposed to sun light had the highest microbial load (6 x 10^5) followed by the local containers those were most exposed (4 x 10^5). Whereas wrapped containers had a positive effect on maintaining good quality of milk during transportation. The microbial load difference might be associated with post harvest handling (Table 6). For instance, at bulking and market centers, microbial contamination increased to almost 100% cfu/ml for the camel milk being stored at high temperature on transit to other distant markets from farm environment (Matofari et al., 2013).

Table 6. Microbial count under the different treatments

<table>
<thead>
<tr>
<th>Sample Code</th>
<th>Colony Forming Unit (CFU/ml of milk)</th>
</tr>
</thead>
<tbody>
<tr>
<td>WME</td>
<td>2.0 x 10^4</td>
</tr>
<tr>
<td>WLE</td>
<td>2.0 x 10^4</td>
</tr>
<tr>
<td>LME</td>
<td>4.0 x 10^5</td>
</tr>
<tr>
<td>LLE</td>
<td>3.0 x 10^4</td>
</tr>
<tr>
<td>NME</td>
<td>6.0 x 10^3</td>
</tr>
<tr>
<td>NLE</td>
<td>1.5 x 10^5</td>
</tr>
<tr>
<td>Control</td>
<td>1.0 x 10^4</td>
</tr>
</tbody>
</table>

Conclusion and Recommendations

The result of the study enabled us to conclude that wrapping the container has an importance in maintaining the quality of milk transported long distance exposing to sun light, as the test gave us a clearly observed results for all the treatments evaluated at community level. Although there had been shortage of cow milk during the season of this study, it is valuable if the study will be repeated for cow milk at the season of its excessive supply to market. On the top of this all the participant responsible for milk quality monitoring and development enhancement have to strengthen and scale up the technology found to be effective in maintaining the quality of milk involved in market transporting long distance.
References


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On Farm Participatory Evaluation and Demonstration of Processing Crude honey and Beeswax in Highland Districts of East Hararghe Zone, Oromia Region, Ethiopia

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Abstract
The study was conducted at Babile, Fadis, Gorogutu, Midaga tola and Kersa districts of eastern Hararghe zone with the purpose of demonstrating crude honey and beeswax processing techniques. Purposive sampling was employed to identify participant beekeepers. Descriptive statistics like frequency and chi-square were used to analyze data. Efficiency of the machine was evaluated by time taken to process crude honey into pure honey and wax. The results of the study revealed that honey presser machine separated 11 kg crude honey into 8.825 kg of pure honey and 2.102 kg of wax within 2 minutes. Farmers became aware of the importance of the machine and crude honey and bee wax processing methods.

Key words: crude honey, efficiency, Wax, honey presser

Introduction
According to central statistical agency (Government of Ethiopia, 2011) the annual total production of honey accounts for 53,000 tonnes. This amounts to only 8.6% of the total potential of the national production. In addition there is an annual beeswax (honeycomb) production of 3,800 tonnes. Out of the total honey produced, roughly 70% is utilized for brewing 'tej' (honey wine) with the balance being sold either as table honey or in other form. For long time honey producer or beekeepers targeted 'tej' market only, and accordingly little or no effort was made to the separate honey from beeswax.

Beekeeping is an important source of off-farm income for small holder farmers in Ethiopia. The total estimate of honey production for Ethiopia ranges from 21,480- 23,700 tonnes per annum. It is estimated that there are over 10 million bee colonies in the country, of which 7.5 million are kept in man-made hives. The country has a conducive environmental condition and natural vegetation, where plants flowers and supply adequate nectar to the bees (EARO 2000). Honey from traditional hives contributes 93% of the total honey production in the country but is not suitable for processing and exporting due to low quality as a result of poor harvesting and post harvesting techniques.

Beeswax is a byproduct of honey produced from traditional hives. Considering the proliferation of traditional hives in Ethiopia, production of beeswax is wide spread throughout the country. In traditional hives, the ratio of honey to beeswax produced is approximately 90:10. Beeswax is used to make candles especially for lighting. Nevertheless, a substantial quantity of beeswax is believed to be wasted at different levels due to lack of awareness of its marketability. Beeswax from honey consumed at the household level of beekeepers (including their relatives and friends) and individual buyers of crude honey is generally discarded. Most 'tej' brewers in small villages are not accessed by collectors. Despite the huge honey production potential of the country, the productivity is very low. From the traditional hives less than 5 kg is collected per season, while with the use of modern beehives it could be in excess of 20 kg per hive; The main challenges that are affecting the promotion and development of honey production and marketing are dependence on traditional and low technology input, poor pre and post harvest management, inadequate extension services and poor marketing infrastructure. Furthermore, lack of smallholders’ access to finance contributes to inhibiting the adoption of improved technologies for honey production.
Honey is the production of apiculture. Honey extractor equipment/crude honey processor equipment is used to separate pure honey from wax. Farmers face different challenges in eastern Hararghe zone to separate pure honey from crude honey. Even if they know about the value of pure honey; they didn’t have enough information about pure wax regarding its price. The value of pure wax is greater than pure honey. Furthermore, much of the honey (81%) is used for subsistence household consumption. Farmers' benefits are very limited due to the low rate of commercialization. The apicultural practice is also very traditional, where the quality of honey produced is low. In order to create market for the products farmers need to improve their capacity in terms of training, utilization of improved inputs like modern bee-hives, extraction and processing facilities. Therefore, this study was conducted to create awareness to farmers on how to process honey and wax by using honey extracting/processor equipment to get simultaneous profit from pure honey and wax. The objective of the study was to evaluate and demonstrate crude honey and beeswax processing equipment in the high land districts of East Hararghe Zone.

Methodology

Description of the study area

The study was conducted in Oromia National Regional State, East Hararghe Zone. Eastern Hararghe zone is one of the 17 zones of the Oromia National Regional State. It is located in the eastern part of the country. It divided into 19 districts and Harar is the capital town of the zone and is located at the distance of 525 Kms from Addis Ababa. The agro-climatic range of Zone includes lowland (kolla, 30-40%), midland (weyna dega, 35-45%) and highland areas (dega, 15-20%), with lowest elevations at around 1,000 m a.s.l, culminating at 3,405 m, at the top of Gara Muleta mountain. There are two rainy seasons, the small belg and the main meher. Belg production is limited within the dega zone and part of the wetter weyna dega, but Belg rains are widely used for land preparation and seeding of long cycle meher crops (sorghum & maize). Annual rainfall averages range from below 700 mm for the lower kolla to nearly 1,200 mm for the higher elevations of weyna dega & dega zones. The variability of rainfall from year to year and it’s often uneven distribution during the growing seasons give place to a wide range of climatic hazards which farmers have to deal with (EHZAO, 2011).

Sites and farmers selection

The participatory evaluation and demonstration was conducted in East Hararghe zone of Oromia region. For this demonstration, five districts namely Babile, Fadis, Gorogutu Midaga Tola and Kersa were selected. Purposive sampling was employed to identify participant beekeepers. The selection criteria for selecting beekeepers was based on number of bee colonies owned, efficiency of beekeepers based on the previous colony management and yield obtained, and accessibility of the area for demonstration and willingness of the beekeeper to be included in the group. One FRG (Farmers Research Group) having 10-15 individual beekeepers were established at each district.

Technology evaluation and demonstration techniques/approach

For evaluation and demonstration of honey extractor and processor. Crude honey was collected from the farm gates or local markets. Method demonstration technique/type was used to evaluate the honey processing machine in terms of time taken to separate crude honey into pure honey and wax. The farmers’ criteria during evaluation were time taken by machine to process a given amount of crude honey based on pure honey and wax obtained by machine. During evaluation, crude honey collected from the traditional hives, plastic pails, weight balance, watch/ o’clock to record time taken to process crude honey and honey presser were used.

Method of data analysis

Descriptive statistics like frequency and chi-square were used to analyze data. In addition graphs and charts were used to present some of the results.
Results and Discussions

Training given for FRGs

Theoretical & practical training was given to the group on crude honey processing machine for farmers, DAs and experts. Evaluation of the machine was undertaken periodically by all groups of participants and researchers during theoretical and practical training to obtain feedback from group and individual farmers.

Farmers' and other stakeholders' participation

The demonstration was undertaken on farmer's field in partnership with apiculture research group, DAs and Researchers. Farmers, DAs, experts from different districts and researchers were participated in demonstration activity. A total of 50 participants; 7 from Babile, 13 from Fedis, 10 from Gorogutu, 15 from Kersa and 5 from Midaga Tola have participated. Majority of the participants (33 or 66%) were farmers. DAs and experts constitute 11(22%) and 6(12%) respectively. Participants have learnt about the importance of the machine, crude honey and bee wax processing techniques and value of pure honey and wax. They have also appreciated the efficiency of the machine (the machine processed 11 kg crude honey into 8.8 kg pure honey and 2.1 kg wax in 2 minutes).

Conclusion and Recommendation

The demonstration work have created good awareness on crude honey and bee wax processing techniques. In the process of demonstration, participant bee keepers have learnt about the importance of the machine, crude honey and bee wax processing techniques and value of pure honey and wax. This have interest to the farmers to use the technology. Hence, government and non-government organizations should work on supply of crude honey processor (machine) scaling up the technology.

References


Participatory Evaluation and Demonstration of Tied-ridging for Improving Sorghum Yield in Fedis district of East Hararghe Zone, Oromia Region, Ethiopia

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Abstract

The study was conducted in Fedis district in the lowlands of eastern Hararghe Zone where there is severe moisture stress and striga weed infestation hampering sorghum productivity. On-farm demonstration and evaluation of tied-riding practices (tied-ridging in furrow, tied-ridging on furrow, Shilshalo) have been conducted on four farmers’ fields with the objective of creating awareness on tie ridging practices for farmers and experts in the target area. Farmers’ perceptions and agronomic data were collected, and analyzing using descriptive statistics, and ranking. Analyses of variances were also conducted for the quantitative data. The result of on-farm evaluation and demonstration work indicated that tied-ridging at planting and planting in furrow produced the highest sorghum grain yield of 3162.46 kg ha⁻¹ where as tied ridging at planting and planting on furrow yielded 2840.35 kg ha⁻¹. The tied-ridging at planting and planting in furrow, and tied ridging at planting and planting on furrow produced 34.14% and 30% higher grain yields, respectively, compared to farmers’ practice with yield difference of 2082.71 kg ha⁻¹. Farmers evaluation also indicated that the tied-ridging at planting and in furrows was ranked first followed by planting on furrows of sorghum due to tolerance to moisture stress, good germination status, good stand vigor and greenness, and higher grain and biomass yields, compared to farmers practice. Hence, the study recommends scaling up of tied-riding practice to increase yield of sorghum in the area.

Keywords: Tied ridging, tillage practices, evaluation, demonstration, sorghum, and yield

Introduction

Sorghum (Sorghum bicolor) is one of the most widely grown cereal crops in Ethiopia. It is a staple food crop on which the lives of millions of Ethiopians depend. The crop grows in a wide range of agroecologies most importantly in the moisture stressed parts where other crops can least survive and food insecurity is rampant (Asfaw, 2007). Therefore, according to Onwueme and Sinha (1991), sorghum is tolerant to drought because of its ability to remain dormant during the drought period and then grow fast again afterwards, it has been found responsive to good amount of water supply.

In eastern Ethiopia, sorghum is a major staple crop in the semi-arid areas of eastern Ethiopia, particularly in lowlands of east Hararghe zone. In the area, sorghum provides not only grain for human consumption, but also stover, which is used as forage for livestock, and as fuel for cooking (IIRR, 2002). Even though the crop has multiple uses in the lowlands of east Hararghe zone, its productivity is low as compared to average national and regional/Oromia’s productivity. The east Hararghe zonal average yield of the crop is estimated at 1.8 tonnes ha⁻¹, which is low as compared to the national and regional/Oromia/ average yield of 2.11 and 2.21 tonnes ha⁻¹, respectively (CSA, 2013). Low productivity of the crop is attributed to the erratic rainfall distribution; low soil fertility and striga weed infestation are ascribed as main reasons for low productivity of sorghum in the area.
In addition, farmers are poorly utilized rain water due to inadequate management practices, and inappropriate agricultural practices such as crop residue removal and improper tillage practices, reduce soil fertility and further aggravated the problem of inefficient rainwater use by crop plants. These problems are mainly attributed to the inadequate efforts to conserve the soil and water resources using improved practices. Proper on-farm conservation of moisture available from rainfall offers the opportunity to lessen the problem of moisture stress for crop production in the area. Tied ridging is one of the most important techniques to conserve soil moisture in the farm land and thereby giving time to be infiltrated in to the soil (Heluf, 2003).

Therefore, to address the problem of soil moisture and increase the productivity the crop, tied ridging practices were conducted in Fedis district for participatory evaluation and demonstration of the practices. So far, however, participatory evaluation and demonstration of tied-ridging for soil moisture conservation has not been done so as to improve the yield of sorghum in the target area. Therefore, this activity was initiated with the objectives of demonstrating and evaluating tie ridging practices at farmers’ level, create awareness about the importance of the tie ridging practices in soil moisture conservation and improving the yield of sorghum, and enhancing farmers’ knowledge and skill on management of rain water on farm fields using tie ridging practices in the study area.

Methodology

Description of the study area

The study was conducted in Fedis district of east Hararghe zone of the Oromiya region. Agro-climatically, Fedis has midland and lowland which account for 39% and 61% of the total area, respectively. The climate of the area is characterized by warm and dry weather with relatively low precipitation. Agriculture is the major source of livelihood of the community. However, its productivity is dependent on the merit of rainfall. The farming system of the district is subsistence type dominated by smallholder farmers. Sorghum, groundnut and maize crops take the largest proportion of crop production. The demonstration of tie ridging practices for rain water harvesting of sorghum yield improvement was conducted during the cropping season under rain fed condition.

Site and farmer selection

The activity was implemented at Umar Kule and Balina -Arba Kebeles of Fedis district by involving farmers, development agents, and experts from district office of agriculture. Sites and farmers selections were carried out together with development agents and experts, and discussions were made with the farmers and DAs on the implementation and evaluation processes of the activity. Farmers Research Groups (FRGs) consisting of male and female farmers were organized at each Kebeles and were involved in the implementation, monitoring and evaluation processes of the trials.

The Nega Umar Kule and Balina -Arba Kebeles sites were purposively selected based on potential in sorghum production, accessible for field monitoring and field visits were considered during site selection. Similarly, participating farmers were identified and selected based on striga infestation, low soil fertility, willingness/interest of farmers, accessibility of the farm fields, and ability to allot land for the intended purpose. Accordingly, a total of 30 farmers were selected and organized as Farmers Research Groups (FRGs), with 80% male and 20% female farmers and they actively participated in the evaluation and demonstration process of the practices. Finally, a total of four (4) farmers were selected as trial farmers to conduct the trials. From each site two farmers were selected.

Research design

The on-farm demonstration and evaluation trials consisting of four tied ridging practices such as flat bed planting, tied-ridging at planting with planting in furrows, tied-ridging at planting with planting on furrows and Shilshalo after sowing and tied-ridging after sowing were conducted at two sites, Nega Umar Kule and Balina -Arba Kebeles of Fedis district. The Shilshalo is a traditional ridging
without ties used for moisture harvesting and weed control using the traditional oxen-drawn plow known as *Maresha*. The trials were conducted on four farmers’ fields following the procedure of RCBD using farmers’ fields as a block. The sorghum was planted on a plot size of 12 m x 12 m at row spacing of 50 cm with plant spacing of 20 cm. A local cultivar of sorghum, locally known as ‘Muyira’ was used as a test crop.

All experimental plots were ploughed once by oxen plow using the local *Maresha* before imposing any of the treatments. Oxen plow tied ridger implement is used for constructing tied ridging. But, traditional plow (*Maresha*) is applied for *Shilshalo*. Seedling establishment at the desired plant spacing is obtained by hand thinning. Nitrogen and phosphorous fertilizers is applied to each plot at the rate of 50 Kg/ha of urea and 100 kg/ha of Diammonium phosphate (DAP). Phosphorus (DAP) is applied at sowing time while split application used for Nitrogen (Urea).

The treatments included:
- Flatbed planting (farmers practice)
- Tied-ridging at planting and after planting with planting on furrow
- Tied-ridging at planting and after planting with planting in furrows
- Flatbed planting with *shilshalo* after planting

**Technology evaluation and demonstration methods**

The evaluation and demonstration of the trials were implemented on farmers’ fields to create awareness about the tied-ridging practices in the target sites. The evaluation and demonstration of the trials was followed process demonstration approach by involving FRG farmers, Development agents and experts at different growth stage of the crop for evaluation and demonstration purpose. The activity was jointly monitored by FRGs, researchers, experts and development agents.

**Training, field visit and experience sharing**

For the effective implementation of the trials, on spot training were provided for the FRGs, development agents and experts on the approach, importance of tied-ridger, on farm soil and water conservation practices and soil fertility management practices. Moreover, field visits were organized to enhance farmer to farmer learning and experience sharing among farmers and other stakeholders.

**Data collection and analysis**

Data on plant growth like plant height, panicle length, number of branches plant¹, and days to maturity, grain and biomass yields were collected using data sheet. In addition, farmers’ views/perceptions during the evaluation process were collected using checklist, and analyzed and narrated using preference ranking. Analysis of variances for the quantitative data collected was conducted. The significant differences among the practices were computed by multiple comparison using least significant difference tests.

**Results and discussion**

**Training of farmers and other stakeholders**

Prior to implementation, training was provided to farmers, development agents and experts on various aspects of improved tied-ridging practice for enhancing their knowledge and skills on tied-ridging practice for on farm rainwater harvesting using tie-ridger farm implement. Accordingly, a total of 30 farmers (24 male and 6 women), 6 DAs and 3 experts attended the training held in Fedis district.

**Farmers’ and other stakeholders’ participation in demonstration**
The evaluation and demonstration of the tied-ridging practices was implemented by involving farmers. DAs and experts and they were evaluating the trials based on their own criteria during the demonstration process. In the process of demonstration and evaluation of the trials, the FRG farmers has been, monitoring and closely evaluating the effect of tied ridging practices on yield performances of the sorghum variety at different growth stages of the crop. Moreover, to disseminate the practice to more farmers in the area, field visits were organized by involving FRGs and non-FRG farmers. DAs and experts for leaning and experience sharing among the participants in the study area. This was also create an opportunities for experience sharing and knowledge transfer among the FRG farmers and non-FRG farmers. Accordingly, a total of 110 farmers (23 women and 87 men), 12 DAs and 6 experts were attended the field visits. As a result of this, there is an increasing demand for the tied-ridging practices for improving sorghum yield practice from the neighboring farmers in the study area.

Agronomic and yield performance of sorghum

A comparison of sorghum growth and yields among improved tied-ridging practices and farmers practice for sorghum is shown in table 1. From the demonstration and evaluation of different tied-ridging practices, it was observed that the highest grain and biomass yields were recorded in improved tied-ridging practice as compared to farmers practice in the study area.

The highest sorghum grain yield (3162.46 kg ha⁻¹) was recorded in tied ridging planting sorghum in furrows followed by tied ridging and planting on furrows with a value of 2840.35 kg ha⁻¹. Similar yield enhancement was reported in sorghum by Gebrevesus Birhane (2012). However, the least grain yield of 2182.71 kg ha⁻¹ was obtained from flatbed planting that was use as control. On the other hand, tied ridging planting in furrow, tied ridging planting on furrow and Shilshalo with row planting produced significantly higher biological yields compared to farmers practice. The highest biomass yield was recorded by tied ridging and planting sorghum in furrow having with a value of 37291.47 kg ha⁻¹ followed by Shilshalo after planting having a value of 28530.13 kg ha⁻¹. The lowest biomass yield of 19064.70 kg ha⁻¹ was attained for the control.

In general, the percentage increment in yield of sorghum obtained due to tied ridge and planting in furrow was 34.14% over the flat bed planting. Similar yield enhancement was reported by Heluf (2003). Therefore, tied ridging and planting of sorghum in furrow can further promoted for its better grain and biomass yields under local conditions.

Table 1. Growth and yield performance of sorghum

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Plant height(cm)</th>
<th>Panicle length(cm)</th>
<th>Stand count at harvesting (4 m²)</th>
<th>Grain yield (kg ha⁻¹)</th>
<th>Biomass yield(kg ha⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T₁</td>
<td>264.90</td>
<td>10.25</td>
<td>10.48</td>
<td>2182.71</td>
<td>19064.70</td>
</tr>
<tr>
<td>T₂</td>
<td>300.20</td>
<td>16.58</td>
<td>15.32</td>
<td>2840.35</td>
<td>22570.61</td>
</tr>
<tr>
<td>T₃</td>
<td>355.80</td>
<td>18.35</td>
<td>20.93</td>
<td>3162.46</td>
<td>37291.47</td>
</tr>
<tr>
<td>T₄</td>
<td>275.60</td>
<td>11.06</td>
<td>13.74</td>
<td>2473.59</td>
<td>28530.13</td>
</tr>
<tr>
<td>LSD 0.05</td>
<td>58.04</td>
<td>2.08</td>
<td>2.66</td>
<td>254.48</td>
<td>860.54</td>
</tr>
</tbody>
</table>

Note: T₁= Flatbed planting (farmers practice), T₂=Tie-ridging and planting on furrow, T₃=Tie-ridging and planting in furrow, and T₄= Shilshalo with row planting

Farmers’ evaluation of tied-ridging practices for sorghum production

The evaluation and demonstration of the tied-ridging practices was implemented on four farmers’ fields in Fedis district. The evaluation and demonstration of the practices was conducted by farmers at different growth stage of the crop by setting different evaluating criteria to evaluate the improved tied-ridging practices with conventional practice. At early stage, farmers were emphasizing on uniform germinations, weed infestation, growth vigorous and tolerance to moisture stress were used as evaluation criteria. Similarly, at flowering and maturity stage, stand vigor and greenness, deep
rooting, stem height, maturity, panicle size and grain filling, tolerance to moisture stress, grain yield and biomass production for animal feed and fuel were the major evaluation criteria used by participants to examine the effect of tied ridging practices on sorghum production.

As shown in Table 2, a cumulative result of farmers’ evaluation indicated that tied-ridging at planting with planting in furrows was ranked first followed by tied-ridging at planting with planting on furrow, flatbed planting with shilshalo in the third and then whilst the flatbed planting without shilshalo was selected in the last rank. The tied-ridging at planting of sorghum with planting in furrows was ranked first due to its uniform germination status at early stage, not/less infested by striga and tolerance to moisture stress in all crop growth stages. Moreover, it has stand vigor and greenness with the longest height of stem results highest biomass yield, which could serve as better feed production for animals. Furthermore, it had the largest panicle size with the required grain filling, this results high grain yields and hence ranked first.

The tied-ridging at planting of sorghum with planting on furrows was the second preferred practice by the farmers because of its good germination status, low weed infestation with good stand vigor and greenness, and also it has medium panicle size with good grain filling. As a result, the trial provided high grain and biomass yields. The flatbed planting of sorghum with shilshalo was the third preferred practice by the farmers because of its low germination, weed infestation with poor stand vigor, and it has small panicle size with less grain filling, but it was deep rooted. As a result, the trial provided low grain and biomass yields.

Table 2: Farmers’ evaluation of the tied-ridging practices for growth and yield of sorghum in Fedis district

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Flatbed planting</th>
<th>Tied-riding and planting on furrow</th>
<th>Tied-riding and planting in furrow</th>
<th>Shilshalo</th>
</tr>
</thead>
<tbody>
<tr>
<td>Germination status</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Weed infestation</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Tolerance to moisture stress</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Stand vigor and greenness</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Deep rooting</td>
<td>3</td>
<td>4</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Plant height</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Maturity</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Panicle size and grain filling</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Biomass yield</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Grain yield</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Score</td>
<td>36</td>
<td>23</td>
<td>14</td>
<td>28</td>
</tr>
<tr>
<td>Over all Rank</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>3</td>
</tr>
</tbody>
</table>

As indicated in Table 2, flatbed planting of sorghum without shilshalo was the least preferred by the farmers because of its poorest germination status, affected by moistures stress and weeds; and also the poorest stand vigor, smallest panicle size, and lowest grain and biomass yields were recorded under this treatment. Finally, farmers’ evaluation was conducted at harvesting and threshing of sorghum where based their evaluation criterion on sorghum biomass yield, grain yield, grain size and color. The participant farmers explained that they mostly produce sorghum on fields which are susceptible to striga weed and this further aggravates the problem of moisture stress and limit plant growth and yield in the area. The participant farmers, DAs and experts observed and learnt from the trial how to improve sorghum yields in areas that are susceptible to moisture stress and striga weed through proper in-situ water harvesting practices. Generally, farmers, DAs, experts and researchers learnt how to increase sorghum production and productivity in areas that are susceptible moisture stress and striga weed through implementation of proper in-situ water harvesting practices in the study area. Farmers evaluating the sorghum grain size and color.
Conclusion and Recommendations

The study was demonstrated that the implementation of proper tillage practices for soil moisture conservation is vital to get better sorghum yield in areas that are susceptible to moisture stress and striga weed. The result indicates that tied-ridging tillage practice made at planting and after planting with planting in furrow is increased sorghum yields by 45% as compared to farmers’ practice such as flatbed. This indicating that farmers can be improved their sorghum production and productivity in areas that are susceptible to moisture stress and striga infestation through implementation of proper tillage practices used for soil moisture conservation in the study area. From this, it is possible to conclude that tied ridging at planting and planting in furrows is the best practice for moisture conservation that can increase sorghum grain and biomass yields. Therefore, tied-ridging at planting with planting in furrows, and tied-riding at planting with planting on furrow should be recommended for up scaling to more farmers in the study area and elsewhere. In addition, tied-ridger farm implements should be made more accessible for farmers.

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Demonstration of OARI-Assela Model-3 Multi-crop Thresher in Arsi Zone, Ethiopia

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Abstract

This activity was done in 2012/13 budget year with the general objective of demonstrating OARI-Assela model-3 multi-crop thresher, creating demand for the technology and collecting feedback on the performance of the technology. In this demonstration activity, OARI-Assela model-111 thresher was demonstrated in three districts of Arsi zone namely Digelu-Tijo and Lemu-Bilbilo and Tiyo districts. Simple need assessment on the threshing technologies of the farmers was also done. Four FREGs with total of 40 farmers (8 females and 32 males) were organized. From the result it was concluded that the technology is more important for the area. Moreover the result shows that most farmers of these areas have interest in using this threshing technology and they prefer if they can get on credit basis even though considerable number of farmers shows their willingness to buy it on cash basis. Therefore, concerned bodies should make available the technology in the market by training and awareness creation to technology producers, availing credit facilities to agricultural mechanization technologies, and conducting extensive further demonstration of the technology.

Key words: Likert scale, OARI-Assela Model-3, Demonstration, Technology, Agricultural Mechanization, Thresher, Promotion

Introduction

In crop production, where traditional way of production is followed, the lion-share of labor requirement goes to threshing and harvesting which accounts for about 40% of its total man-day. Moreover, in traditional method (manual and animal trembling methods) of harvesting and threshing, huge amounts of harvest and post harvest loss is recorded which was estimated to about 12.9%, 13.6% and 10.9% for teff, wheat and maize respectively per annum ((Derege et al., 1989). According to African Post Harvest Loss Information System (APHLIS) a report by Hodges, R.J et.al (2010), shown that there is highest losses in agricultural outputs for small farms than large farms both during harvest and post harvest period until consumption because of technological intervention gap in those small farms.

Ethiopian agriculture, which is highly characterized by small-scale and subsistence farming system, faces great problem of post harvest loss also (Abebe H. Gabriel and Bekele Hundie, 2006). Most grain loss was also recorded during harvesting/field drying, platform drying, threshing hulling and winnowing (Hodges R.J et.al, 2010). Until recent days, the main reason for this was due to the improper utilization and/or absence of appropriate intermediate threshing technologies for small-scale farmers in Ethiopia. But thanks to technology, Assela Agricultural Mechanization research center developed a cereal threshing machine with good and promising capacity. According to the report by the center’s harvest and post harvest research team, the currently modified and improved machine has a capacity of 250kg to 1700kg per hour.
With optimum straw moisture content, rotation per minutes of the machine parts and feeding rate, the machine performance was reported as: cleaning efficiency, threshing efficiency, and grain breakage percentage to be 98.97%, 99.50% and 0.05% respectively (Ibd). The fuel consumption is 1.47/hr at optimum feeding rate. The machine was found to be superior in all its performance quality compared to other machines so far developed in the country and even imported from abroad. And considering this fact, Assela Agricultural mechanization research center planned to make the machine to be utilized in a wider basis by small-scale farmers of cereal producers. To achieve this goal the center organized training programs for different private and non-private manufacturers on how to manufacture this machine and avail the machine in market in enough amounts. Simultaneously, demand creation activity for these manufacturers was also planned so that these trained manufacturers could engage to production of the machine immediately after the training.

After a technology is developed, adapted or modified, the next step is obviously to address the end-users with all its benefits over the previous practices and this should be effective through demonstration, workshops and other activities.

Objectives

This demonstration activity was initiated with the main objectives of demonstration and popularization of the OARI-Assela model-3 multi crop thresher in Arsi zone while the specific objectives of the activity were:

- to demonstrate OARI-Assella model-3 multi-crop thresher and create demand for the technology
- to collect feedback/farmers’ opinion on the performance of the technology/machine
- to facilitate the transferring of the technology through enhancing linkage with stakeholders
- to assess need of the engine-driven threshing technology in Arsi zone

Research methodology

Description of the Study Area

The research was conducted in three selected districts of Arsi zone namely Lemu-Bilbilo, Digalu-Tijo and Tiyo districts. These districts of the zone were selected purposively because of the fact that they are known for their high production potentials of wheat and barley crops. Arsi zone is known as wheat-belt of Ethiopia and these districts, Lemu-Bilbilo and Digalu-Tijo are found 56 km, and 25km to south of Assela the capital of Arsi zone while Tiyo district is around Assela. The main crops produced in these areas are wheat and barley with barley dominating in some high land of Digalu-Tijo and Lemu-Bilbilo around the base of mountain Chilalo. Digalu-Tijo has an altitude range of 2500 to 3560masl and agroecology of highland 78% and mid-altitude of 22% with temperature range of 10-20°C and bimodal type of rainfall ranging from 800mm to 1200mm. the rainfall is generally high and erosive type. The main crop type of the district is cereal type with wheat and barley domination and where both of the crops are almost equally important (BOFED, 2011).

Lemu-bilbilo district has an altitude of 1500 to 3800masl and characterized by a highland of 80% and mid-altitude of 20% with bimodal, heavy and erosive type of rainfall ranging from 800mm to 1200mm annually. The average annual temperature is around 15°C. Cereals are the major crop type with wheat and barley domination. Tiyo district has a total of 665km² areas and altitude ranging from 1500 to 4105masl which enabled the district has four types of agro-ecologies highland 31.7%, mid-highland
42.5%, temperate highland (vitch) 20.1% and lowland of 5.7%. The district is generally characterized by bimodal, heavy and erosive temperate type rainfall with annually ranging from 900 to 1100mm. Cereals are dominating crop type of which wheat and barley are more important with wheat slightly higher degree (ibid).

Site selection and Methods of demonstration

Demonstration was conducted in a total of three PAs namely Digalu-Kidame, Lemu-dima and Duna which were selected from each Digalu-Tijo, Lemu-Bilbilo and Tiyo districts respectively. After site (PAs) selection being with districts’ experts, a Farmers Research Extension Groups (FREGs) of 15 members were organized at each site and one experimental (demonstration) farmer was selected from each group. The rest members and non-member farmers were invited at each site during the demonstration period and 7 to 14 hours of threshing wheat and barley crop was done at each site. Checklist was developed to collect farmers’ views and comments and to record the machine performance. Totally 40 (forty) FREG members who took training on how to use and simple servicing and maintenance of the technology and other 68 (sixty eight) farmers participated on demonstration.

Farmers’ training

Basically, there are two principal types of demonstration used by both extension agents and agricultural researchers; method demonstration and result demonstration. In method demonstration the researcher basically shows farmers how to do something. In the method demonstration, the farmer is shown step by step how, for example, to plant seeds in line, to use a mechanical duster to control insects, or how to operate a machine to thresh his crop. The second type of demonstration is a result demonstration method in which a farmer is shown how a particular recommendation is superior (better than) to the local existing practice and practicable under local conditions, for example, the comparison between uses of engine-driven threshing machine and traditional way of threshing by using animal trampling.

To deliver training, two personnel from harvest and post harvest research team (one researcher and a technical assistance) participated on the activity. As mentioned above members of FREGs farmers at each site were given both practical and theoretical training on working principles of the machine, safety during operation, the importance of threshing technologies in reduction of harvest and post harvest loss and how it minimize the work drudgery. Then practical training was also given during operation. Mini field days to facilitate technology and information transfer were also organized at each site being with districts’ bureau of agriculture and rural development.

Data collection and analysis

Simple socioeconomic and perception and opinion of farmers on the thresher were collected using semi-structured questionnaires. In addition to this, efficiency of the thresher like cleaning efficiency, threshing efficiency, and grain breakage percentage were collected and compared against the result reported by the post-harvest research team. Finally the data was analyzed descriptively using mean, standard deviation, percent, likert scale method.

Results and Discussions

Technology demonstration and evaluation

For this purpose both method demonstration and result demonstration types of demonstration were used. Under method demonstration type of demonstration, the farmers were trained how to give simple services and how to operate the thresher safely while under result demonstration comparison of cleanliness of grain, grain breakage, cost of threshing, drudgery of work(work easiness) and post harvest loss between traditional (manual) and engine-driven machine threshing was conducted.
The demonstration process was conducted by giving simple training for all member farmers. At Lemu-dima peasant association (PA) threshing was done for 15 hours and a total of 7100 kg (7.1 quintals) of wheat was threshed and the average threshing capacity per hour was found to be 4.73 quintal. At Digalu kidame and Duna PAs total time of threshing were 5hr and 8hrs and average threshing capacity per hour were found to be 4.65 quintal and 3.95 quintals respectively. Average cleaning efficiency of machine during demonstration was 97.75% with 98.5, 96.5 and 98.25% at Lemu-Bilbilo, Digalu-Tijo and Tiyo districts respectively. While average threshing efficiency was 98.34 with value of 97.75, 98.5 and 98.77% at Lemu-Bilbilo, Digalu-Tijo and Tiyo districts respectively and average grain breakage for the three sites was 0.06% with value of 0.07, 0.058 and 0.052% at Lemu-Bilbilo, Digalu-Tijo and Tiyo districts respectively.

Farmers' preference

Farmers were asked for their preference to the new technology and traditional one and all of them preferred the new technology in terms of its given features/attributes like time saving, cleaning efficiency, and capacity of threshing per hour and in general its cost minimization compared to traditional method of threshing. Likert scale method was used to measure respondent's opinion/views towards the attributes of the new technology with respect to traditional ways of threshing. A Likert scale is an ordered scale from which respondents choose one option that best aligns with their view. It is often used to measure respondents' attitudes by asking the extent to which they agree or disagree with a particular question or statement. In this case an odd number of response categories having five responses (strongly disagree, disagree, neither disagree nor agree, agree, and strongly agree) were used.

Accordingly, the result indicated that all farmers strongly agree that the technology is good for its cleaning capacity. Moreover, 67.5% agree that the machine is not complicated to use. The same number of farmers also agree that the machine easy to transport. But 50% of the participants disagree with the best threshing capacity of the thresher and they opt for more capacity thresher in the future from the technology owners.

Following this, the participants were asked if they need to use the technology in future either in buying or by renting from others and if they want to buy how (in group, individually, and if in group maximum number of group members). Accordingly, most of the participants want to buy the technology and use it in group (80%) with maximum number of group members of five and minimum of two. Considerable number of participants (eight out of forty which is 20% of total) wants to buy the thresher individually (Table 1).

Table 1: Participants willingness to use the thresher and their mode of use

<table>
<thead>
<tr>
<th>Preferred mode of owning thresher</th>
<th>Number of farmers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual basis</td>
<td>8(20%)</td>
</tr>
<tr>
<td>Group basis</td>
<td>32(80%)</td>
</tr>
<tr>
<td>Credit basis</td>
<td>27(67.5%)</td>
</tr>
<tr>
<td>Cash basis</td>
<td>13(32.5%)</td>
</tr>
</tbody>
</table>
Conclusions and Recommendations

Conclusions

From the result of this demonstration activity and simple need assessment survey made for this demonstration purpose, it is clear that farmers of Arsi highlands who are producing cereal crops like wheat and barley and do not have combine harvesting technologies access, are suffering from alternative harvesting technologies and they are completely using traditional ways of harvesting and threshing methods like trampling on flat plain of fields plastered by mud and animal dung called “Awudima/Hogdi” by animal foots and biting by stick in the house or on Awudima/Hogd. This way of traditional threshing method obviously consumes more time, more labor and moreover contributes more to postharvest loss. Moreover, the result shows that most farmers of these areas have interest in using this threshing technology and they prefer if they can get this technology on credit basis even though considerable number of farmers shows their willingness to buy it on cash basis.

Recommendations

In general based on the general discussion made with stakeholders (head and deputy Arsi zone administrator, districts’ administrators etc and others) in order to able all farmers having interest to use this technology, the following were recommended by the forum.

1. Availing the technology in the market: the main gap created in agricultural mechanization technology utilization is that once the technologies are recommended by research centers, there is no as such concerned body to produce and distribute such technologies. Even though there are some microenterprises which want do produce such technologies, there is no linkage between such enterprises and end users. Therefore, in order to make sure of the utilization of such technologies and avail the technologies in the market, two things have to be done (1) there must be promotion of such technology and micro-enterprises to farmers and show where they can get and buy it and (2) guaranteeing the micro-enterprises that their product will be purchased by farmers and enable them produce the machine by creating linkage between them.

2. Credit facility: Farmers need some amount of credit to buy such huge machineries which they can repay with some down payment of 2 to 5 years. Therefore, to facilitate such things government intervention and some other non-governmental organization and cooperatives is very important.

3. Extensive further demonstration and pre-scaling up: inline with all these activities, further extensive demonstration and pre-scaling activities in the rest part of the region are very important to create more need and demand/market for manufacturers and make ease of technology transfer and this should not be the task of only research center and it has to be the assignment for all development agents and moreover the extension wing of the agricultural development sector should take lion-share of the task.

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Pre-extension Demonstration of Rope and Washer Pump in Jimma and Ilubabor zones

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Abstract

The study was conducted in Jimma and Ilubabor Zones of Oromia Regional State, Ethiopia. The objective of the study was to promote rope and washer pump. A total eight farmers were selected as hosting farmers for the popularization of the technology in five selected districts Jimma and Ilubabor zones. In addition, 450 farmer households have attended field demonstration at different sites involving men and women. The study showed that of the farmers interviewed, 75% had responded that it is simple to operate the rope and washer pump for lifting water from the distant water hole in relation to using only human energy. While only 25 % of the respondents stated that it requires some technical knowledge to use and make maintenances when it get damaged. The rope and washer pump operates with minimum force requirement. About 43.75% of the farmers responded that the construction cost is medium that can be affordable by the average farmers compared to the engine driven pumps. And 56.25% of the respondent farmers also indicated it is easy to repair and maintain by local technicians or by themselves.

Key words: Rope and washer pump, demonstration, energy, technicians

Introduction

The rope pump is based on an ancient Chinese technology, which was introduced in the 1990s to Central America. It was further developed in Nicaragua and now contributes significantly to rural water supply coverage (WSP, 2008). Over the past decade efforts have been made to transfer the technology to various parts of Africa, often drawing upon the Central American experience (Sutton, 2009). Desertification and drought has been used as common identification for Ethiopia. To get out of these problem different personalities, intellectuals, institutions and foreign donors have been making different efforts. However, these efforts did not bring sustainable solution for desertification and drought. Some of the technologies used for irrigation to the purpose of horticulture and small farms like tree seedling growing etc. were engine, wind, solar power and manual driven pumps.

But, these pumps still did not solve the rural family household problems because the engines need well trained operators while the rural societies do not have this ability and capable man power. The solar wind and also manual pumps after giving service for short period always fail to perform continuously. The solar and wind pumps are driven by sun light and wind which is natural resource free of cost except the development and installation, but they are sensitive and fall due to simple disturbance. The diesel engine pump is relatively effective in performance except the cost of fuel and availability of trained man power among the rural agricultural communities. Unless these two things are fulfilled the diesel engine pump will not be appropriate. The overflow pump and treadle pumps were good but need much more human labor and are manipulated by adult and healthy men implying if there is no one to pump the pump, lifting water for drinking and garden irrigation is impossible.

In Ethiopia the technology transfer process started in 2005. Rope pumps were introduced here around 2006 by the Practical foundation and supported by organizations like IDE, JICA and Water Aid. During several years local metal workshops have been trained in production and model. However the pump became so popular that untrained workshops also started to produce and sell the pumps. By 2012, there were an estimated 10,000 rope pumps installed in but often the pump and installation was of a poor quality without a good seal resulting water to leak back in the well and causing recontamination of the water. According to Sally Sutton and Tsegaw Hailu (2011), currently some
rope pumps have been produced in Ethiopia, but uptake and sustainability remain key areas which need much more popularization. Adoption of the rope pump as an effective technology is being promoted not just by the water sector but also by the Ministry of Agriculture (MoA), with a focus on the expansion of small-scale irrigation. This is in line with the Growth and Transformation Plan (MoFED, 2010) aims of developing community participation and labour intensive, low cost technologies.

The revised rope pump and washer (MOWE. 2009) puts considerable emphasis on the potential of the rope pump to provide safe and sustainable water supply for households. It highlights the low cost technologies role, both within community and household contexts. Even as community low cost supplies (hand pumps on hand-dug wells and shallow boreholes) are household level low cost systems that can be paid for in full by themselves. Further introducing of the pump to the farmers is therefore a key aspect if uptake is to make a significant difference to rural water supply coverage. Training, promotion and monitoring is needed to encourage self-supply of the households as it is relatively low cost though it is not a cost-free. Therefore, the rope and washer pump however is a solution for the above draw backs of the mentioned water lifting for drink and garden small irrigation purpose. It is easily driven by human labor thus enabling access to the water both for drinking as well as for garden small irrigation sustainably. It has no additional cost except development and installation costs. The pump enables harness and use water from different depth. Jimma and Ilubabor zones are also potential areas to apply easily built, low maintenance rope and washer pump to offer Water without the need for fuel where the potential water exists. Hence, popularization of this water lifting technology is undertaken in selected districts of Jimma and Ilubabor zones.

Objectives

- To create awareness about use of the water lifting technologies among the rural farmers
- To enhance farmers’ knowledge and skill of operation and maintenance of the pump
- To collect feed backs on the technology for further improvement in the future

Materials and Methods

Materials

Eight Prototypes of rope and washer pumps were manufactured in workshop as per its design for the demonstration purposes. Use of water holes of different depths of up to 15m, water size and supply duration were considered for the conducting demonstration. Finally the eight pumps were installed at the identified sites for the demonstration purposes.

Methods

The study was conducted in two districts of Jimma zone namely Dedo and Kersa and three districts of Ilubabor zone namely Matu, Gechi and Borecha. Eight hosting farmers who have irrigation experience, willingness to assist follower farmers and appropriate site were selected for the popularization of technology. The Agricultural Extension Department of the respective Districts and Development Agents were involved in demonstration processes. Participating farmers were given both formal and informal training on general aspects of operation and maintenance of the improved technology to improve the user farmers’ skill.

All selected farmers were given training. Selected farmers were divided into two groups. A group of 8 farmers made to lift ½ a barrel (100 liter) of water from 11 meter depth well by using (rope and washer pump) while the same group of farmers were made lift the same amount of water and same depth of well without using the technology that is only by their labor. The farmers were trained on how to properly operate the pump. In using the technology field demonstration organized and popularized. During the study data was collected on users’ perceptions, ease of operation costs of
inputs, advantage and limitation of technology. Data were collected and analyzed using quantitative method by descriptive statistics as well as quantitative techniques.

**Results and discussions**

**Farmers' participation**

Demonstration activities undertaken at 8 different sites where the instillation of the pump made in Dedo, Kersa, Matu, Gechi and Borecha Districts. Eight interested farmer household were purposively selected as hosting farmer for the popularization of the technology. Finally a total of 450 farmers attended the field demonstration that conducted at different sites. The pump were installed for hosting farmers. Sixteen district agricultural workers and twenty-four development agents also participated in demonstration and training on the pump operation and maintenance trainings.

**Farmers' response**

Among the farmers interviewed, 75% had responded that it is simple to operate the rope and washer pump for lifting water from the distant water hole in relation to using only human energy. While only 25 % of the respondents stated that it requires some technical knowledge to use and make maintenances when it damages. The Rope and Washer Pump operates with minimum force requirement. It has good discharge capacity (2litres/s). As far as its affordability is concerned, 43.75% of the farmers responded that the constriction cost is medium that can be affordable by the average farmers compared to the engine driven pumps. About 56.25% of the respondent farmers also indicate that it is possible to repair and maintain by local technicians or by themselves even if the pump damages.

Table 1 Farmers response on nature of the rope and washer pump (no= 32)

<table>
<thead>
<tr>
<th>No</th>
<th>Criteria</th>
<th>No. of respondents</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ease of operation</td>
<td>Simple</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Not Simple</td>
<td>8</td>
</tr>
<tr>
<td>2</td>
<td>Maintenance</td>
<td>Easy</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Difficult</td>
<td>12</td>
</tr>
<tr>
<td>3</td>
<td>Affordability (Construction cost)</td>
<td>High</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Medium</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Low</td>
<td>8</td>
</tr>
</tbody>
</table>

The farmers saw very much time variation in lifting water from the lengthy water hole by using the pump and only human labor that it took in average 30 seconds to lift 25liters of water from an 11m depth hole. In the contrary, in average it took 75 second to get 25liters of water from the same depth hole without using the pump.
Table 2 Water lifting time variation in using rope and washer and the local method (No= 32)

<table>
<thead>
<tr>
<th>No</th>
<th>Lifting system</th>
<th>Participant (equal no. of male and female)</th>
<th>Water lifted by each participant</th>
<th>Average time per 25 litre</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Using rope &amp; washer</td>
<td>32</td>
<td>25 litre</td>
<td>30 seconds</td>
</tr>
<tr>
<td>2</td>
<td>By local method</td>
<td>32</td>
<td>25 litre</td>
<td>75 seconds</td>
</tr>
</tbody>
</table>

Problems raised by the farmers

Once the pump is successfully installed and operation and maintenance training is provided to the users of the pump usually there is no follow-up and further help and advice while the damage of the pump happens after sometimes mainly where the user farmer is technically not well capacitated. Usually operation and maintenance sheet, which may distributed together with the pump, for the users incomplete or some spare parts like piston or plastic washer usually lacked at local markets of rural areas.

Using the rope and washer pump on communal wells on by different households fasten the rate of pump damage and easily loss of water from the well. So functioning and life time of the pump will be increased when care is taken during operation of the pump. The pump need only rotated clockwise but turning the pump reverse direction can damage it if not locked after pumping is stopped. Sometimes it needs checking the tension of the rope and adjusting. Though the bushings need lubricating every 2 weeks when they running dry or start to make a shrieking noise, but the farmers usually fail to lubricate regularly. Similarly, the rope also can show a lot of damage and need be changed preferably before it breaks.

Conclusion and Recommendation

Conclusion

The rope and Washer pump however is a solution for the rural household draw backs of the water lifting for drink and garden small irrigation purpose. It is easily driven by human labor thus enabling access to the water both for drinking as well as for garden small irrigation sustainably. It has no cost incurred except development and installation costs. The rope and washer pump enables rural farmers to sufficiently harness and use water up to wells depth of 10 to 12m. Besides, it doesn’t need much cost once it is successfully installed and operation and maintenance training is provided to the users. It is easy to operate, maintain and train others to produce as it can be made locally at micro enterprise level.

Recommendation

The technology is very much liked by the farmers and therefore it needs further extension through pre-scaling up research activities. Since the pump efficiency and sustainability depends on frequent maintenance like oiling the bushings, it needs some blocking system on the handle to avoid unexpected return of the handle and its further extension requires training provision to the local micro enterprises for the technology maintenance and production quality.
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Pre-Scaling up of Improved Bread Wheat Technologies in Potential Production Areas of East, Horro-Guduru Wellega and West Shewa Zones of Oromia

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Abstract

This activity was conducted in selected districts of western Oromia, Jimma Arjo, Horro, Bako Tibe and Chaliya with the objective of disseminating two recently released bread wheat varieties, Danda’a and Digalu. Multidisciplinary team of Bako Agricultural Research Center comprising of wheat breeder, pathologist, agronomist, socio-economist and Agricultural Research Extensionist, together with district bureau of Agriculture selected appropriate sites in the districts; and farmer selection was entirely done by district experts and their respective DAs. The varieties were promoted from past demonstration a year ahead of pre-scaling up, and have met the farmers’ selection criteria (Yield potential, good agronomic characteristics, resistance to major disease, superior in injera/bread making quality and market demand). Accordingly, a total of 100 farmers were reached and an area of 25 ha was covered with the activity, each farmer allocating 0.25 ha. The grain yield performances of the two improved varieties ranged from 12 q/ha (local) to 45 (Digalu) and 12 to 52 q/ha for Danda’a representing about 333.3% yield advantage over the local variety. Food security and the livelihood of participating farmers was improved in that farmers produced surplus for marketing, maximized their income, purchased oxen, cows, cross bred heifers, contributed in schooling their children, Purchased other agricultural inputs with cash. At the completion of the activity an exit strategy that guarantees sustainability was designed where the district Bureaus of Agriculture offices were officially informed to take over and go for large scale dissemination. To this end official letters were written and handed over to all of the districts under consideration

Keywords: prescaling up; Bread wheat; Digalu, Danda’a stakeholders’ linkage; Multidisciplinary

Introduction

In Sub-Saharan Africa (SSA), wheat is grown in sub-humid or humid agro-ecological zones of the highland temperate mixed farming system. Ethiopia contains the majority of this cropping system in the Africa, although there are smaller areas in the highlands of Eritrea, Lesotho, South Africa, Angola, Cameroon and Nigeria. This cropping system accounts for only four percent of cultivated area in SSA, but supports seven percent of the region’s population. Within Ethiopia, the Oromia and Amhara regions produce 59% and 27% of the region’s wheat, respectively, with an additional nine percent coming from the Southern Nations, Nationalities, and Peoples Region (SNNPR). Bread wheat accounts for about half of the area planted; wheat, durum and emmer wheat accounts for the remainder. Bread wheat is widely grown in the highland and semi-highland areas of the Tigray, Amhara and Oromiya regions. (Kate Schneider et al., 2010).

Despite the economic and food security importance of crops like wheat, sorghum, maize, lentils and peas, data and opinion suggest a yield gap: actual smallholder farm yields do not achieve estimated potential yields. Wheat in particular demonstrates a significant yield gap in comparison to the East Africa regional and world averages, and domestic production accounted for only 79% of local supply in 2007. Ethiopian wheat yields have been consistently well below East African and world average yields, indicating low productivity of
According to FAO data, Ethiopian wheat yields fluctuated between 88% and 99% of the regional average yield between 2004 and 2008. Even in the highest yielding year (2008), this amounted to only 77% of average African wheat yields and 56% of world average yields. (Kate Schneider et al., 2010).

In developing countries like Ethiopia it is believed to cover up to about 25% calorie requirements of the population. Despite its greater economic and nutritional contribution to our population, the national average does not exceed 1.8t/ha. (Kebede et al., 2013). As compared to the on-station research results, that of fields of some innovative farmers and global productivity level, this is very low. Shortage of improved seed, disease, and limited use of necessary inputs are among the factors that contribute to the low productivity of the crop. (Kebede et al., 2013).

It is a staple food crop in all high land areas of western Oromia. 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 seeds are among the constraints that lowered the productivity. (EAAPP, 2014). In 2013-2014, for instance, stem rust of wheat occurred at epidemic level breaking resistance of Digalu variety (EAAPP, 2014). Recently, Danda’a, to our dismay was also attacked by the disease, despairing bread wheat producers. To tackle such a challenge, Bako Agricultural Research Center has been conducting intensive research work on the crop, and has recently adapted two wheat varieties that have better disease tolerance than the previous varieties.

Therefore, this activity was initiated with objectives of popularizing improved bread wheat technologies in the study areas.

**Objectives**

- To popularize demonstrated and proven improved bread wheat technologies for small holders’ farmers found in study areas.
- To strengthen linkage between farmers, extension, research and others key stakeholders to make improved seed easily accessible for the users.
- To improved the knowledge and skills of farmers on bread wheat technologies production and management practices.

**Materials and Methods**

**Description of the Study area**

**Horro District**

Horro is located 315 km from Addis Ababa in the Oromia regional state in western Ethiopia. The district has two major agro-ecologies: high land and mid-high land. Mixed crop-livestock agriculture is the mainstay of the farming communities. Livestock species raised in the district include cattle, sheep, horses, poultry, goats, donkeys and mules. Major crops are wheat, barley, tef, field peas and faba beans. Based on information from Horro 3 district office of agriculture, the human population of the district is 103,707 (61,553 males and 42,154 females). There are 12,805 male- and 3,236 female-headed households in the district. Total land area of the district is 77,998 hectares (ha) of which 6,458 ha (8.3%) is allocated for grazing. The proportion of highland, mid-highland and lowland areas in the Horro district are
49.8%, 48.9% and 1.24%, respectively. The district has one long rainy season that extends from March to mid-October with mean annual precipitation of about 1800 millimeters (mm) (Olana 2006). The mean, average maximum and average minimum temperatures of the area are 22°C, 27°C and 12°C respectively. (Gemeda et al., 2013)

Jimma Arjo District

Jimma Arjo is one of the woredas in the Oromia Region of Ethiopia. It shares the name of one of the subgroups of the Oromo people, the Jimma Arjo. Part of the Misraq Wellega Zone, Jimma Arjo is bordered on the southwest by the Didesa River which separates it from the Iluababora, on the northwest by Diga Leka, on the northeast by Guto Wayu, and on the southeast by Nunu Kumba. The administrative center of this woreda is Arjo. The 2007 national census reported a total population for this woreda of 86,329, of whom 42,093 were men and 44,236 were women; 9,172 or 10.63% of its population are urban dwellers. The majority of the inhabitants observed Protestantism, with 48.85% reporting that as their religion, while 45% observed Ethiopian Orthodox Christianity, and 5.59% were Muslim. (Wikipedia, the free encyclopedia). Major cereal crops grown include barley, tef, wheat, and pulse and oil crops include linseed, faba bean and field pea.

Chaliya District

It is one of the districts from west Showa zone which is located at about 63 kilometers to the west of Addis Ababa. Mixed crop-livestock agriculture is the mainstay of the farming communities. Livestock species raised in the district include cattle, sheep, horses, poultry, goats, donkeys and mules. Major crops are wheat, barley, tef, field peas and faba beans. Rainfall in the district is uni-modal in nature that extends from March to October.

Approaches to the pre-scaling up activity

Procedurally, pre-scaling up activities is preceded by demonstration and participatory variety selection with farmers and relevant stakeholders. Accordingly, a year before the pre-scaling up process, the varieties were demonstrated on some farmers plots using plot size of 100 m² at the respective sites where the technology was planned to be scaled up. Results from the evaluation process revealed that the variety was has met the farmers' requirement that paved way to the pre-scaling up process. It was based on this result that the prescaling up phase was planned and executed.

Stakeholder Analysis (SA)

In enhancing wheat technologies generation, dissemination, improving wheat production and productivity, the research center was closely working and has made frequent consultation with its respective stakeholders. Pre-scaling up activity should be done by different actors in partnership and collaborative approach. So, SA is highly important for institutional arrangement (who does what?) before embarking on the pre-scaling up activity. Thus, stakeholder analysis was undertaken to identify potential stakeholders. Points such as: Who are the stakeholders? How big is their stake? How much they are closer to the project? What are their roles, duties and responsibilities in implementing the activity? How does the synergy support the opportunities to bring the required impact? And finally the roles, duties and responsibilities of each actor were clearly stated in implementing the activity.

Accordingly, 6 responsible and collaborative participant stakeholders/actors were identified. Namely, zonal and district agricultural experts, district administrators, district cooperatives, Development Agents and Researchers were the identified stakeholders.
Site and farmer selection

This activity was the follow-up of the past demonstration of the varieties a year before the pre-scaling up activity. Selection of the districts was accomplished by a multidisciplinary team of Bako Agricultural Research center in collaboration with experts of the respective districts. Accessibility and potentiality were the two most important criteria to select both the districts and the kebeles under consideration.

Farmer selection criteria

As Development Agents are closer to, and information rich about the farmers in their respective jurisdiction, the task of farmer selection was entirely left to them given the farmers fulfill the criteria set by researchers. As the team does not provide other inputs along with seeds, model farmers who are capable of purchasing fertilizer and other relevant inputs were selected. On top of this, experience in wheat production, having appropriate and sufficient plots, good history of managing experimental or non-experimental plots were the other criteria used to select the host farmers.

Seed delivery mechanism

As compared to technology demonstration the prescaling up process involves relatively large number of farmers that makes it difficult to reach each farmer individually. Thus it was mandatory to go via the respective bureau of agricultural and rural development offices, specifically the agricultural extension wing to which the seeds were to be handed over. The district offices in turn had to assign their respective DAs who are closer to, and know more about each farmer than the district experts. To brush up memory of the training session, and stick to the recommendations, such information as variety, seed rate, fertilizer rate, and time of fertilization, spacing and other important agronomic information was tagged to and was delivered with the seed.

DAs of the respective PAs have been helping and closely supervising the farmers during planting so as to ensure appropriate planting of the material. In order to ensure continuity, and address more number of farmers, the original seed was used as revolving seed, and each farmer gave back the amounts he used. This amount was, thus, given to other farmers within the same PA or adjacent to the previous PA. The lion’s share of seeds delivered, however, was covered through purchase from some of the host farmers whose farms were closely supervised to ensure production of pure and quality seeds. Quality seeds from such reliable sources are purchased for about 15% premium price and distributed to other farmers. This incentive was thought considering additional cost of production, and at the same time to encourage farmers produce quality seeds. All field activities, starting from field preparation to final harvesting and threshing were carried out by farmers as per recommendation and guidelines given by the researchers. Besides, the multidisciplinary team made frequent field supervision at different stages of the crop development.

Plot size and input use

The activity was conducted on a plot size of 0.25 ha. A farmer could use both of the varieties on his/her farm given they could afford to allocate appropriate land, labour and purchase relevant inputs like fertilizer and other necessary agro-chemicals. Seed was planted at the rate of 126 kg per hectare. 100 kg/ha DAP was applied at planting and 50 kg/ha UREA was applied at early stage of the plant growth.

Field day participants

Each year field days were arranged though not in all locations in the same year. Summation of the different years reveals that 300 farmers, of which 20 were females; 9 district experts and 12 Development Agents and 15 researchers attended the field days organized.
Data collection and analysis

Both qualitative data (farmers’ opinions, challenges) numeric data were collected. As it was difficult to collect yield data from all farmers detailed analysis was difficult, thus limiting us to mean yields.

Experience sharing platforms and information dissemination process

Even though there are numerous methods that can help in information dissemination process, only a few of them were used to share experience among the farming community and other actors in the process. Among them are: training workshops, regional and Center based reviews, Zonal and District based ADPLAC review meetings and field days. Accordingly, each year, the team has participated in different zonal and district ADPLAC meetings where it presented outreach activities in the respective zones. At this platform, opportunities and challenges were presented and the way forward was presented to proceed with the activities. Comments at this platform are used as a valuable input to initiate new activities or manipulate the on-going ones. Field days are among the important platforms where information is disseminated among the relevant stake holders. To this end, these platforms were arranged each year where farmers, researchers, zonal and district agricultural experts, cooperative professionals participate.

Results and Discussions

Training of farmers and other stakeholders

Before commencing the pre-scaling up activity, a comprehensive training on crop production and management was given to host farmers, DAs and district experts. At this juncture, breeders, crop protection researchers, agronomists, Agricultural Research Extensionists and Agro-economics professionals have given training in their professional spheres. Accordingly, 120 farmers, 6 district experts and 12 Development Agents were trained.

Joint supervision of activities

Fields were supervised at two different levels. The first supervision was the one executed by a joint between farmers, district experts, Development Agents and researchers from the Agricultural Extension Research team of the Bako Agricultural Research Center. The second was conducted by representatives from each discipline in the center (representatives from each research team) and planning head of the research center. The latter type of supervision is a routine type of supervision conducted every year as part of the center’s activity. Status of the activities under consideration is presented on the forum organized for this joint venture. Comments during the supervision are taken in to account to take any necessary corrective measures and fill the observed gaps.

Seed distribution

In the first year of the activity (2012) a total of 30 farmers were reached in Horro, Chaliya and Jimma Arjo districts of western Oromia. In 2013, 30 more farmers were reached with the technology in the same districts. Based on high demand and frequent request from farmers in the intervention areas, and insisted claim from district and zonal experts, the team has decided to use one more year extension for the pre-scaling up activity. Accordingly, in the year 2014, 6 farmers from Bko Tibe and 34 farmers from Horro district were reached with the technology. Total number of farmers reached so far, area covered and amount of seed distributed so far is 100 farmers, 24.5ha and 3216 kg, respectively.
Table 1. Shows No of beneficiary farmers and area covered in hectare by year

<table>
<thead>
<tr>
<th>No</th>
<th>Year</th>
<th>Area covered (hectare)</th>
<th>No of beneficiary Farmers per district</th>
<th>Total</th>
<th>Amount of seed distributed(kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Arjo</td>
<td>Horro</td>
<td>Gedo</td>
</tr>
<tr>
<td>1</td>
<td>2012</td>
<td>7.5</td>
<td>10</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>2013</td>
<td>8</td>
<td>8</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>2014</td>
<td>9</td>
<td>6</td>
<td>31</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Total</td>
<td>24.5</td>
<td>23</td>
<td>56</td>
<td>20</td>
</tr>
</tbody>
</table>

On-farm performance of the varieties

In spite of the inevitable variability in performance between and even within locations, yield performance of the varieties was still promising. The variability in yield performance might have stemmed from difference in the status of soil fertility, difference in management (usage of recommended cultural practices and inputs) and others. One important point to note is the issue attached to row planting. Due to the fact that there is no standard material (implement) that can draw uniform line between rows, a very wide distance between rows was observed that resulted in lower population per plot and reduced yield as a consequence. Despite this fact a yield of 52 qt for Danda’a and 35 qt/ha for Digalu, respectively was reported as compared to the local variety that yields only 10 qt/ha or even less.

The grain yield performance of the Danda’a in the current study was lower than its on-station potential, by about 10 quintal, but greater than that reported as the highest for sub Saharan Africa (4140 kg/ha) where as the regional average was only 2,020 kilograms per hectare. (Kate Schneider et al., 2010). The productivity gap between the on-station and on-farm yield of the current study might be differences in management level between the field managed by researchers and farmers, differences in soil fertility status, failure of some farmers to use full package and the like. By applying proper management, however, it’s possible to narrow the gap, though impossible to close. Much then is expected from professionals in helping the farmers technically.

Institutional and attitudinal change

Despite the efforts made by various institutions in transforming the agricultural sector and improving the livelihoods of resource poor farmers so far, it was not possible to attain sustainable and incremental economic development. The major reason, among others, was that most intervention made by different institutions was unilateral and lacked coordination and synergy. The present approach of developing partnership and institutional linkage in bread wheat technology promotion proved successful and therefore is viewed as a win/win working model by stakeholders involved in the value chain from technology generation all the way through production to marketing of value added products. Moreover, the successful accomplishment of this innovative work through the active involvement of all stakeholders has brought about significant and positive attitudinal change towards partnership and collaboration and thus built mutual trust and confidence among themselves in expanding their cooperation in other similar joint initiatives.
Through direct pre-scaling up, 100 farmers were reached with the technology that helped them produce surplus for marketing, which in turn maximized their income. Income from the sale has helped farmers in schooling their children and purchase agricultural inputs with cash. More importantly, mutual trust between farmers, researchers, DAs and other stakeholders was fostered.

Farmers’ Opinion/ Feedback
During the course of the scaling up process, and at the final stage of the activity, an assessment was made to know how the farmers perceived the technology. Result of the assessment revealed that both of the varieties were liked by farmers as they exhibit better injera/bread quality, preferable color, better yield performance and market price.

Success factors
There are a lot of factors that have contributed to success of the work, one or the other way. The presence of enthusiastic biological researchers, compatibility of the technology with farmers’ needs, synergy between different teams, active participation and strong linkage among stakeholders, scaling up strategy with shared vision and supportive research management both at center and institution level were some of the conditions that contributed much.

Lessons learned
During the course of the work, the team has learned that concerted effort among different actors is instrumental for fruitful work. Thus, identification & collaboration with key stakeholders was one important lesson learned from the process. The other lesson drawn was the importance of using innovative farmers, as their fields speak louder and clearer than researchers, DAs and experts. Thus, using them for technology dissemination is a wise approach to reach the vast majority.

Challenges encountered
During the course of the pre-scaling up activity, a lot of challenges were entertained, but the major ones were vehicle shortage to cover wider areas, no or scanty feedback especially on yield data, failure of a few farmers to use full package. A very recent, but shocking phenomenon is devastation of the two varieties (Both Danda’a and Digalu) by rust.

Exit strategy/hand over strategy
In addition to technology generation and adaptation, BARC extends technologies only to a limited scope (time horizon and spatial dimension). Wider scale scaling up, thus, remains the activity to be undertaken by bureau of agriculture in the respective localities. Thus it is becoming mandatory to create a relay type of extension system to ensure continuity of the technology until better option emerges. To ensure sustainability, finally the letter of handing over was dispatched to the respective districts where the activity was undertaken.

Conclusions and Recommendations

Conclusions
The technologies proved themselves capable of changing the lives of many farmers one way or the other. The recent phenomenon of stem rust that attacked both of the varieties, however, was shocking and is a big blow to the farming community that bases its livelihood on wheat production. It is thus, an urgent task to look for better varieties that can withstand the plague. Until better option emerges, the farmers are advised to use recommended chemicals at recommended rates.

Recommendations
Bako Agricultural Research Center has recently released two improved wheat varieties that have better tolerance/resistance to the disease. An urgent intervention through these technologies is crucial
to save the lives of many farmers in the area. Thus, researchers and bureau of agriculture of the respective districts have to come together to devise mechanism that helps reach the community as early as possible.

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Pre-scaling up of Improved Food Barely Technologies (HB-1307) in Potential Areas of Western Oromia
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Abstract
This activity was conducted in Jimma Arjo; Horro and Chaliya districts of western Oromia with the objective of disseminating one recently released Food barley variety, HB-1307. Multidisciplinary team of Bako Agricultural Research Center comprising of Barley breeder, pathologist, agronomist, socio-economist and Agricultural Research Extensionist together with district Bureau of Agriculture selected appropriate sites in the districts, and farmer selection was entirely done by district experts and their respective Development Agents. The variety was promoted from past demonstration a year ahead of the pre-scaling upon the basis of farmers’ selection criteria. (Yield potential, good agronomic characteristics, resistance to major disease, superior in injera/bread making quality and market demand). Accordingly, during the course of this pre-scaling up activity a total of 203 farmers were reached and an area of 50.75ha was covered with the activity, each farmer allocating 0.25 ha. The grain yield performances of the variety ranged from 8 qt/ha (local) to 40 qt/ha (HB-1307), implying about 412.5 % yield advantage over the local. Food security and the livelihood of participating farmers was improved in that farmers produced surplus for marketing, maximized their income. At the completion of the activity an exit strategy that guarantees sustainability was designed where the district Bureau of Agricultural offices were officially informed to take over and go for large scale dissemination. To this end official letters were written and handed over to all of the districts under consideration.

Keywords: Food barley prescaling up, HB-1307, Stakeholders’ Linkage, Multidisciplinary

Introduction
Barley is thought to have originated in the Fertile Crescent areas of the Near East from the wild progenitor Hordeum spontaneum. It is one of the first cereals to have been domesticated, having been cultivated for more than 10000 years with archeological evidence of barley cultivation in Iran as long ago as 8000 BC. It was part of the staple diet for those living in ancient Egypt, Greece and China. It is grown in a wide range of agro-climatic conditions under several production systems. In 2005 barley was grown in more than 100 countries world wide with total barley grain world wide of 138 million tons from 57 million ha with productivity levels at round 2.4t/ha. The highest productivity was attained in France (6.3t/ha) (Bayeh et al., 2011). Barley holds a unique place in farming in Ethiopia, and various sources agree that it has been in cultivation for at least the past 5000 years in the country. (Bayeh et al., 2011). In Ethiopia the production of barley, by-and-large, has been below 1 million tons per year for the most of the past 25 years except during the years when the area under barley increased above 1 million hectare. However, productivity has never increased above 1.3t/ha, which is about half the world average. (Bayeh et al., 2011).

With regard to area coverage it is the fourth following tef, maize and sorghum. Both area coverage and production has increased from 2011/2012 to 2012/2013 (CSA area and production 2012/2013). According to the report the land covered by the crop has increased from 948,107.43 ha during the year 2011/2012 to 1,018,752.94 ha during 2012/2013 and production has increased from 15,852,869.21 qt during 2011/2012 to 17,816,522.08 qt during the year 2012/2013.(CSA area and production 2012/2013). Despite its enormous economic and nutritive importance, productivity is very low as compared to other cereals (1.2 tone/ha). For instance, there is a decline in production/ ha for the same

There are a number of attributes that make the crop desirable to resource poor farmers: it is a dependable source of food, as it is grown at different seasons and production systems, it does well in marginal areas of low soil fertility, a low input crop requiring relatively low investment. In addition to its grain barley straw is also useful as a good source of livestock feed during the dry season when there is an acute shortage of good quality fodder (Yosef et al., 2011). Despite its underlined importance to poor farmers, there are a few, if any, improved bread wheat varieties for farmers. As a result most farmers are using local varieties of low productivity. The crop is among the most important crops produced in the highland areas of the study districts, but still is characterized by low productivity.

To tackle productivity problem the national and regional research systems in the country have been conducting a series of research activities on improvement of the crop and have been releasing different varieties. Among them is a variety known as HB-1307 which has better productivity and disease resistance compared to local and other released varieties. This variety had about 85% yield advantage over the local variety produced in the study areas. 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 activity, therefore, was initiated with objectives of prescaling up of improved food barley technologies to the farming communities in the study areas.

Specific Objectives

- To popularize demonstrated and proven improved food barley technologies for small holder farmers in selected zones of Western Oromia which in turn will facilitate the adoption process and bridge the productivity gap.
- To strengthen linkage between farmers, extension, research and others key stakeholders to make improved seed easily accessible for the users.
- To establish community based seed production and marketing scheme to facilitate Farmer-to-farmer improved seed exchange to improved the knowledge and skills of farmers on tef technologies production and management practices.

Methodology

Description of the Study Area

Horro District

Horro is located 315 km from Addis Ababa in the Oromia regional state in western Ethiopia. The district has two major agro-ecologies: Mixed crop-livestock agriculture is the mainstay of the farming communities. Livestock species raised in the district include cattle, sheep, horses, poultry, goats, donkeys and mules. Major crops are wheat, barley, tef, field peas and faba beans. Based on information from Horro 3 district office of agriculture, the human population of the district is 103,707 (61,553 males and 42,154 females). There are 12,805 male- and 3,236 female-headed households in the district. Total land area of the district is 77,998 hectares (ha) of which 6,458 ha (8.3%) is allocated for grazing. The proportion of highland, mid-highland and lowland areas in the Hono district are 49.8%, 48.9% and 1.24%, respectively. The district has one long rainy season that extends from March to mid-October with mean annual precipitation of about 1800 millimeters (mm) (Olana, 2006). The mean, average maximum and average minimum temperatures of the area are 22°C, 27°C and 12°C respectively. Total livestock population of the district is 351,305 head, of which cattle and sheep accounted for 60% (cattle 43% and sheep 17%). Gemeda et.al. 2013.
Jimma Arjo

Jimma Arjo is one of the woredas in the Oromia Region of Ethiopia. It shares the name of one of the subgroups of the Oromo people, the Jimma Arjo. Part of the Misraq Wellega Zone, Jimma Arjo is bordered on the southwest by the Didesa River which separates it from the Iluababora, on the northwest by Diga Leka, on the northeast by Guto Wayu, and on the southeast by Nunu Kumba. The administrative center of this woreda is Arjo. The 2007 national census reported a total population for this woreda of 86,329, of whom 42,093 were men and 44,236 were women; 9,172 or 10.63% of its population are urban dwellers. The majority of the inhabitants observed Protestantism, with 48.85% reporting that as their religion, while 45% observed Ethiopian Orthodox Christianity, and 5.59% were Muslim. (Wikipedia, the free encyclopedia). Major cereal crops grown include barley, tef, wheat; and pulse and oil crops include linseed, faba bean and field pea.

Chaliya District

It is one of the districts from west Showa zone which is located at about 63 kilometers to the west of Addis Ababa. Mixed crop-livestock agriculture is the mainstay of the farming communities. Livestock species raised in the district include cattle, sheep, horses, poultry, goats, donkeys and mules. Major crops are wheat, barley, tef, field peas and faba beans. Rain fall in the district is uni-modal in nature that extends from March to October.

Approaches followed

Formation of a multidisciplinary team

Before beginning the pre-scaling up, the team was convinced that it could not handle the whole task unless collaborated with other research teams within the center and other stakeholders. To this end, a multi disciplinary team composed of biological researchers (breeders, pathologists, agronomists) and social scientists (Agricultural Economists and Agricultural Research Extensionists) was formed. This team has set objectives, designed approach, and identified key stakeholders and their respective roles. The stake holders identified were zonal and woreda bureau of agriculture, Zonal and district cooperatives, zonal and woreda administration including Bako Agricultural Research center. The identified stakeholders were invited to the center, shared responsibilities, developed collective action plan and signed memorandum of understanding.

Site and farmers selection

To address the afore mentioned objectives, the core multi-disciplinary team of the Bako Agricultural Research Center together with the Woreda experts and Development Agents of the respective districts, selected appropriate sites and farmers that most suit the process. Accordingly, potential districts that hosted the previous on-farm demonstrations were purposively selected. The districts were Horro, Chaliya and Jimm Arjo from Horro Guduru Wollega, West Shoa and East Wollega zones, respectively. Selection of the varieties were made from the previous field demonstration and evaluation by FRG members based on their merit of high grain yield potential, good agronomic characteristics, resistance to major disease, superior in bread making quality and high market demand.

Farmers Selection Criteria

As the team does not provide other inputs along with seeds, model farmers who are capable of purchasing fertilizer and other relevant inputs were selected. On top of this, experience in barley production, accessibility, having appropriate and sufficient plots, good history of managing experimental or non experimental plots in the past, or loyalty to entrust trials to, were the other criteria used to select the host farmers.

Entry point to the pr-scaling up process
Procedurally, pre-scaling up activities is preceded by demonstration and participatory variety selection with farmers and relevant stakeholders. Accordingly, a year before the pre-scaling up process, the varieties were demonstrated on some farmers plots using plot size of 100 m² at the respective sites where the technology was planned to be pre-scaled up. Results from the evaluation process revealed that the variety has met the farmers' requirement that paved way to the pre-scaling up process. It was based on this result that the pre-scaling up phase was planned and executed. Varieties used during the earlier demonstration were MB-1307 with local check, but only the former variety was used for the pre-scaling up.

Seed delivery mechanism

The pre-scaling up process involves relatively large number of farmers as compared to technology demonstration that makes it difficult to contact each farmer individually. Thus it was mandatory to go via the respective bureau of Agricultural and Rural Development offices, specifically the agricultural extension wing, to which the seeds were to be handed over. The district offices in turn assigned their respective DAs who are closer to, and know more about each farmer than the district experts. Such information as variety, seed rate, fertilizer rate and time of fertilizer application, spacing and other important agronomic information was tagged to, and was delivered with the seed. Development Agents of the respective kebeles have been helping and closely supervising the farmers during planting so as to ensure appropriate planting of the material.

Sustaining the seed delivery system

In order to ensure continuity, and address more number of farmers, the original seed was used as revolving seed, and each farmer gave back the amount S/he was given. This amount was, thus, given to other farmers within the same kebele or adjacent to the previous kebele. The lion's share of seeds delivered, however, was covered through purchase from some of the host farmers whose farms were closely supervised to ensure production of pure and quality seeds. Quality seeds from such reliable sources are purchased for about 15% premium price and distributed to other farmers following similar procedure. This incentive was thought considering additional cost of production, and at the same time to encourage farmers produces quality seeds. All field activities, starting from field preparation to final harvesting and threshing were carried out by farmers as per recommendation and guidelines given by the researchers. Besides, the multi disciplinary team made frequent field supervision at different stages of the crop development.

Stakeholder Analysis (SA)

In enhancing food barley technologies generation, dissemination, improving wheat production and productivity, the research center was closely working and has made frequent consultation with its respective stakeholders. Pre-scaling up activity should be done by different actors in partnership and collaborative approach. So, Stakeholders’ Analysis is highly important for institutional arrangement (who does what?) before embarking on the pre-scaling up activity. Thus, stakeholder analysis was undertaken to identify potential stakeholders. Points such as: Who are the stakeholders? How big is their stake? How much they are closer to the project? What are their roles, duties and responsibilities in implementing the activity? How does the synergy support the opportunities to bring the required impact? And finally the roles, duties and responsibilities of each actor were clearly stated in implementing the activity.

Accordingly, 8 responsible and collaborative participant stakeholders/actors were identified. The stakeholders were: Zonal and Woreda Bureau of Agriculture, Zonal and District Cooperatives, Zonal and Woreda Administration, Farmers and Development Agents, to be coordinated by Bako Agricultural Research center.

Experience sharing platforms and information dissemination process

Even though there are numerous methods that can help in information dissemination process, only a few of them were used to share experience among the farming community and other actors in the process. Among them are: training workshops, regional and Center based reviews, Zonal and District
based review meetings and field days. Accordingly, each year, the team has participated in different zonal and district ADPLAC meetings where it presented outreach activities in the respective zones. At this platform, opportunities and challenges were presented and the way forward was presented to proceed with the activities. Comments at this platform are used as a valuable input to initiate new activities or manipulate the on-going ones.

Results and Discussions

Farmers and other stakeholders training

Before commencing the prescaling up activity, a comprehensive training on crop production and management was given to host farmers, DAs and district experts. At this juncture, breeders, crop protection researchers, agronomists, Agricultural Research Extensionists and socio-economic professionals have given training in their professional spheres. Accordingly, 100 farmers, 15 Development Agents, and 9 district experts were trained.

Input distribution

During the first and the second years of the activity (2011 & 2012) a total of 87 farmers were reached in Horro, Chaliya and Jimma Arjo districts of western Oromia. In 2013, thirty-three (33) more farmers were reached with the technology in the same districts. Based on pressing demand and frequent request from farmers in the intervention areas, and insisted claim from district and zonal experts, one more year extension was used for the pre-scaling up activity. Accordingly, in the year 2014, sixty-six (66) farmers from Horro (Gitlo and Leku Seed Producers Cooperatives, and 11 other farmers from Chabir of the same district, four farmers from Jimma Rare and two farmers from Jimma Arjo were reached with the technology. Total number of farmers reached, total area covered and quantity of seed distributed were, 203, 50.75 ha and 4640 kg, respectively.
Table 1. Shows No of beneficiary farmers and area covered in hectare by year

<table>
<thead>
<tr>
<th>No</th>
<th>Year</th>
<th>Area covered (hectare)</th>
<th>No of beneficiary Farmers per district</th>
<th>Total</th>
<th>Amount of seed Distributed In kg</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
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<td>Horro</td>
<td>Gedo</td>
</tr>
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<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
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<tr>
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<td>15</td>
<td>15</td>
</tr>
<tr>
<td>2</td>
<td>2012</td>
<td>10.5</td>
<td>14</td>
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<td>2014</td>
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<tr>
<td>5</td>
<td>Total</td>
<td>50.75</td>
<td>39</td>
<td>67</td>
<td>39</td>
</tr>
</tbody>
</table>

Gedo = Chaliya district; Arjo = Jimma Arjo

Joint supervision of activities

Fields were supervised at two different levels. The first supervision was the one executed by a joint between farmers, district experts, Development Agents and researchers from the Agricultural Extension Research team of the Bako Agricultural Research Center. The second was conducted by representatives from each discipline in the center (representatives from each research team) and planning head of the research center. The latter type of supervision is a routine type of supervision conducted every year as part of the center’s activity. Status of the activities under consideration is presented on the forum organized for this joint venture. Comments during the supervision are taken in to account to take any necessary corrective measures and fill the observed gaps.

On-farm yield performance of the variety

In spite of the inevitable variability in performance between and even within locations, yield performance of the varieties is still promising. The variability in yield performance might have stemmed from difference in the status of soil fertility, difference in management (usage of recommended cultural practices and inputs) and others. One important point to note is the issue attached to row planting. Due to the fact that there is no standard material (implement) that can draw uniform line between rows, a very wide distance between rows was observed that resulted in lower population per plot and reduced yield as a consequence. The mean on-farm yield of the variety was reported to reach as much as 40 qt ha as compared to the local variety that yields 8 qt/ha., or even less. The grain yield performance of the variety in the current activity was less than its on-farm potential by 3.5 quintal reported by Dagnachew et al., 2009.

Institutional and attitudinal change

Despite the efforts made by various institutions in transforming the agricultural sector and improving the livelihoods resource poor farmers so far, it was not possible to attain sustainable and incremental economic development. The major reason, among others, was that most intervention made by different institutions was unilateral and lacked coordination and synergy.

The present approach of developing partnership and institutional linkage in tef technology promotion proved successful and therefore is viewed as a win win working model by stakeholders involved in the value chain from technology generation all the way through production to marketing of value added products. Moreover, the successful accomplishment of this innovative work through the active involvement of all stakeholders has brought about significant and positive attitudinal change towards partnership and collaboration and thus built mutual trust and confidence among themselves in expanding their cooperation in other similar joint initiatives.
Improvements in the livelihood of farmers

Through direct pre-scaling up, 203 farmers were reached with the technology that helped them produce surplus for marketing, which in turn maximized their income. There were situations where some farmers purchased oxen, others local cows and cross-bred heifers. Income from the sale has helped farmers in schooling their children and purchase agricultural inputs with cash. More importantly, mutual trust between farmers, researchers, DAs and other stakeholders was fostered.

Farmers' perception

During the course of the scaling up process, and at the final stage of the activity, an assessment was made to know how the farmers perceived the technology. Result of the assessment revealed that both of the varieties were liked by farmers as they exhibit better injera/bread quality, preferable color, better yield performance, better market demand and market price.

Success factors

Covering large area does not guarantee success. Success depends rather on how right the activity was conducted. There are a lot of factors that have contributed to success of the work, one or the other way. The presence of enthusiastic biological researchers, compatibility of the technology with farmers' needs, synergy between different teams, active participation and strong linkage among stakeholders, scaling up strategy with shared vision and supportive research management both at center and institution level were some of the conditions that helped much.

Lessons learned

Technology scaling up is not a unidirectional process where only farmers learn from researchers. Rather, it is a platform where both parties learn from each other. During the course of the work, the team has learned that concerted effort among different actors is instrumental for fruitful work. Thus, identification & collaboration with key stakeholders was one important lesson learned from the process. The other lesson drawn was the importance of using innovative farmers, as their fields speak louder and clearer than researchers, DAs and experts. Thus, using them for technology dissemination is a wise approach to reach the vast majority.

Challenges encountered

During the course of the pre-scaling up activity, a lot of challenges were entertained. A fierce competition for resource especially vehicle was the major challenging factor that has really constrained timely seed purchase, collection and delivery. It also made timely supervision of activities very difficult. The other challenge faced was high mobility of Development Agents as a result of which timely yield data and feedback collection was constrained. Failure of some farmers to use full package (use of limited input) was the other challenge encountered.

Exit / handover strategy

In addition to technology generation and adaptation, the center extends technologies only to a limited scope (time horizon and spatial dimension). Wider scale dissemination, thus, remains to be undertaken by bureau of agriculture in the respective localities. It is thus becoming mandatory to create a relay type of extension system to ensure continuity of the technology until better option emerges. To this end, letters were dispatched to the respective district and zonal bureau of agriculture so as to hand over the technology to the right body in order to ensure sustainability.

Conclusions and recommendations

Conclusions

The pre-scaled up/disseminated variety proved itself of being appropriate technology in that could really improve the livelihood of the farmers, both as source food and income source. Its better yield performance accompanied by preferred injera/bread colour and better market price has increased the importance of the crop and won the attention many farmers in the study areas. As a result, there is a
pressing demand for the crop in all of the locations, but there is a conflict of interest between termination of the activity and the urge for the technology.

Recommendations
To ensure continuous supply of seed after termination of the pre-scaling up activity, it seems crucial to create a reliable seed source in the study areas. Thus, gearing towards community based seed production is important. It is, thus, advisable that district Cooperative offices, bureaus of agriculture and the research center have to work closely to organize the farmers and render technical backstopping and physical resources, when needed.

References
Abstract

This activity was conducted in Arjo, Horro, Chaliya, Bako Tibe, Jimma Rare and Jimma Geneti districts of western Oromia with the objective of disseminating two recently released tef varieties, Kenna and Guduru. The activity was a follow-up of demonstration work. Accordingly, in the course of implementation, a total of 568 farmers were reached, 2199.2 kg seed was distributed and an area of 142 ha was covered with the activity. The grain yield performances of the two improved varieties ranged from 20 to 30 and 18 to 25 quintal per hectare for Guduru and Kenna varieties respectively, implying 75-83% yield advantage for Guduru and 83%-80% for Kenna compared to the local varieties. The research intervention has contributed to improved food security and the livelihood of participating farmer. With the income obtained from increased tef production, participant farmers could purchase oxen, cows, crossbred heifers, other agricultural inputs and could also send their children to school. At the completion of the activity an exit strategy that contributes to sustainability was designed where the district Bureau of Agriculture offices were officially informed to take over and go for large scale dissemination. To this end official letters were written and handed over to all of the districts under consideration.

Keywords: Tef, pre-scaling up, Kenna, Guduru, Stakeholders' linkage, Multi disciplinary

Introduction

Grown as food grain only in one other country, Eritrea, tef is the most important cereal, both in terms of production and consumption in Ethiopia. As the most preferred cereal among better-off households, especially urban areas, tef fetches relatively high price in the market, making it an attractive cash crop to farmers. It is nutritionally rich with high levels of iron and calcium, as well as highest amount of protein among cereals consumed in Ethiopia. Tef is relatively resistant to many biotic and abiotic stresses and can be grown under different agro-ecological conditions, ranging from lowland to highland areas. (Demeke et al., 2013)

Among cereals, tef accounts for the largest share of the cultivated area (28.5 percent in 2011), followed by maize (with 20.3 percent). Tef is second (to maize) in terms of quantity of production. However, because its market price is often two or three times higher than maize, tef accounts for the largest share of the total value of cereal production. Tef is grown by a total of 6.2 million farmers. Since tef farm operations such as land preparation, weeding and harvesting are highly labor intensive, with limited availability of suitable mechanical technology, there are no large scale tef farmers in the country. Many farmers grow tef as cash crop because of its higher and more stable market price. 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) Tef remained an important crop to Ethiopian farmers for several reasons, namely: the price for its grain and straw are higher than other major cereals; the crop performs better than other cereals under moisture stress and waterlogged conditions; its grain can be stored for a long period of time without being attacked by weevils; there is no disease epidemic that has threatened its performance (Bekabil et al., 2011).
Tef is likely to remain a favorite crop of the Ethiopian population and the crop is also gaining popularity as a health food in the western world. Studies show that tef is a gluten free crop, which makes it suitable for patients with celiac disease (Dekking and Koning, 2005). However, productivity has remained stagnant or has even declined in some cases until recent years due to several technical and socio-economic constraints. Weed competition, low or declining soil fertility, diseases, inappropriate use of agronomic practices such as seeding rate, sub-optimal fertilizer application and herbicide use are some of the major technical constraints. Limited supply of seeds of improved varieties, high price and unavailability of augmenting technologies like fertilizer and herbicides in required quantity and at required time, and inadequate cash or credit for purchase of inputs are the major socio-economic constraints (Kenea et al., 2000). The crop is also among the most important cereal crops in western Oromia, both for consumption and as cash crop, but as is the case in other parts of the country productivity is very low.

In order to increase productivity of this crop, National Agricultural Research System (NARS) has been making great efforts over last ten years to develop and release large numbers of tef crop varieties and associated production technologies for diversified agro-ecology of Ethiopia. Among these are Kenna and Guduru, the recently released improved tef varieties. These varieties have more than fourfold yield advantage over the local varieties used in the study areas. In spite of the availability of these improved tef technologies, most of the farmers in western Oromia depend on the local varieties characterized by lower productivity per unit area. This activity, thus, was initiated with the objective of popularizing these improved varieties in the study areas.

Specific objectives

❖ To popularize demonstrated and proven improved tef technologies for small holders' farmers in selected zones of Western Oromia and bridge the productivity gap.
❖ To strengthen linkage between farmers, extension, research and others key stakeholders to make improved seed easily accessible for the users.
❖ To establish community based seed production and marketing scheme to facilitate farmer-to-farmer improved seed exchange
❖ To improved the knowledge and skills of farmers on tef technologies production and management practices.

Materials and methods

Description of the study areas

Horro District

Horro is located 315 km from Addis Ababa in the Oromia regional state in western Ethiopia. The district has two major agro-ecologies. Mixed crop-livestock agriculture is the mainstay of the farming communities. Livestock species raised in the district include cattle, sheep, horses, poultry, goats, donkeys and mules. Major crops are wheat, barley, tef, field peas and faba beans. Based on information from Horro 3 district office of agriculture, the human population of the district is 103,707 (61,553 males and 42,154 females). There are 12,805 male- and 3,236 female-headed households in the district. Total land area of the district is 77,998 hectares (ha) of which 6,458 ha (8.3%) is allocated for grazing. The proportion of highland, mid-highland and lowland areas in the Horro district are 49.8%, 48.9% and 1.24%, respectively. The district has one long rainy season that extends from March to mid-October with mean annual precipitation of about 1800 millimeters (mm) (Olana 2006). The mean, average maximum and average minimum temperatures of the area are 22°C, 27°C and 12°C respectively. Total livestock population of the district is 351,305 head, of which cattle and sheep accounted for 60% (cattle 43% and sheep 17%) (Gemeda et al., 2013).

Jimma Arjo district
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Chaliva District

It is one of the districts from west Showa zone which is located at about 63 kilometers to the west of Addis Ababa. Mixed crop-livestock agriculture is the mainstay of the farming communities. Livestock species raised in the district include cattle, sheep, horses, poultry, goats, donkeys and mules. Major crops are wheat, barley, tef, field peas and faba beans. Rain fall in the district is uni-modal in nature that extends from March to October. (Personal communication with Bersufekad)

Approaches followed

Formation of multi disciplinary team

The activity was started when each team supposedly composed of biological researchers of all sort and social science professionals. Accordingly, a team composed of tef breeders, pathologists, agronomists, socio-economists and Agricultural Research Extensionist was formed. This team has set objectives, designed approach, and identified key stakeholders and their respective roles. The stakeholders identified were zonal and woreda BoA, cooperatives, zonal and woreda administration including BARC. The stakeholders were invited to the center, shared responsibilities, developed collective action plan and signed memorandum of understanding.

Site and farmer selection

To address the afore-mentioned objectives, the multi-disciplinary team of the Bako research center together with the Woreda experts and development agents of the respective districts selected appropriate sites that that are accessible and potential for tef production. Accordingly, Horro, Jimma Arjo, Bako Tibe, Jimma Rare and Jimma Geneti districts were selected. Pre-scaling up involves large number of farmers than technology demonstration that makes it difficult to contact each farmer individually. This called for assigning the entire task of farmer selection to district experts and Development Agents of the respective sites.

Farmer selection criteria

As the team does not provide other inputs along with seeds, model farmers who are capable of purchasing fertilizer and other relevant inputs were selected. On top of this, having appropriate and sufficient plots, good history of managing experimental or non experimental plots were the other criteria used to select the host farmers. Before commencing the pre-scaling up activity, a comprehensive training on crop production and management was given to host farmers, DAs and district experts. At this juncture, breeders, crop protection researchers, agronomists, Agricultural Research extensionists and socio-economic professionals have given training in their respective professional spheres.

Seed delivery mechanism

The seeds were then given to the respective BoA along with all the necessary labels (variety, seed rate, fertilizer rate, time of fertilization, spacing etc.). As the DAs are closer to, and know the farmers than researchers and district experts, they were guiding the district experts in selection of appropriate
famers. The DAs have been helping the famers while planting and supervised the whole activity thereafter. All activities from land preparation to final harvesting was entirely carried out by famers and the multi-disciplinary team made frequent joint field supervision. In order to ensure continuity, and address more number of famers, the original seed was used as revolving seed, and each famer gave back the amounts/he used.

This amount was, thus, given to other famers within the same kebele or adjacent to the previous kebele. The task of seed recollection and re-distribution, however, was given to Development Agents and respective district experts. The lion’s share of seeds delivered, however, was covered through purchase from some of the host famers whose farms were closely supervised to ensure production of pure and quality seeds. Quality seeds from such reliable sources are purchased for about 15% premium price and distributed to other famers. This incentive was thought considering additional cost of production, and at the same time to encourage famers produces quality seeds.

Experience sharing platforms and information dissemination

Even though there are numerous methods that can help in information dissemination process, only a few of them were used to share experience among the farming community and other actors in the process. Among them are: training workshops, regional and Center based reviews, Zonal and District based ADPLA review meetings and field days. Accordingly, each year, the team has participated in different zonal and district ADPLA meetings where it presented outreach activities in the respective zones. At this platform, opportunities and challenges were presented and the way forward was presented to proceed with the activities. Comments at this platform are used as a valuable input to initiate new activities or manipulate the on-going ones. Field days are among the important platforms where information is disseminated among the stake holders. To this end, these platforms are arranged each year where farmers, researchers, zonal and district agricultural experts, cooperative professionals participate.

Stakeholder Analysis (SA)

In enhancing wheat technologies generation, dissemination, improving wheat production and productivity, the research center was closely working and has made frequent consultation with its respective stakeholders. Pre-scaling up activity should be done by different actors in partnership and collaborative approach. So, SA is highly important for institutional arrangement (who does what?) before embarking on the pre-scaling up activity. Thus, stakeholder analysis was undertaken to identify potential stakeholders. Points such as: Who are the stakeholders? How big is their stake? How much they are closer to the project? What are their roles, duties and responsibilities in implementing the activity? How does the synergy support the opportunities to bring the required impact? And finally the roles, duties and responsibilities of each actor were clearly stated in implementing the activity.

Accordingly, 4 responsible and collaborative participant stakeholders/actors were identified. Namely, District bureau of Agriculture, District cooperative offices, District administration development Agents and famers were identified as our stakeholders.

Results and Discussions

Training of farmers and other stakeholders

Training of farmers and other stakeholders is one way of information delivery that enhances the level of awareness of the target groups. To this end different training sessions were arranged in which farmers, Development Agents, district experts and district administrators took part.

Seed distribution

Varieties used for this activity were Guduru and Kenna. During the first three years of the activity (2010-2012) a total of 392 farmers were reached in Horro, Chaliya, Jimma Arjo districts of western
Oromia. In 2013, 39 more farmers were reached with the technology in Horro, Chaliya and Jimma Arjo districts. In the year 2014, 13 farmers from Bko Tibe, 24 farmers from Horro district, 22 farmers from Chaliya, 23 farmers from Jimma Arjo, 28 farmers from Jimma Rare, 27 farmers from Jimma Geneti totaling to 137 were reached with the technology. Total number of farmers reached so far sums up to 568. The total area covered and amount of seed distributed was 142 ha and 2199.2 kg respectively.

<table>
<thead>
<tr>
<th>No</th>
<th>Year</th>
<th>Area covered (hectare)</th>
<th>No of beneficiary Farmers per district</th>
<th>Amount of seed Distributed In kg</th>
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<tr>
<td></td>
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<td>Genet</td>
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</tr>
<tr>
<td>2</td>
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<tr>
<td>3</td>
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<tr>
<td>4</td>
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<td>9.75</td>
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<td>10</td>
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<tr>
<td>5</td>
<td>2014</td>
<td>34.25</td>
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<td>24</td>
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<tr>
<td>6</td>
<td>Total</td>
<td>142</td>
<td>158</td>
<td>159</td>
</tr>
</tbody>
</table>
**Joint supervision of activities**

Fields were supervised at two different levels. The first supervision was the one executed by a joint between farmers, district experts, Development Agents and researchers from the Agricultural Extension Research team of the Bako Agricultural Research Center. The second was conducted by representatives from each discipline in the center (representatives from each research team) and planning head of the research center. The latter type of supervision is a routine type of supervision conducted every year as part of the center’s activity. Status of the activities under consideration is presented on the forum organized for this joint venture. Comments during the supervision are taken in to account to take any necessary corrective measures and fill the observed gaps.

**Yield performance**

In spite of the inevitable variability in performance between and even within locations, yield performance of the varieties still is promising. The grain yield performance of the two improved varieties ranged from 20 to 30 and 18 to 25 quintal per hectare for Guduru and Kenna varieties, respectively. Guduru variety had a yield advantage of 201.25% over the local one. The yield performance of Guduru in the current study is greater than that reported by (Dagnachew et al., 2009), for the same varieties. Dagnachew et al., 2009 reported the on-farm yield performance as 14-20 qt/ha. The grain yield performance of Kenna, on the other hand, is in similar range with their previous report of the on-farm performance (15-27qt/ha), but is nearer to the lower end (15 qt/ha), and less than the upper end (27qt/ha) by about 8.8 quintal per ha. The yield difference between the two reports might have stemmed from the fact that their work did not cover as much vast number of farmers, ecologies and plot size per variety, as compared to the current work. The grain yield performance of the varieties in the current work is lower than that reported by Debrezeit Agricultural Research Center for other varieties, at Ginchi (3.1t/ha), followed by Adet (2.93t/ha), Debrezeit on light soil (2.92t/ha) and Debrezeit black soil (2.83 t/ha). Adapting these varieties in our mandate areas might, then, increase productivity of the commodity under consideration. On the other hand Guduru variety excelled the grain yield reported for Quncho (1821 kg/ha) (Debrezi Agricultural Research Center, Annual Research report, 2009/2010).

Farmers involved in this activity have maximized their income because of one of the most important and highly complementary benefit. The benefit was that farmers incomes were almost four times due to the increased productivity of the two improved tef varieties ( 23 and 25 quintal per hectare for kena and Guduru respectively) Vis-a- vis the local land races ( about 8 quintal per hectare) Therefore, based on the prevailing local market price of birr 1500 birr per 100 kg of the tef, farmers income with improved varieties were significantly increased and reached between 34500 and 37500 birr per hectare in that order, whereas the incomes of farmers from the sale of the local tef varieties were about 12000 birr per hectare.

![Fig. 1. Yield performance of Kena and Guduru varieties](image-url)
Field days

Field days were organized different years to be attended by different stakeholders. Accordingly, 1000 farmers (80 F, 920 M), 20 Experts (Zonal & Woreda, 30 DAs, 8 Administrators (Zonal & Woreda) and 30 Researchers have attended the field days.

Institutional and attitudinal change

Despite the efforts made by various institutions in transforming the agricultural sector and improving the livelihoods of resource poor farmers so far, it was not possible to attain sustainable and incremental economic development. The major reason, among others, was that most intervention made by different institutions was unilateral and lacked coordination and synergy.

The present approach of developing partnership and institutional linkage in tef technology promotion proved successful and therefore is viewed as a win/win working model by stakeholders involved in the value chain from technology generation all the way through production to marketing of value added products. Moreover, the successful accomplishment of this innovative work through the active involvement of all stakeholders has brought about significant and positive attitudinal change towards partnership and collaboration and thus built mutual trust and confidence among themselves in expanding their cooperation in other similar joint initiatives.

Improvements in the livelihoods of participant farmers

Through direct pre-scaling up, 570 farmers were reached with the technology that helped them produce surplus for marketing, which in turn maximized their income. There were situations where some farmers purchased oxen; others purchased local cows and cross-bred heifers. Income from the sale has helped farmers in schooling their children and purchase agricultural inputs with cash. More importantly, mutual trust between farmers, researchers, Development Agents and other stakeholders was fostered.

Farmers' perception

During the course of the pre-scaling up process, and at the final stage of the activity, an assessment was made to know how the farmers perceived the technology. Result of the assessment revealed that both of the varieties were liked by farmers as they exhibit better injera/bread quality, preferable color, better yield performance and market price. On the contrary, however, the farmers revealed low threshability as a drawback of Guduru.

Success factors

Covering large area does not guarantee success. Success depends rather on how right the activity was conducted. There are a lot of factors that have contributed to success of the work one or the other way. The presence of enthusiastic biological researchers, compatibility of the technology with farmers' needs, synergy between different teams, active participation and strong linkage among stakeholders, scaling up strategy with shared vision and supportive research management both at center and institution level were some of the conditions that much.

Lessons learned

Technology scaling up is not a unidirectional process where only farmers learn from researchers. Rather, it is a platform where both parties learn from each other. During the course of the work, the team has learned that concerted effort among different actors is instrumental for fruitful work. Thus, identification & collaboration with key stakeholders was one important lesson learned from the process. The other lesson drawn was the importance of using innovative farmers, as their fields speak louder and clearer than researchers, DAs and experts. Thus, using them for technology dissemination is a wise approach to reach the vast majority.

Challenges encountered

During the course of the pre-scaling up activity, a lot of challenges were entertained. A fierce competition for resource especially vehicle was the major challenging factor that has really
constrained timely seed purchase, collection and delivery. It also made timely supervision of activities very difficult. The other challenge faced was high mobility of Development Agents as a result of which timely yield data and feedback collection was constrained. Failure of a few farmers to use full package (use of limited input) was the other challenge encountered.

Exit strategy/ Handover strategy

In addition to technology generation and adaptation, the center extends technologies only to a limited scope (time horizon and spatial dimension). Wider scale dissemination, thus, remains to be undertaken by bureau of agriculture in the respective localities. It is thus becoming mandatory to create a relay type of extension system to ensure continuity of the technology until better option emerges. To this end, letters were dispatched to the respective district and zonal bureau of agriculture so as to ensure sustainability.

Conclusions and recommendations

Conclusion

Besides their higher productivity, the varieties by far excelled the local ones with regard to color, injera quality, market demand and market price. The four fold yield advantage over the local variety helped the farmers in either saving their land for other crops or produce surplus for marketing. As a result, demand for the varieties is increasing than ever before. Exit from the activity, on the contrary, may result in a pause to the seed supply.

Recommendation

Agriculture and Rural Development bureaus of the respective districts are expected to secure seeds from trusted host farmers and multiply to sustain the supply system. To this end, establishing and managing community based seed production is crucially important.

References


Pre-scaling up of Bread Wheat Variety (Danda’a) through FRG/FREG in Bale and West Arsi Zones of Oromia National Regional State, Ethiopia
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Abstract
The paper presents the success of pre-scaling up activity of the best performing improved bread wheat variety (Danda’a) with recommended full packages in Sinana, Agarfa and Ginnir districts of Bale Zone and Adaba and Dodola districts of West Arsi Zone of Oromia National Regional State, Ethiopia in the year 2013/14 through the support of East African Agricultural Productivity Project in multi-stakeholder approach. The objectives were to convince the merits and increase confidence on Danda’a variety, thereby to facilitate dissemination and adoption of the technologies through farmer-to-farmer extension approach, to change the outlook and increase farmers’ motivation through participatory training on principles of wheat production and management packages, to strengthen and enable farmers to produce quality seeds for their own use and disseminate the technology to their surrounding farmers through farmer-to-farmer seed dissemination mechanisms, to strengthening the established and/or form new farmer research groups or farmer research extension groups and to enhance better linkage among the relevant stakeholders in the study zones. Three wheat growing potential kebeles were selected from each participant district and a total of fifteen kebeles were selected for the study. A total of 300 farmers (with the composition of men, women and youth farmers) were participated in the activity. Three trial farmers at each kebele (a total of 45 hosting farmers in five districts) were selected with the help of group members and development agents. Farmers were considered as replications. A total of 375 individuals (87.7% male and 12.3% female) from the five districts were participated on both theoretical and practical training on wheat production and management packages. To show the overall performance of Danda’a variety, field day was jointly organized in collaboration with other stakeholders at each district and a total of 500 participants were participated on this event. Besides, handover strategy of Danda’a variety for further scale-out on wider area was also facilitated. Strong linkage among stakeholders (links to networks) was created that bridge further participatory effective up-scaling/dissemination of the best performing wheat technologies that fulfilling farmers’ need and interest. Adoption and dissemination of improved bread wheat technologies enhanced through farmer-to-farmer learning mechanisms. Thus, demand-driven agricultural technologies transfer created.

Key Words: Bread wheat. Pre-scaling up, Danda’a, FRG/FREG, Demand-driven, linkage, farmer-to-farmer

Introduction
Agriculture, the largest employer of the rural population, is the largest complex industry in the world. The statistics shows that about three-quarters (75%) of world population still live in rural areas and have something to do with agriculture. About 70% of poor people in Africa live in rural areas and 90% of the labor force among those people is employed directly or indirectly in agriculture and most of them depend on it for their livelihoods. Most of them practices subsistence agriculture i.e. African farmers are the principal consumers of what they produce & they will give priority to producing what they prefer to consume. Hence, in the 21st century, it remains fundamental to economic growth, employment, poverty alleviation, food security, environmental sustainability and development process in general (FAO, 2014).

The agriculture sector is a core driver of Ethiopia’s growth, eradicating poverty, improving rural livelihood, long-term food security and economy (MoFED, 2010). It supports 85% of the population’s livelihoods/employs labor force, accounts for 41.6% of gross domestic product (GDP), generates over 70% of the country’s export (foreign currency) earnings and 80% of raw materials supply for agro-
industries (UNDP Ethiopia, 2012). It is also a cornerstone of Ethiopia’s medium term strategy—the Growth and Transformation Plan (GTP) (MoFED, 2010). Fighting poverty today means making smallholder agriculture moving and accelerating agricultural development by means of technological and institutional innovations that can be resulted in transformation of rural lives and livelihoods. The ADLI policy, development strategies and plans of Ethiopia emphasizes the need to bring about rapid agricultural development through the use of improved agricultural technologies (variety/seed, knowledge, information, management practices, farm equipment, tools, and machine) in a sustainable way as the main means of reducing poverty in the country (ATA, 2012). Transforming smallholder agriculture, thus, fulfilling the aggregated demand by Ethiopian consumers, reducing huge importation of food products, and taking advantage of export opportunities is one of the major goals of GTP I (2010/11 to 2014/15) and GTP II (2015/16 to 2019/20). Therefore, extension of bread wheat technologies, which improve the productivity of the crop and its production in potential areas of the country, has associated benefits for Ethiopia’s balance of trade (export-import).

Ethiopia is the second largest producer of wheat in Sub-Saharan Africa next to South Africa. It is one of the major food crops produced in the country. Recently, wheat in general has become one of the most important cereal crops (strategic crop) in terms of production and food security in the country (Tolesa, 2014). It has been selected as a target crop for the strategic goal of national food self-sufficiency. Based on area of production, wheat is the fourth widely produced cereal crops in the country next to teff, maize and sorghum (CSA, 2013). At national level, during 2013/14 cropping season 1,605,653.9 ha of land was covered by wheat (bread and durum) and 39,251,743.5 quintals were harvested from this land (Crop Variety Registry Book, 2014). It is one of the major cereal crops grown within the range of 1500 to 2800masl in Bale, Arsi, West Arsi and Shewa zones, Oromia National Regional State, Ethiopia. These areas have reliable rainfall and are considered as “the wheat belt area of the country” (Bekele, 2011). Despite enormous economic and dietary values of wheat in Ethiopia, the national average yield has remained low (2.1 t/ha) due to different factors (biotic and abiotic) including dependency on rainfall (insufficient and erratic), poor agronomic practices and low utilization of UREA fertilizer, incidence of diseases and insect pests, land degradation (declining of soil fertility), technology utilization i.e. limited use of improved varieties and associated technologies (recommended full packages). Thus, the availability, access and use of improved varieties and seeds along with their recommended full packages play an important role in increasing wheat production and productivity, ensuring food security and improving livelihoods of the rural poor.

Despite the release of a number of improved potential high yielding and quality wheat varieties from different research centers in the country, it is hardly possible to say that most of these varieties with their recommended full packages have been properly used by the majority of smallholders and boosted productivity at farm level as desired. The on-going efforts to improve access to and use of available technologies is below the requirements in terms of area coverage and the number of beneficiaries. The transfer of wheat technologies to smallholder farmers/end users takes longer time. This is not because of government policy, the environment/agro-ecology, or not because of the potential high yielding varieties, rather due to lack of well prepared plan, coordination and linkage in a sustainable way (multi-stakeholder approach). Besides, sustainable improvements in production and productivity depend on an efficient system of channeling demand-driven; need and interest based improved agricultural technologies to the end users.

In view of this, since 2011 the East African Agricultural Productivity Project (EAAP) had planned different activities that contribute towards the improvement of wheat production and productivity in Ethiopia. It supports dissemination of available improved wheat technologies and knowledge through training and farmer-to-farmer extension mechanisms. One of the planned activities under this project was to support generating, demonstrating, participatory evaluating, validating, undertaking pre-scaling up of the best performing wheat varieties, popularizing and disseminating the technologies with the participation of farmers and other stakeholders in Bale and West Arsi Zones. Besides, capacitating the farmers’ skill, knowledge, attitude and acceptance through deployment of all necessary trainings and advisory services is vital. In other words, strengthening the capacity of farmers/end users in technology up-take and utilization is highly important. Consequently, one (1) commercial (Madda
Walabu) and four (4) recently released bread wheat varieties (Danda’a, Huluka, Hidase and Shorima) were planted at Dodola district of West Arsi Zone, and Sinana and Agarfa districts of Bale Zone in 2012/13 production season and demonstrated to farmers in the area. At all districts, Danda’a was selected in the first place by the evaluators (preferred variety by the target beneficiaries). During participatory assessment and evaluation farmers raised the issue of getting seed locally, willing to see the performance of the variety on larger plot size/one ‘midde’ (32m X 32m) for pre-scaling up and scaling-up out in wider area coverage within similar agro-ecologies.

To this end, the use of Farmer Research Groups (FRGs) or Farmer Research Extension Groups (FREGs) is one of the approaches, which make the farmer to be central to agricultural research and dissemination. Hence, bearing these factors in mind, this activity is designed with the aim of addressing farmers’ keen problems by involving them in the activity that would contribute to the betterment of their livelihood. Therefore, the aim of this research was to pre-scale up the best-bet wheat variety (Danda’a) with existing recommended full packages, build confidence on the variety, ensure the local availability of seed and create better linkage among stakeholders in order to facilitate the hand over strategy of the activity. Moreover, technology deployment started with inventory of best performing wheat technologies.

Objectives

General Objective

☐ To increase bread wheat production and productivity thereby to improve the livelihood of farmers and food security, and contribute to enhance import substitution and satisfy the local demand (both in quantity and quality) of agro-industries through pre-scaling up of improved wheat technologies.

The specific objectives

➢ To convince the merits and increase confidence on Danda’a variety, thereby to facilitate dissemination and adoption of the technologies through farmer-to-farmer extension approach.
➢ To change the outlook (knowledge, skill and attitude) and increase farmers’ motivation through participatory training on principles of wheat production and management packages.
➢ To strengthen and enable farmers to produce quality seeds for their own use and disseminate the technology to their surrounding farmers through farmer-to-farmer seed dissemination mechanisms.
➢ To strengthening the established and/or form new FRGs/FREGs.
➢ To enhance better linkage among the relevant stakeholders in the study zones.

Methodology

Description of the study area

Bale Zone

Bale zone has eighteen (18) rural and two (2) town districts, out of which nine (9) rural districts are suitable for crop production. The other nine (9) rural districts are agro-pastoralists and pastoralists. The total area of Bale zone is about 63,555km² (6,355,500 hectares), which is 16.22% of ONRS. It is estimated that 38% and 22% are rural and urban dwellers, respectively. About 95% of the population is engaged in agriculture. The agro-ecological zones of the zone are extreme highland (cold) 0.04%, highland (14.93%), midland (21.5%) and lowland (63.53%). The mean annual temperature of the zone is found between 3.5°C and 35°C, respectively. The area receives an average annual rainfall of 1450mm where as the minimum and maximum rainfall is 400mm and 2500mm, respectively. Bale zone has bimodal rainfall patterns and two distinct seasons, namely, Belg (in Afan Oromo called ‘Ganna’ by referring to the harvesting time) extends from March to July and Meher (in Afan Oromo called ‘Bona’ by referring to the harvesting time) extends from August to January. The zone is
bounded by West and East Hararghe zones in the North. Arsi and West Arsi zones in the West, Guji zone in the South and Somali National Regional State in the East. Robe town is the capital town and administrative center of the zone (BZADO, 2014).

West Arsi Zone

West Arsi zone has twelve (12) rural and two (2) town districts and having the total area of 12,556km² (1,255,600 hectares). About 95% of the population is engaged in agriculture. Geological Survey 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). Most parts of the zone have elevations of ranging from 1500m to 2300m a.s.l. The mean annual temperature of the zone is found between 10°C - 25°C. For most of the areas, the rainy season starts in March and extends to November with the increasing concentration in June, July and August. On average, the zone gets annual mean rainfall of 1300mm. The zone is bounded by East Shewa zone in the North, South Nations, Nationalities and People National Regional State in the East, Arsi zone in the northeast, Guji zone in the South and Bale Zone in the East. Shashamne town is the capital town and administrative center of the zone (WAZADO, 2014).

Approaches followed

Participatory and multidisciplinary approaches were used during pre-scaling up activity. Multidisciplinary team consists of seven researchers (breeder, pathologist, agronomist, weed scientist, economists, agricultural research-extensionist and seed expert) was established at Sinana Agricultural Research Center (SARC) for the implementation the activity. For the sake of enhancing efficiency and effectiveness, integration and cooperation (synergy) were institutional innovation/tool implemented for the achievements of the strategy.

i) Joint Planning: organizing stakeholder forum for consultation meeting with responsible and collaborative participants to have a common understanding of pre-scaling up activities; establishing stakeholder platforms at zone and district levels; signing memorandum of understanding (document having the roles and responsibilities of each actor); appointing focal persons and establishing taskforces at all levels and establishing FRGs/FREGs at each participant kebeles were done successfully.

ii) Training on capacity building (on knowledge, skill and attitude): for farmers, agricultural experts (zone and district level) and development agents (DAs) on bread wheat production and management packages (from site selection to post harvest handling) and on roughing and seed dissemination system was delivered.

iii) Packaging and distribution of wheat technologies and other agricultural inputs (fertilizers, agro-chemicals-herbicides). Improved bread wheat variety (Danda’a) with its recommended packages distributed to selected zones, districts and farmers.

iv) Farmers (FRG/FREG members and other follower farmers) were encouraged to participate in the physical activities from the beginning up to the end and at each stage of the pre-scaling up activity.

v) Joint monitoring and evaluation: regular field visit by extension agents i.e. trial sites were regularly visited by extension counterparts, joint field visit and supervision at different crop stage, field day organized at each district, discussion session and result communication forum were also organized.

vi) Facilitating seed delivery mechanisms: revolving seed system was designed i.e. initial seed and other agricultural inputs were provided to the hosting farmers in the first year of the activity while during the next years farmer-to-farmer seed exchange mechanism devised.

Stakeholder analysis (SA)
In enhancing wheat technologies dissemination, improving wheat production and productivity, the research center was closely working and has made frequent consultation with its respective stakeholders. Pre-scaling up activity should be done by different actors in partnership and collaborative approach. So, SA is highly important for institutional arrangement (who does what?) before embarking on the pre-scaling up activity. Thus, SA was undertaken to identify potential stakeholders. Points such as: Who are the stakeholders? How big is their stake? How much they are closer to the project? What are their roles, duties and responsibilities in implementing the activity? How does the synergy support the opportunities to bring the required impact? and finally the roles, duties and responsibilities of each actor were clearly stated in implementing the activity.

Site and farmers’ selection

Three districts from Bale zone (Sinana, Agarfa and Ginnir) and two districts from West Arsi zone (Dodola and Adaba) were selected purposively for the implementation of the activity. In collaboration with DAs and agricultural experts, three (3) wheat growing potential kebeles were selected from each district (Salka, Nano Robe and Walta’i Barisa kebeles from Sinana district; Ali, Elabidu and Ianni kebeles from Agarfa district; Qabbana, Ebbisa and Akasha kebeles from Ginnir districts and Washa, Furunna and Ejesa kebeles from Adaba districts and Barisa, Dannaba and Kachama-Chare from Dodola districts) making a total of fifteen (15) kebeles were selected for the pre-scaling up.

Interested of farmers in bread wheat production and potential land they have (who can give 32m X 32m land), their ability and willingness to perform cultural practices as per recommendation, social status in the community (that can influence his/her community in decision making) and gender equality issues (at least 25%) were considered as farmers’ selection criteria.

Trial farmers were selected based on ownership of suitable and sufficient land to accommodate the trials, willingness to contribute the land, vicinity to roads so as to facilitate the chance of being visited by many farmers, initiatives to implement this activity in high-quality, good in field management and willingness to explain the technologies to others. Accordingly, three representative trial farmers from each FRG/FREG were selected at each kebele (with the help of group members and DAs) making a total of forty five (45) hosting farmers in all the five districts. Farmers were considered as replications i.e. the pre-scaling up activity was replicated on three farmers per kebele. Trial site (farm land) was obtained through cost sharing i.e. hosting farmers contributed the trial land, while SARC delivered all agricultural inputs and finally, the initial seed returned to SARC at harvesting time as revolving seed.

In general, a total of 300 farmers were selected and grouped into FRG/FREG. In each kebele, each FRG/FREG had 20 members with the composition of men, women and youth farmers. Under FRGs/FREGs members other farmers were organized as follower farmers to share knowledge, skill and experience for further promotion mechanism. Thus, a total of 1200 follower farmers (1 farmer has 4 follower farmers) were participated in the activity (directly or indirectly).

Trial design

SARC was the source of all agricultural inputs (seed of improved bread wheat variety/Danda’a, fertilizers-DAP and UREA, herbicides-Pallas 45 OD). One best performing improved bread wheat variety (Danda’a) was planted on selected farmers’ plot (32m X 32m) in 2013/14 main (Meher) season. The variety was treated with full recommended wheat production packages (agronomic recommendations and practices). Row planting method and other crop management practices were used during the pre-scaling up activity. The spacing of 20cm between rows was used. The recommended seed rate of 150 kg/ha was used by drilling in the prepared rows. Shallow planting of 5cm depth was used in the presence of ample soil moisture. The recommended inorganic fertilizer rate 50/100 kg/ha UREA/DAP was applied with split application of nitrogen: 1/3 at planting time and 2/3 at tillering stage of the crop.
Depending on weed infestation, two effective weeding were done; the first at one month after sowing and the second at two months after sowing of improved bread wheat varieties. All farm operations (land preparation-ploughing four to five times using oxen plough, land leveling, planting, first and second weeding, agro-chemical spray, harvesting, threshing) were carried out by hosting as well as FRGs/FREGs member farmers with close assistance and supervision of concerned participating institutions (research centers and agricultural development offices). Farmers’ full participation at all stages of the activity was maintained during the implementation period.

Training

The effectiveness of the work is measured in terms of the changes brought about in the knowledge, skill and attitude, and adoption behavior of the people but not merely in terms of achievements of physical targets. Hence, training is very important to bring improvement on the job after filling the gap on knowledge, skill and attitude (KSA). Training was given to farmers, DAs, and agricultural experts on wheat crop production techniques and management packages, agro-chemical applications and safety precautions. Stakeholders such as zone and district level agriculture development 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, field days were organized at each pre-scaling up site in order to involve key stakeholders and enhance better linkage among relevant actors. Discussion session and result communication forum were also organized.

Communication methods used

Appropriate extension approaches (project and participatory) and all extension teaching methods (individual, group and mass contact methods) were employed alone or in a judicious combination according to the situations during the implementation of the pre-scaling up activity.

- Telephone (fixed and/or mobile)
- Study tour or field visit and supervision
- Workshop (for status evaluation)
- Field day
- Demonstration: method (to impart the skills) and result (to show the performance) demonstrations
- Group meeting and discussion session
- Training (in-room and on-spot or practical)
- Mass media (TV, Radio)
- Print Media (leaflets, pamphlets, flyers, posters, etc) was used for creating awareness, enhancing user knowledge and skill, changing attitude on using fully recommended packages of improved malt barley technologies.
Data collection

Both qualitative and quantitative data were collected using appropriate data collection methods such as direct field observation/measurements, household/participant interview, focused group discussion (FGD) and knowledge test.

The types of data collected include:

- Agronomic data such as days to heading, days to maturity, plant height, spike length, seed per spike, stand, thousand seed weight and grain yield per plot were recorded.
- Total number of farmers participated on training, field visits, field days and assessment by gender,
- Numbers of farmers become aware of the relative advantage of the technology by gender,
- Role of farmers and other stakeholders in Danda'a pre-scaling up,
- Change in level of knowledge and skill of farmers and DAs,
- Farmers, DAs, agricultural experts and researchers' opinion/feedback assessment (perceptions, interests and views towards the performance of the technologies) were collected.

Method of data analysis

SPSS was used as statistical package (descriptive statistics was used to analyze the data).

Results and Discussions

Training of farmers' and other stakeholders

In this activity, training on knowledge, skill and attitude were the main approaches that used to create awareness about improved bread wheat technologies among farmers, to capacitate the farmers' and others' knowledge and skill about wheat production and management packages. To this end, multidisciplinary team consists of seven SARC researchers were organized to deliver the training in capacity building and facilitating extension efforts of bread wheat technologies. The team was composed of socio-economist, research-extensionist, breeder, pathologist, agronomist, weed scientist and seed scientist from SARC.

A total of 375 individuals (87.7% male and 12.3% female) from the five districts (300 FRGs/FREGs member farmers, 25 agricultural experts, 45 DAs and 5 supervisors) were participated on both theoretical (in-room) and practical (on-spot) training on wheat production and management packages (Table 1). In specific, the trainings were focused on available improved bread wheat technologies (varieties, agronomic recommendations and practices/packages, etc.); input utilization (type, quantity required and application methods); weeds, diseases, insect pests and their controlling ways; agro-chemicals applications and safety precautions; the importance of crop rotation to break monocropping problem, the concept of FRGs/FREGs approaches and quality seed production techniques and post harvest handling. The softcopy of training materials were provided in CD and flash disk to the concerned body (agricultural experts) at each district.
Table 1. Summary of wheat training participants (2013/14)

<table>
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<th>Districts</th>
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<td>Farmers</td>
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<td>Agricultural Experts</td>
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<tr>
<td>DAs</td>
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<td>-</td>
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</tr>
<tr>
<td>Agarfa</td>
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<td>60</td>
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<tr>
<td>Farmers</td>
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<td>-</td>
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<td>DAs</td>
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<tr>
<td>Ginnir</td>
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<tr>
<td>Farmers</td>
<td>4</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Agricultural Experts</td>
<td>7</td>
<td>2</td>
<td>9</td>
</tr>
<tr>
<td>DAs</td>
<td>1</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Adaba</td>
<td>53</td>
<td>7</td>
<td>60</td>
</tr>
<tr>
<td>Farmers</td>
<td>4</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Agricultural Experts</td>
<td>6</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>DAs</td>
<td>1</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Dodola</td>
<td>55</td>
<td>5</td>
<td>60</td>
</tr>
<tr>
<td>Farmers</td>
<td>4</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Agricultural Experts</td>
<td>7</td>
<td>2</td>
<td>9</td>
</tr>
<tr>
<td>DAs</td>
<td>1</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Grand Total</td>
<td>329</td>
<td>46</td>
<td>375</td>
</tr>
</tbody>
</table>

Seed and fertilizer distribution

A total of 691.2 kg seed, 230.4 kg UREA and 460.8 kg DAP was distributed to 45 trial farmers for pre-scaling up purpose. In addition, 2.5 liter Pallas 45 OD herbicide was used for pre-scaling up purpose on 4.608 ha (46080 m^2) land of 45 trial farmers.

Supervision

The multidisciplinary team jointly conducted supervisions, monitoring and evaluation of the activities among the participating districts based on the necessities and requirements. As a result, the group had offered advice based on the practical problem observed on the spot in the implementation areas.

Field days

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.

Pallas 45 OD was demonstrated (both method and result demonstrations) to the farmers, DAs, agricultural experts and other stakeholders at each district (in collaboration with Chemtex PLC) on 32mX32m area of land. To show the overall performance of Danda'a variety, field day was jointly organized in collaboration with other stakeholders (Chemtex PLC, zone and district level agriculture development offices and participant farmers) at each district and about 500 participants were participated on this event including FRGs/FREGs members and follower farmers in the five districts. Besides, handover strategy of Danda'a variety for further scale-out on wider area was also facilitated.

Yield performance

The variety gave highest yield (66.8 qt/ha) at Ginnir district followed by followed by Sinana(64.3 qt/ha) and agarfa (63.5 qt/ha). The overall average for the study area was 63.3 qt/ha.
Conclusions and Recommendations

Conclusions

Farmers had first hand observation on the actual performance and benefit of the Danda’a variety. Awareness was created and confidence was developed on the bread wheat variety (Danda’a) that paves the way for further scale out in wider area with in similar agro-ecologies. There is an opportunities to harvest high yield from commercial bread wheat variety if and only if our farmers use appropriate 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 and safety precaution by those smallholder farmers in the study zones. In the effort of bridging this gap, knowledge is gained, skill is acquired and attitude of the farmers is changed through intensive training especially on the importance and the dynamics of wheat rusts epidemics and on using full recommended packages (packages approach). Knowledge and skill of DAs and agricultural experts also enhanced through training.

Besides, farmers access to improved bread wheat technologies increased; large number of farmers was persuaded and information was disseminated to several farmers, which might pave the way for scaling-out. Thus, demand driven technology transfer created. Furthermore, competitiveness among smallholders on technology (with full package) utilization increased. Information on market access provided (inputs and produce). Strong linkage among stakeholders (links to networks) was created that bridge further participatory effective bread wheat technology generation, demonstration, evaluation, validation and up-scaling/dissemination of the best performing wheat technologies that fulfilling farmers’ need and interest. Dissemination of improved bread wheat technologies enhanced through farmer-to-farmer learning mechanisms using FRGs/FREGs approach.

During focused group discussion (FGD), the participant farmers suggested that researchers should consider all categories of farmers (resource rich, medium and poor), use both model and non-model in conducting on-farm trials (pre-scaling up activities) so that it can help the researchers to teach people practically from success stories of model farmers and failure story of non-model farmers. In doing so, the non-models mind will be changed through field visit/experience sharing and it is a good source of problem for intervention and to motivate non-model farmers by showing the difference. During FGD and field days, the participant farmers highly emphasized the constraint of row planter, seed supply shortage (in quantity, quality, with reasonable price and at required time), mono-cropping problem due to growing of wheat after wheat and emerging big challenge of wheat rust disease epidemics in the study zones.

Recommendations

Effective and efficient delivery of technical advices and support to smallholder farmers is highly required to enhance wheat production and productivity, and bring the targeted impact. Strengthening the pre-scaling up of the best performing bread wheat variety/ies under farmers’ condition is important to make our research demand-driven. Recently, farmers’ group is seen as the smallest unit of the farmers. Hence, establishing and strengthening FRGs/FREGs is one of the approaches for channeling improved agricultural technologies to farmers (in packages approach), which make the
farmer to be central to agricultural research and dissemination. Strengthening the capacity of farmers/end users in technology up-take and utilization is the base for technology adoption. So, demand-driven training should be designed.

During pre-scaling up activity, the researchers should try to include all types/categories of farmers (from model/resource rich, middle and resource poor categories by considering all men, women and youth farmers) during site and farmers’ selection. Otherwise, only few and selected groups/farmers are benefited out of pre-scaling up activity/improved technologies dissemination. Generally, strengthening the linkages among actors and key potential stakeholders (research-extension-farmers-private service providers as well as agro-industries/food processors) are indispensable to attain the goal. Since it requires multi-stakeholder approach, commitment of actors and individuals at all stages of the pre-scaling up activities, especially at zone and district levels are crucial.

References


Pre-scaling-up of Malt Barley Technologies in Bale and West Arsi Zones, Southeastern Oromia, Ethiopia: The Experience of Public-Private Partnership

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Abstract

The paper presents the output, progress and success of pre-scaling up activities of improved malt barley technologies in Sinana, Goba, Dinsho and Gassera Districts of Bale zone, and Adaba and Dodola Districts of West Arsi zone of Oromia National Regional State, Ethiopia in the year 2009 to 2013 through the support of Asela Malt Factory and four breweries in multi-stakeholder approach. Generating, demonstrating, evaluating, validating, popularizing and disseminating improved malt barley technologies to smallholder farmers are vital in facilitating adoption of these technologies. The objectives were to convince the merits and increase confidence on the technologies, to strengthen on-farm seed production scheme and farmer-to-farmer seed dissemination system, increase the availability of malt barley seed for farmers and farmers’ ease access to the technologies, improve malt barley seed and grain production knowledge and skill of farmers with the standards of desired quantity and quality, organize producers, strengthening the linkage and pave the way for marketing their produce to agro-industries. Stakeholder analysis was made to select potential stakeholders to implement the activity. Thirty six (36) actors were identified, signed memorandum of understanding and participated in the activity. In capacity building and facilitating farmer-to-farmer extension effort of the technologies, about 1358 individuals (64.8% farmers, 35.2% agricultural experts, development agents and other stakeholders) were attended trainings on malt barley seed and grain production and management practices/packages. In popularizing malt barley technologies, 236.17qt (57qt Misical-21, 142.02qt Holker, 5.5qt Beka and 31.65qt Sabani) have been delivered to 880 smallholder farmers (201 in Adaba, 198 in Dodola, 150 in Dinsho, 101 in Gassara, 150 in Goba and 80 in Sinana districts) during the project period for production of seed that transferred to surrounding other farmers through farmer-to-farmer seed dissemination mechanisms. Field days and travelling workshops were organized to share the experience, evaluate the performance and to communicate the progress of the activity. A total of 450 and 120 individuals were participated on these events during the project period, respectively. Better accessing of malt barley varieties, improving farmers’ skill, knowledge and attitude on this business venture are the impacts attained during the project period. Strengthening linkage of key stakeholders, widely extending the scaling up of improved malt barley technologies in well-organized and systematic approach, and mapping malt barley value chain require due considerations in order to satisfy exceedingly mounting malt barley demand in Ethiopia.

Key Words: Malt barley, Technology, Innovation, Holker, Sabani, Beka, Partnership, Linkage, Value chain

Introduction

Ethiopia is the largest producer of barley in Sub-Saharan Africa. Barley is the most important cereal crops cultivated in the country. It is a cool-season crop that is adapted to high altitudes ranging from 2300 to 3000masl (Bayeh and Birhane, 2011). They added that at altitudes of about 3000 masl or above, it may be the only crop grown that provides food, beverages and other necessities to many
millions of people. Regarding to its utilization, barley is a traditional crop and has strong tie with the society; it is deep-rooted to cultural food and local beverages; it is also used as raw material for malt (linking agriculture with agro-industries); feed for animal (straw); for making thatching roofs; serves as a relief crop (offers early crop harvest) and it is a versatile/multipurpose crop. In Ethiopia, barley (both food and malt together) stands fifth after tef, maize, sorghum and wheat being produced on about 1 million hectares of land from which 1.90 million tons of grain is produced annually with an average national yield of 1.87 tons per hectare (CSA, 2014). Out of this, the share of malt barley is insignificant which could not exceed 5% to 10%. Yet, malt barley is among the priority commodities that have attracted the attention of malt factories, breweries and policy makers in general. Because, at the present time, it is considered as one of the cash crops and its demand by agro-industries has increased due to the increased capacity of malt barley processing in line with the expansion of the existing and establishments of new brewery plants.

Barley (both food and malt) is the major cereal crop grown in the highland areas of Arsi, West Arsi and Bale zones next to Wheat. Bale zone is the second both in barley area and production volume next to Arsi (CSA, 2013). Based on the productivity and land coverage, it is understood as it is under produced. Whereas, in Bale and West Arsi zones the present production land allocated for barley is decreasing, while it has potential production if expanded with scientific knowledge, technologies, practices and information.

Increased urbanization, population growth, and rising incomes are the driving forces that increase beer consumption levels in the country. As indicated in business sector report of Trade and Industry Minister (2011), the market for malt barley can be estimated to grow at 15% to 20% per year in line to the beer market. Besides, the demand for malt barley grain is about 600,000 quintals per year and projected to reach 1,700,000 quintals in 2016 to produce 1.3 million qt of malt. At the end of GTP 2 (up to 2020), about 2.21 million qt of malt barley grain will be needed to produce 1.7 million qt of malt (AMF, 2015 Unpublished). However, the current local supply is only about 40% of the demand. The balance has been fulfilled through importing malt and/or malt barley grain forms, which costs the country over thirty million USD ($30,000,000.00) or six hundred million Ethiopian Birr (>600,000,000.00 Eth. Birr) per annum (AMF, 2015). The gap between current production and consumption levels could be minimized by expansion/extension of improved malt barley technologies through institutional innovation for efficient distribution of the technologies among the end users. By doing so, the production (both in quantity and quality) and marketing system will be properly managed to ensure the linkage.

Table 1. Malt demand of breweries in Ethiopia in the year 2016.

<table>
<thead>
<tr>
<th>Breweries</th>
<th>Malt demand (Qt) in 2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>BGI Ethiopia</td>
<td>360,000</td>
</tr>
<tr>
<td>HEINEKEN (Bedele, Harar and Kilinto)</td>
<td>330,000</td>
</tr>
<tr>
<td>Meta Diageo</td>
<td>130,000</td>
</tr>
<tr>
<td>Dashen (in Gonder and in D/Birehan)</td>
<td>300,000</td>
</tr>
<tr>
<td>Habesha-D/Birehan</td>
<td>85,000</td>
</tr>
<tr>
<td>Raya – in Tigray</td>
<td>51,000</td>
</tr>
<tr>
<td>Zebider – in Walkite</td>
<td>45,000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1.3 million qt malt</strong></td>
</tr>
</tbody>
</table>

**Source:** Asela Malt Factory (AMF), 2015 (Unpublished)
Though, malt barley is among crops demanded in large quantity in the country, it lacks supply in which its impact is directly connected with national economy, as beer plants import it from abroad with high hard currency. Furthermore, malt barley supply in Ethiopia is characterized by continued scarcity due to low productivity attributed by low input utilization, limited availability of improved varieties, existence of pests and diseases and mono-cropping farming system. Sustained increase in agricultural production and productivity is dependent largely on the development/generation of improved varieties of crops, other associated recommended technologies, demonstration, evaluation, validation, popularization, dissemination and on an efficient system for timely supply of quality seeds to beneficiary farmers.

Extension of malt barley technologies, which improve the productivity of the crop and its production in potential areas of the country, has associated benefits for Ethiopia's balance of trade (export-import). Besides, it has direct impact on the country's smallholder farmers, which would supply malt factories with malt barley grain. To this end, research have been making continuous and unreserved endeavors in varietal development and seed/variety replacement to ensure the sustainability of early generation seed source for both formal and informal seed multipliers and distributors. As a result, the research system has produced substantial amount of improved agricultural technologies (variety, knowledge, information, management practices, farm equipment, tools, and machine) in the past decades. With this effort, twelve (12) malt barley varieties were released/registered for commercial purpose.

Table 2. Released malt barley varieties

<table>
<thead>
<tr>
<th>Variety</th>
<th>Year of release/registered</th>
<th>Altitude (masl)</th>
<th>Yield (t/ha)</th>
<th>Protein (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beka</td>
<td>1976</td>
<td>2300-2800</td>
<td>2.5-3.8</td>
<td>10.0</td>
</tr>
<tr>
<td>Holker</td>
<td>1979</td>
<td>2500-2800</td>
<td>2.4-3.1</td>
<td>10.4</td>
</tr>
<tr>
<td>HB-120</td>
<td>1994</td>
<td>2300-2800</td>
<td>2.4-3.5</td>
<td>11.9</td>
</tr>
<tr>
<td>Misical-21</td>
<td>2006</td>
<td>Mid-highland</td>
<td>2.5-4.6</td>
<td>11.5</td>
</tr>
<tr>
<td>Sabini</td>
<td>2011</td>
<td>2000-2800</td>
<td>2.5-3.0</td>
<td>8.5</td>
</tr>
<tr>
<td>Bahati</td>
<td>2011</td>
<td>2300-3000</td>
<td>2.5-3.0</td>
<td>8.7</td>
</tr>
<tr>
<td>EH1847</td>
<td>2011</td>
<td>2300-3000</td>
<td>3.5-4.0</td>
<td>10.6</td>
</tr>
<tr>
<td>Bekoji-1</td>
<td>2010</td>
<td>2300-3000</td>
<td>3.5-4.0</td>
<td>10.5</td>
</tr>
<tr>
<td>IBON 174/03</td>
<td>2012</td>
<td>2000-2800</td>
<td>3.0-5.7</td>
<td>10.0</td>
</tr>
<tr>
<td>Grace</td>
<td>2013</td>
<td>2000-2800</td>
<td>2.4-4.5</td>
<td>10.5</td>
</tr>
<tr>
<td>Traveler</td>
<td>2013</td>
<td>2300-3000</td>
<td>2.5-4.6</td>
<td>10.3</td>
</tr>
<tr>
<td>Fanaka</td>
<td>2015</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Variety Registration Book. 2015

Due to the weak linkage between research, extension, farmers and other stakeholders (in extension, multiplication and utilization), however, these technologies delayed to reach the majority of smallholder farmers particularly and the growers generally to bring the required impact. Besides, the impacts and benefits have been limited in scope and coverage. The scenario was not different for malt barley, which serves as a bridge for agriculture-industry linkage. By the aim of enhancing malt barley
production and productivity in the country, malt barley project (Public-Private Partnership) has been launched since 2009 by joint collaboration of Asella Malt Factory and four Breweries (BG1- Ethiopia, Meta Abo, Bedelle and Harar) to support research capacity through financial support and improve access of malt barley technologies to smallholders farmers in potential malt barley producing areas of Ethiopia. This project has planned its activity to contributes towards the improvement of malt barley production and productivity in Arsi, West Arsi, Bale and central highlands through participatory generation, demonstration, evaluation, validation, pre-scaling up/popularization and dissemination of improved malt barley technologies developed by Ethiopian Institute of Agricultural Research (EIAR) and Regional Agricultural Research Institutes (RARIs).

Thus, a pre-scaling up of malt barley technologies have been conducted in Bale and West Arsi zones, southeastern Oromia, Ethiopia with objectives of ensuring the introduction and dissemination of improved malt barley varieties with associated technologies. It also aimed to ensure the availability of pure seed of the varieties to the farmers through informal seed system and thereby strengthening the malt barley grain supply to agro-industries. Hence, this document presents overall progress and success of this activity, the approaches followed, challenges confronted and future direction in improving malt barley technology supply in the two zones.

Objectives

General objective

To ensure the dissemination of improved and newly released malt barley varieties with associated recommended technologies and availability of pure seed of the varieties to the farmers through informal seed system for the improvement of malt barley production and productivity and thereby strengthening the malt barley grain supply to agro-industries and contribute to enhance import substitution and satisfy the local demand (both in quantity and quality) of agro-industries.

The specific objectives

- To convince the merits and increase confidence on improved malt barley technologies, thereby to facilitate dissemination and adoption of the technologies through farmer-to-farmer extension approach,
- To strengthening on-farm seed production scheme and farmer-to-farmer seed dissemination mechanisms,
- To increase the availability of malt barley seed for farmers/malt barley growers and farmers’ ease access to the technologies,
- To enhance the capacity (knowledge, skill and attitude) of malt barley growers through training on principles of barley seed and grain production and management practices/packages with the standards of desired quantity and quality,
- To strengthen the linkage (links to networks) between the farmers, researches, improved malt barley technologies and agro-industries and
- To pave the way for marketing their produce to agro-industries.

Methodology

Description of the Study Area

The research was carried out in Dinsho, Goba, Gasara and Sinana districts of Bale Zone, and Dodola and Adaba districts of West Arsi zone of Oromia National Regional State (ONRS), Ethiopia. Bale and West Arsi zones are among the 18 administrative zones of the ONRS and located in southeastern Ethiopia.
Bale zone

Bale zone has 18 rural and 2 town districts, out of which 9 rural districts are suitable for crop production. The other 9 rural districts are agro-pastoralists and pastoralists. The total area of Bale zone is about 63,555 km² (6,355,500 hectares), which is 16.22% of ONRS. It is estimated that 88% and 22% are rural and urban dwellers, respectively. About 95% of the population is engaged in agriculture. The agro-ecological zones of the zone are extreme highland (cold) 0.04%, highland (14.93%), midland (21.5%) and lowland (63.53%). The mean annual temperature of the zone is found between 3.5°C and 35°C, respectively. The area receives an average annual rainfall of 1450 mm where as the minimum and maximum rainfall is 400 mm 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 and East Hararghe zones in the North, Arsi and West Arsi zones in the West, Guji zone in the South and Somali National Regional State in the East. Robe town is the capital town and administrative center of the zone (BZADO, 2014).

West Arsi zone

West Arsi zone has 12 rural and 2 town districts and having the total area of 12,556 km² (1,255,600 hectares). About 95% of the population is engaged in agriculture. 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 and dissected plateaus (BOFF.D. 2009). Most parts of the zone have elevations of ranging from 1500 m to 2300 m above sea level. The mean annual temperature of the zone is found between 10°C - 25°C. For most of the areas, the rainy season starts in March and extends to November with the increasing concentration in June, July and August. On average, the zone gets annual mean rainfall of 1300 mm. The zone is bounded by East Shewa zone in the North, South Nations, Nationalities and People National Regional State in the West, Arsi zone in the northeast, Guji zone in the South and Bale Zone in the East. Shashamanne town is the capital town and administrative center of the zone (WAZADO, 2014).

Public-Private Partnership (PPP) as an institutional innovation

Why do breweries and AMF fund research and Extension of malt barley? This extension approach was preferred to build capacity for research and extension activities, to ultimately increase malt barley production and productivity (both in the desired quantity and quality set by agro-industries) and to satisfy local demand, to strengthening linkage and synergy among stakeholders and to enhance malt barley value chain in the project implementation areas.

Linkage among stakeholders

Research have been making continuous and unreserved endeavors in varietal development and seed/variety replacement to ensure the sustainability of early generation seed source for both formal and informal seed multipliers and distributors. As a result, the research system has produced substantial amount of improved agricultural technologies (variety, knowledge, information, management practices, farm equipment, tools, and machine) in the past decades. However, due to the weak linkage between research, extension, farmers and other development partakers, limited access to inputs and lack of market opportunities yet, these technologies delayed to reach the majority of smallholder farmers in the country. Hence, in extension, multiplication and utilization still the impacts and benefits have been limited in scope and coverage. So, for the sake of enhancing efficiency and effectiveness, integration and cooperation were institutional tools/innovations implemented for the achievements of the strategy.

Approaches Followed
The inception of malt barley technology extension was started with potential malt barley growing areas identification and inventory of the best suitable technologies according to the agro-ecologies of the areas. Multidisciplinary team consists of eight researchers (Center Director/Entomologist, Breeder, Pathologist, Agronomist, Weed Scientist, Economists, Agricultural Research-Extensionist and seed expert) was established at Sinana Agricultural Research Center (SARC) for the implementation the project. For the sake of enhancing efficiency and effectiveness, integration and cooperation were institutional tools/innovations implemented for the achievements of the strategy.

i) **Joint Planning:** organizing stakeholder forum for consultation meeting with responsible and collaborative participants to have a common understanding of scaling up activities; establishing stakeholder platforms at zone and district levels; signing memorandum of understanding (document having the roles and responsibilities of each actor) and appointing focal persons and establishing taskforces at all levels were done successfully.

ii) **Training on capacity building (knowledge, skill and attitude):** for farmers, agricultural experts and development agents (DAs) on malt barley seed and grain production and management packages (from site selection to post harvest handling), quality requirements by agro-industries, on roughing and seed dissemination system was delivered.

iii) **Packaging and distribution of malt barley technologies:** different improved malting barley varieties, namely, Miscal-21, Holker, Beka and Sabini and other agricultural inputs (fertilizers, agro-chemicals) distributed to selected zones, districts and farmers.

iv) **Joint monitoring and evaluation:** regular field visit by extension agents i.e. trial sites were regularly visited by extension counterparts, joint field visit and supervision at different crop stage, field day organized at each district, workshop (marketing, travelling), discussion session and result communication forum were also organized.

vi) **Facilitating seed delivery mechanisms:** revolving seed system was designed i.e. initial seed and other agricultural inputs were provided to the hosting farmers in the first year of the activity while during the next years farmer-to-farmer seed exchange mechanism devised.

**Site and farmers’ selection**

**Site selection**

Four districts from Bale zone (Sinana, Goba, Dinsho and Gassara) and two districts from West Arsi zone (Dodola and Adaba) were selected purposively for the implementation of the activity. In collaboration with DAs and agricultural experts, Basmamui and kaso kebeles from Sinana district; Fasil Angaso and Ititu Sura kebeles from Goba district; Abbakara, Kararri, Dinsho 02 and Garamba Dima kebeles from Dinsho district; Birbirsa and Baneba Guranda from Gassara district; Washa and Furunna kebeles from Adaba districts and Dannaba and Serofta from Dodola were selected for the pre-scaling up activity.

**Farmers’ selection**

Interest of farmers in malt barley production and potential land they have (who can give 32m X 32m land), their ability and willingness to perform cultural practices as per recommendation, social status in the community (that can influence his/her community in decision making) and gender equality issues (at least 25%) were considered as farmers’ selection criteria.

Trial farmers were selected based on ownership of suitable and sufficient land to accommodate the trials, willingness to contribute the land, vicinity to roads so as to facilitate the chance of being visited by many farmers, initiatives to implement this activity in high-quality, good in field management and willingness to explain the technologies to others were additional criteria used to select the hosting farmers. Accordingly, a total of 880 hosting farmers were selected in all the five districts during the project period (2009 to 2013). Trial site (farm land) was obtained through cost sharing i.e. hosting
farmers contributed the trial land, while SARC delivered all agricultural inputs and finally, the initial seed returned to SARC at harvesting time as revolving seed.

**Trial design**

SARC was the source of all agricultural inputs (seed of improved malt barley varieties, fertilizers-DAP).

Among malt barley varieties released, Holker, Miscal-21, Beka and Sabini have been the varieties popularized and distributed in the potential zones and districts. They planted on selected farmers’ plot (32m X 32m) in the main (Meher) season during 2009 to 2013. The varieties were treated with full recommended malt barley production packages (agronomic recommendations and practices). Row planting method and other crop management practices were used during the pre-scaling up activity. The spacing of 20cm between rows was used. The recommended seed rate of 120 kg/ha was used by drilling in the prepared rows. Shallow planting of 5cm depth was used in the presence of ample soil moisture. The recommended inorganic fertilizer rate 100 kg/ha DAP only was applied.

Depending on weed infestation, two effective weeding were done; the first at one month after sowing and the second at two months after sowing of improved bread wheat varieties. All farm operations (land preparation-ploughing four to five times using oxen plough, land leveling, planting, first and second weeding, agro-chemical spray, harvesting, threshing) were carried out by hosting farmers with close assistance and supervision of concerned participating institutions (research centers and agricultural development offices). Farmers’ full participation at all stages of the activity was maintained during the implementation period.

**Technology assessment methods/techniques**

Hosting farmers were encouraged to participate on different extension events organized at each site. These were mechanisms used to enhance farmer-to-farmer learning and information exchange such as trainings, field visits/tours, field days, etc.

**Training**

The effectiveness of the work is measured in terms of the changes brought about in the knowledge, skill and attitude, and adoption behavior of the people but not merely in terms of achievements of physical targets. Hence, training is very important to bring improvement on the job after filling the gap on knowledge, skill and attitude (KSA).

Training was given to farmers, DAs and agricultural experts on malt barley crop production techniques and management packages, quality requirements by agro-industries, roughing (seed quality maintenance) and post harvest handling of the seed. Expert from Asela Malt Factory, zone and district agriculture development office, primary cooperatives/farmers’ group, unions and private service providers 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, field days were organized at each pre-scaling up site in order to involve key stakeholders and enhance better linkage among relevant actors. Discussion session and result communication forum were also organized.
Communication Methods Used

Appropriate extension approaches (project and participatory) and all extension teaching methods (individual, group and mass contact methods) were employed alone or in a judicious combination according to the situations during the implementation of the malt barley project.

- Telephone (fixed and/or mobile)
- Study tour or field visit and supervision
- Workshop (for status evaluation)
- Field day
- Demonstration: method (to impart the skills) and result (to show the performance) demonstrations
- Group meeting and discussion session
- Training (in-room and on-spot or practical)
- Mass media (TV, Radio)
- Print Media (leaflets, pamphlets, flyers, posters, etc) was used for creating awareness, enhancing user knowledge and skill, changing attitude on using fully recommended packages of improved malt barley technologies.

Data collection

Both qualitative and quantitative data were collected using appropriate data collection methods such as direct field observation/measurements, household/participant interview, focused group discussion (FGD) and knowledge test.

The types of data collected include:

- Agronomic data such as days to heading, days to maturity, plant height, spike length, seed per spike, stand, thousand seed weight and grain yield per plot were recorded.
- Total number of farmers participated on training, field visits, field days and assessment by gender,
- Numbers of farmers become aware of the relative advantage of the technology by gender,
- Role of farmers and other stakeholders in improved malt barley varieties pre-scaling up,
- Change in level of knowledge and skill of farmers and development (Das),
- Farmers, DAs, agricultural experts and researchers’ opinion/feedback assessment (perceptions, interests and views towards the performance of the technologies)
- Amount of total seed produced and revolved were collected.

Method of data analysis

SPSS was used as statistical package (descriptive statistics was used to analyze the data).

Results and Discussions

Stakeholder identified, their roles and responsibilities

Based on SA, thirty six (36) responsible and collaborative participant stakeholders/actors were identified for implementation of the activity. Namely, Sinana Agricultural Research Center (SARC), Asella Malt Factory (AMF), four Breweries (BGI-Ethiopia, Harer, Meta and Bedelle), Bale and West Arsi zones Administration Offices, Bale and West Arsi zones Agriculture Development Offices, Bale and West Arsi zones Cooperative Promotion Offices, Bale and West Arsi zones Input Supply and Distribution Offices, Rayya Wakana Union, Sikomando Union, Dinsho, Gasara, Goba, Sinana, Adaba and Dodola Districts Administration Offices; Dinsho, Gasara, Goba, Sinana, Adaba and Dodola Districts Agriculture Development Offices; Dinsho, Gasara, Goba, Sinana, Adaba and Dodola Districts Cooperative Promotion Offices and Dinsho, Gasara, Goba, Sinana, Adaba and Dodola Districts Input Supply and Distribution Offices.
Besides, stakeholders’ forum was organized for consultation meeting; stakeholder platforms were established at zone and district levels; Memorandum of Understanding (MoU) was signed; focal persons were appointed and taskforces were established at all levels. Accordingly, initially at zonal level, planning and agreement was done with potential and collaborative stakeholders/partners after detail discussion was made on the importance of the initiated project. In the course of consultation, SARC shared roles and responsibilities with the identified stakeholders by signing MoU.

Table 1. Stakeholder roles and responsibilities in implementing the activity

<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>Roles and Responsibilities</th>
</tr>
</thead>
</table>
| Sinana Agricultural Research Center (SARC) | ✓ Coordination and facilitation  
✓ Provision of improved malt barley technologies  
✓ Provision of training in capacity building and supervision  
✓ Technical backstopping and  
✓ Organize field days to share experiences and travelling workshops for monitoring and evaluations with other stakeholders  
✓ Follow up the revolving seed |
| Asela Malt Factory, (AMF) | ✓ Financial support for malt barley research and extension, disseminate malt barley production and management packages  
✓ Provide training with other stakeholders in the project districts  
✓ Organize field days and travelling workshops in collaboration with research center, zone and district agricultural development offices |
| Four Breweries (Harer, BGI, Meta and Bedelle) | ✓ Financial support for malt barley research and extension  
✓ Participate on field days to share experiences and on traveling workshops for monitoring and evaluations with other stakeholders |
| Bureau of Agriculture (at zone, district and kebele level) | ✓ Assist in site and participant farmers selection  
✓ Provide training with other stakeholders in the project districts  
✓ Facilitate seed distribution and follow up farmer-to-farmer seed system  
✓ Follow up day to day activities from zone to kebele levels  
✓ Organize field days to share experiences and travelling workshops for monitoring and evaluations with other stakeholders  
✓ Facilitate seed distribution |
| Malt barley growers/ smallholder farmers | ✓ Allocate land (cost sharing) and perform required agronomic practices  
✓ Actively participate on the training for capacity building  
✓ Share skills and experiences to neighbor farmers through field visit  
✓ Participate on field days to share experiences and traveling workshops for monitoring and evaluations  
✓ Transfer produced revolving seed to other farmers in the project area and  
✓ Finally, supply malt barley grain (in bulk production) to AMF |
| Cost Sharing | ✓ Agricultural inputs supply (seed, fertilizers, agro-chemicals, etc.) |
| Cooperatives/Union | ✓ Malt barley grain collection and facilitate marketing to AMF |
Results and discussions

Farmers' participation

Multidisciplinary team was organized to deliver the training on knowledge, skill and attitude and facilitating extension efforts of malt barley technologies. The team was composed of socio-economists, agricultural research-extensionists, breeders, pathologists, agronomists and seed scientists. Both theoretical and practical trainings on malt barley seed and grain production and management packages (malt barley varieties quality and yield level, agronomic practices, major diseases, insect pests, weeds, etc.), on seed quality maintenance/roughing, on malting quality parameters and post harvest handling of the seed were given to the participating farmers. DAs and agricultural experts by itinerant group of researchers from SARC. About 1358 individuals (64.8% farmers, 35.2% agricultural experts, development agents and other stakeholders) were attended this training. The softcopy of training materials were provided in CD to the concerned body.

![Fig.1. Summary of farmers participated in pre-scaling up activity (2009-2013)](image)

Seed distribution

Based on the availability of the technologies, the participant farmers in pre-scaling up activity were determined each year. Selection of farmers and farm land was conducted by DAs and district agricultural experts. Then, initial investment (starter seed) is decisive to ensure the local availability of seed for farmers and thus, 'help people to help themselves' is the best approach. At initial stages of the project, a starter seed of 25kg of the improved malt barley varieties (any of the four varieties) was given to the farmers in selected districts. In popularizing malt barley technologies, 236.17qt (57qt Misical-21, 142.02qt Holker, 5.5qt Beka and 31.65qt Sabani) have been delivered to 880 smallholder farmers (201 in Adaba, 198 in Dodola, 150 in Dinsho, 101 in Gassara, 150 in Goba and 80 in Sinana districts) and planted on 2ha during the project period for production of seed that transferred to surrounding other farmers through farmer-to-farmer seed dissemination mechanisms. This system is a relatively good low-cost system that can maintain kind, quantity, quality and access (at right time, place and reasonable price) of the seed to a level satisfactory to neighboring farmers locally.

The seed provided for the seed growers were collected by districts agriculture development office at harvesting time to be re-distributed to other farmers in the project area. This seed was used as revolving seed for the project. Each year, records were made on the amount of seed produced, the attitude of the farmers towards the technologies and the adaptability of the varieties to the locations.
Supervision

The multidisciplinary team jointly conducted supervisions, monitoring and evaluation of the activities among the participating districts based on the necessities and requirements. As a result, the group had offered advice based on the practical problem observed on the spot (timely weeding, roughing, harvesting time and post harvest handling on the farm) in the project areas.

Field days and travelling workshops

Field day was organized in collaboration with zone and district level agriculture development offices and participant farmers to show the new innovation, to participate more farmers in the pre-scaling-up process in seed multiplication and grain production activities and satisfy the booming need of agro-industries. The events were organized to share the experience among seed growing farmers in October or November of the year as per required during the project period. Accordingly, about 450 participants (including farmers in the area) were participated on these events during the project period.

Travelling workshops was also organized to evaluate the performance, progress, to communicate the result of the activity and pave the way forward. A total of 120 individuals/participants (Researchers, experts, DAs, farmers, officials) were participated on this event. During discussion session, it suggested that concentrating at potential districts and using produced seed efficiently is highly important to increase participant farmers’ and area coverage of malt barley in the zones.

Access to markets

Integrating smallholder farmers into markets (local, national or international) is essential if they are to innovate and increase their productivity. For farmers, market participation and technology adoption are very closely linked (Barrett, 2008). Technologies help farmers to enter the market by allowing them to produce a marketable surplus, while the availability of market opportunities provides farmers with incentives to produce more or change their patterns of production, to add value to their production and to innovate. Markets therefore strongly influence the technologies and practices adopted by farmers (FAO, 2014).

Marketing is a multi-stage process. The inclusion of small scale farmers in modern value chain could offer rural household market opportunities. For the improvement and development of marketing structure, a co-ordinate approach aiming at removing all the weak links of the marketing chain is essential. A package of improved marketing services in the form of regulated markets, facilities for grading, weighing, storing, transporting, handling services and marketing finance need to be made available to ensure the producer a fair return from his production efforts and a better share in the price paid by the consumer. Thus, for strong linkage between producers and agro-industries and effective marketing system is required. To this end, there are alternative marketing channels where producers can sell their product directly to processors or through primary cooperatives and unions.
Major achievements

Awareness

Awareness was created on the importance and contribution of malt barley production as a raw material for the booming beer industries (agro-industries).

Improved on-farm malt barley seed production and seed dissemination system

The seed system of Ethiopia mainly biased towards production and multiplication of hybrid maize and improved bread wheat seeds. Ethiopian seed enterprise (ESEs) and Region seed enterprises (RSEs) give limited attention to the multiplication of seeds of other crops (barley, durum wheat, tef, sorghum, pulse and oil crops, etc.). The supply of seeds of these crops to the farmers through formal seed supply is negligible. The pre-scaling program under malt barley project has contributed a lot in improving the availability and access of improved and newly released malt barley seeds to the smallholders in their locality since 2009. It enabled farmers to produce malt barley seeds which informally transferred to the surrounding farmers through seed exchange, gifts, sells and borrowing. It also served as the main source for the majority of the malt barley varieties (seed) that are currently in production in major malt barley producing areas of Bale and West Arsi zones. For instance, Misical-21, Holker and Sabini varieties are the main varieties that have been delivered to farmers in relation to the agro-ecology requirement.

Improved seed production skill and knowledge of farmers

The malt barley demonstration and pre-scaling up program has introduced malt barley seed and grain production for first time to new potential areas. Since the activity is accompanied by trainings, awareness creation activities like field days, frequent joint supervisions and on field advisory programs; farmers in target areas have been equipped with the skills and knowledge of malt barley seed and grain production and management packages; however, the impact is hidden by occasionally existing climatic factors and vastly raising demand of malt barley grain by agro-industries.

Improved the linkage between research, extension, farmers and agro-industries (links to networks- among farmers and with private sector firms)

The synergy among different stakeholders (multi-stakeholder approach) along malt barley value chain is inevitable to satisfy the existing malt barley demand in Ethiopia as well in the region. The research system has produced substantial amount of technologies, information and knowledge since barley research commenced at DebreZeit Agricultural Research Centre in the 1950s (Bayeh and Berhane, 2012). The weak linkage and synergy among the stakeholders contributed to the unmet need of malt barley and its product in the country. Malt barley project organized by partnership of public and private institutions has bridged research, extension, farmers, Malt Factories and breweries towards attaining common goal of improving malt barley production and productivity since 2009. Towards searching solutions for malt barley scarcity, the major actors (malt barley research and development, extension, AMF and breweries) in malt barley value chain have worked together (discussed on annual reviews, monitored and evaluated through travelling workshops and field days) in the lifespan of the project (2009-2013).

Challenges and lessons learned

While performing malt barley technologies transfer, it creates a great chance for researchers to closely work with the smallholders who further enabled to evaluate the farmers’ problems and situation in malt barley seed and grain production and management practices. Accordingly, the practical challenges in the farming communities are described as follows.

Improper site and farmer selection: in scaling-up of improved malt barley technologies, the duty of selecting proper farmers and sites belongs to agricultural experts and DAs. Sometimes, the farmers
and sites selected for pre-scaling up activities were inappropriate for monitoring and evaluation, marginal lands and farmers who are not in a position to apply the required associated recommended packages for malt barley seed and grain production and management.

**Mono-cropping and grass weeds:** in the project areas, farmers commonly grow barley (malt and food) and wheat interchangeably for longer years. The culture of rotating barley or wheat with pulses is hardly observed. On the other hand, the mono-cropping farming system has created comfortable condition for grass weeds development since recent years.

**Disease and insect pests:** however, the level of problem varies across locations; leaf blotch and scald are major diseases attributing for malt barley yield reduction in the districts of Bale and West Arsi zones. In addition to the diseases, shoot fly is the most commonly affecting malt barley especially at early stage and the damage is sever especially in the plain areas of Bale zone.

**Shortage of improved malt barley variety/seed:** the shortage of improved genetically potential malt barley varieties (high yielding) and the availability of malt barley clean and pure seeds were the smallholders’ problem and bottleneck to malt barley production. According to the farmers complain, improved malt barley seed supplying agents (GOs and NGOs) are limited as compared to hybrid maize and improved bread wheat suppliers and producers. Besides, quality of improved malt barley varieties are the issue that needs due consideration.

**Institutional factors (seed distribution and market linkage):** The produced seed are not formally distributed to farmers on time and demand bases. Traders are the main actors in malt barley marketing and they are the main beneficiary from malt barley production business on behalf of farmers even though the situation was improved in 2012 in West Arsi zones. Most farmers sell malt barley at lower price in their closer markets early after production (from December to February) due to absence of market driven price setting system.

**Poor agronomic practice:** it possibly contributes for low malt barley productivity and quality stated above as a constraint to malt production that resulted in low market price. Majority of the malt barley fields are not properly prepared, fertilized, rotated with pulses or oil crops, weeded and rouged out from mixed crops and varieties even.

**Challenges in coordination and linkage of multi-stakeholder platforms as well as in making it live and sustainable:** institutional innovation is complex and includes laws/polices, leadership, linkages and partnership, communication, attitude, social capital, incentives/markets, etc. Therefore, bringing these all key and potential collaborative stakeholders around one table for common goal require high commitment and flexible approach.

Lack of organizing malt barley producing farmers in to cooperatives or community based seed multipliers (LSBs) and initiate contractual farming--- in Bale and West Arsi zones

Poor linkage between producers, cooperatives, unions and agro-industries

**Conclusions and Recommendations**

**Conclusions**

By the pre-scaling of malt barley technologies (varieties) program, the majority of research outputs that was generated have been transferred to smallholders in the targeted areas in lifespan of malt barley project. Misical-21, Holker and Sabini were the varieties popularized and transferred to the producers while Bahati, Bekoji-I, EH1847, IBON 174/03, Grace and Traveler were the new varieties that were demonstrated among farmers in different areas since 2012. The pre-scaling up of malt barley technologies require concentrated involvements of different stakeholders (multi-stakeholder approach) and other approaches including analysis of existing situation. Capacity of farmers and agriculture experts (DAs and SMSs) has been built through trainings, awareness creation, monitoring
and evaluations, stakeholder meetings, field days, travelling and marketing workshop organized in 2009 to 2013.

Barley mono-cropping and grass weed development, shortage of improved productive (high yielding) malt barley varieties, institutional factors like timely distribution of improved seed and weak market linkage are the major challenges noticed in malt barley production. Improper site and farmer selection and weak commitment of actors and individuals at all stages of the pre-scaling up activities were also among challenges observed during implementation of malt barley pre-scaling up program.

Recommendations

Our farmers should not only be seed receivers but also seed growers. Besides, they should not always be in the front line of problems, but also in the forefront of the solution. Thus, farmer-to-farmer seed dissemination mechanism is the best way with close supervision of DAs, agricultural experts and researchers. Moreover, establishing and strengthening community seed multipliers/malt barley producer cooperatives/LSBs can enhance the activity.

Improving institutional factors in seed distribution and strengthening market linkages (market driven price setting system), commitment of actors and individuals at all stages of the pre-scaling up activities, especially at zonal and district level is crucial. Strengthening the linkage among actors, mapping malt barley value chain to decrease side selling of malt barley grain and widely extending the scaling up of malt barley technologies in well-organized and systematic approach requires due considerations in the future in order to satisfy exceedingly mounting/increasing malt barley demand in Ethiopia. For strong linkage between producers and agro-industries and effective marketing system, the study recommends producers’ direct marketing of their products through their cooperatives based.

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Multiplication, Evaluation and Promotion of Improved Desert Banana Varieties in the Lowlands of Bale

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Abstract

This study intended to multiply, evaluate and promote improved banana varieties to farmers in the lowlands of Bale zone. Dello Menna and Barbere districts were purposively selected for their irrigation as well as banana production potential. Two kebeles with better banana production potential and fifteen active and interested farmers from each kebele were selected with the help of woreda agricultural development office. Permanent banana multiplication site were established at Chiri farmers training center and suckers of seven selected varieties were planted along with local check in three replication. All management practices were made according to the recommendation. Finally, the varieties were exposed to the selected farmers for evaluation. As a result all the seven varieties were selected by farmers based on their own criteria such as: number of suckers per plant, number of fruits per bunch, fruit size, days to maturity and total yield per plant. Effort were made to multiply and distribute the suckers of the selected varieties. As a result, about 105 and 56 suckers were distributed to farmers in Dallo and Barbare district during 2012/13 respectively. In the year 2013/14, about 210 suckers were also distributed to 30 farmers in the study districts. Based on feedback collected from the farmer, all banana varieties introduced to the area were well adapted and have better potential over local cultivar. However shortage of land and absence of responsible organization for multiplication of planting material, and absence of irrigation facilities at research Sub-site were the major challenges that should be improved through involvement and collaboration of different stakeholders.

Key words: Desert Banana; improved variety; evaluation; multiplication and promotion

Introduction

Eastern and Southern Africa produces over 20 million tonnes of bananas (Musa spp.) annually which accounts for 25.58% of total world output (Karamura et al., 1998). Banana is a staple food for over 20 million of people in eastern Africa (Wambugu et. al., 2008). It is an important source of income for small-scale subsistence farmers in the region. It is also good sources of vitamins and minerals and provide raw materials for the processing industries (UAAIE, 2001). Reports indicate that local cultivars of banana were under cultivation in Ethiopia since mid 18 century (EARO, 2001). According to CSA (2012), it is the first major fruit grown in Ethiopia, both in area coverage (35,869.31ha) and total production (2,705,715.16 Quintals). The bulk of banana is produced in traditional agricultural system in the homestead where gardens are small and intensively managed (Seifu, 1999). Banana is also a major fruit crop grown in Bale zone. It covers 68% of area under fruit (930.61ha) crops (CACC 2003).

The overall development of fruit sector in the country is limited. This could be attributed to constraints such as lack of improved varieties, limited inputs, skilled manpower and extension approaches and, focus of agricultural development efforts on grain production amongst others (Berhe et. al., 2008). Similarly, the yield obtained is very low due to the use of low yielding local varieties, lack of appropriate knowledge about banana production and management, lack of sufficient quantity of planting material and insufficient orientation to make aware of the nutritive and economic advantages of these crops. To revert these trend about eleven banana varieties were tested for their adaptability in Dallo district. As a result about seven best performed varieties were recommended
(Seifudin, 2012). However farmers were not participated in the evaluation process during adaptation trial. Moreover the varieties were not distributed to farmers due to shortage of planting materials. Therefore this activity was proposed with aims evaluating the varieties under farmers' circumstances, multiplying and promoting the selected ones in the study area.

**Objective of the study**

To multiply, evaluate and promote improved banana varieties to Dello and Barbare district of Bale Zone.

**Research Methodology**

**Description of the study areas**

Dello Mena and Berbare districts are located in Bale zone. The capital of Dello Mena district (Menna) is located at 555km and 125km from Addis Ababa and Robe respectively. While the capital of Barbare district (Haro Dumal) has a distance of 100 km from zonal capital Robe and 530 km from Addis Ababa. The mean annual temperature of Dello Mena district is 29.5°c with the lowest and the highest being 21°c and 38°c respectively. The mean annual rainfall of the district is 701.5 mm. While the average annual temperature of Barbare district is 16.5°c and annual average rainfall is 850mm. Welnel, Yadot and Dumal rivers are the major sources of irrigation in the districts. In Barbare district the area covered by traditional irrigation was 3277ha and over 961ha was under modern irrigation during 2008 production year. Cereals are the main crop produced during the main season followed by pulses, oil seed, vegetables, and spices. Coffee, Banana, Mango and Avocado are the major permanent crops in both districts (BZFEDO, 2008).

**Site and farmers selection**

Dello Menna and Barbere districts were purposively selected for their irrigation as well as banana production potential. Two Kebeles with better banana production (Chiri and Erba PA’s from Dello Menna and Sirrima and Gabe PA’s from Barbare district) were purposively selected from each district with the help of Woreda agricultural development office. Farmers’ selection criteria were land ownership (at least 0.5ha), access to irrigation water, proximity to main road, willingness to host and manage the trial and willingness to use recommended inputs. Therefore based on the criteria a total of sixty farmers (fifteen farmers from each 4 kebeles) were selected in collaboration with development agents.

**Research design**

Seven desert Banana varieties were planted along with local variety on 25mx30m area and 3mx3m spacing at Chiri kebele with 3 replication. All management practices were made during seedling multiplication. The varieties were demonstrated to farmers so that they get insight about the production management and relative advantage of improved varieties. Farmers were also participated in evaluation of the varieties using their own criteria like number of suckers per plant, number of fruits per bunch, fruit size, days to maturity and total yield per plant.

**Data collection and management**

Biological data like number of suckers per plant, plant height, number of fruits per bunch, fruit length, fruit and stem girth and total yield per plant were collected with the help of breeder and agronomists. Farmer perception on the improved technologies (variety, agronomic, disease management and post-harvest handling) were recorded. Identification and prioritization of problems through discussion with farmers.
Data analysis

Biological data collected were analyzed using Genstat software, while simple descriptive statistical analysis like mean, SD and ranking were employed to analyze farmers' perception about the improved varieties.

Results and discussions

Seedling multiplication

Permanent sucker multiplication site were established at Cirri farmers training center during 2012/13. Seven desert Banana varieties (Williams-1, Grand nain, Robusta, Butazua, Poyo, Jiant Cavendish, dwarf Cavendish) were planted along with local variety on 25mx30m area at 3mx3m spacing with 3 replication. All management practices like weeding, hoeing, composting and watering were made during seedling multiplication.

Stakeholders participated and approach followed

A multi-disciplinary team of researchers, experts from agricultural development offices, development agents and farmers were participated in technology evaluation and promotion process. Training was given on banana production and management practices, to 60 farmers, 12 DAs and 8 experts, from Dallo and Barbare, out of which 12 of them were female headed farmers ahead of evaluation process. The trial were demonstrated to farmers, DAs, experts and researchers so that they get insight about the production management and relative advantage of improved varieties.

Agronomic and yield performance

Both agronomic data and farmers' perception were collected to select best performed varieties from the eight varieties including local. Agronomic data collected were analyzed using GenStat software. The analysis result showed that there is significant different between the varieties at 5% significant level. The varieties Robusta, Grand nain, Dwarf Cavendish and Jiant Cavendish ranked from 1-4 in total yield in that order. The gross income/plant that could be obtained from the varieties in one season were assessed keeping the cost of production and price per kilogram for all varieties constant. Accordingly improved varieties have profit advantage of 131-321 Birr per plant over local variety. The analysis result is summarized in the table below.

Table 1. Agronomic performance of improved banana varieties

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Plant Height (cm)</th>
<th>Sucker/plant</th>
<th>Fruits/bunch</th>
<th>Fruit Length (cm)</th>
<th>Fruit Weight (gm)</th>
<th>Fruit Yield (kg/plant)</th>
<th>Days to maturity</th>
<th>Gross income</th>
</tr>
</thead>
<tbody>
<tr>
<td>Williams-1</td>
<td>151.5</td>
<td>3&lt;sup&gt;b&lt;/sup&gt;</td>
<td>128.7&lt;sup&gt;c&lt;/sup&gt;</td>
<td>19.83</td>
<td>150.23</td>
<td>19.33&lt;sup&gt;d&lt;/sup&gt;</td>
<td>502&lt;sup&gt;b&lt;/sup&gt;</td>
<td>270.62</td>
</tr>
<tr>
<td>Grand nain</td>
<td>216.5</td>
<td>7&lt;sup&gt;a&lt;/sup&gt;</td>
<td>146.7&lt;sup&gt;b&lt;/sup&gt;</td>
<td>21.97</td>
<td>195.83</td>
<td>28.72&lt;sup&gt;b&lt;/sup&gt;</td>
<td>498&lt;sup&gt;b&lt;/sup&gt;</td>
<td>428.96</td>
</tr>
<tr>
<td>Robusta</td>
<td>220</td>
<td>7&lt;sup&gt;a&lt;/sup&gt;</td>
<td>155&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>21.73</td>
<td>197.67</td>
<td>30.64&lt;sup&gt;a&lt;/sup&gt;</td>
<td>475&lt;sup&gt;a&lt;/sup&gt;</td>
<td>238.70</td>
</tr>
<tr>
<td>Butazua</td>
<td>217.5</td>
<td>6&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>121&lt;sup&gt;d&lt;/sup&gt;</td>
<td>18.77</td>
<td>140.93</td>
<td>17.05&lt;sup&gt;c&lt;/sup&gt;</td>
<td>498&lt;sup&gt;b&lt;/sup&gt;</td>
<td>428.96</td>
</tr>
<tr>
<td>Poyo</td>
<td>222.5</td>
<td>6&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>130&lt;sup&gt;c&lt;/sup&gt;</td>
<td>20.00</td>
<td>151.40</td>
<td>19.68&lt;sup&gt;cd&lt;/sup&gt;</td>
<td>463&lt;sup&gt;a&lt;/sup&gt;</td>
<td>275.52</td>
</tr>
<tr>
<td>J/Cavendish</td>
<td>218.5</td>
<td>8&lt;sup&gt;a&lt;/sup&gt;</td>
<td>120&lt;sup&gt;d&lt;/sup&gt;</td>
<td>21.11</td>
<td>185.57</td>
<td>22.27&lt;sup&gt;bcd&lt;/sup&gt;</td>
<td>496&lt;sup&gt;b&lt;/sup&gt;</td>
<td>311.78</td>
</tr>
<tr>
<td>D/Cavendish</td>
<td>90</td>
<td>5&lt;sup&gt;b&lt;/sup&gt;</td>
<td>156&lt;sup&gt;c&lt;/sup&gt;</td>
<td>19.1</td>
<td>160.47</td>
<td>25.03&lt;sup&gt;bde&lt;/sup&gt;</td>
<td>520&lt;sup&gt;a&lt;/sup&gt;</td>
<td>350.42</td>
</tr>
<tr>
<td>Local</td>
<td>298</td>
<td>2&lt;sup&gt;c&lt;/sup&gt;</td>
<td>74.7&lt;sup&gt;e&lt;/sup&gt;</td>
<td>11.93</td>
<td>103.00</td>
<td>7.69&lt;sup&gt;e&lt;/sup&gt;</td>
<td>518&lt;sup&gt;b&lt;/sup&gt;</td>
<td>107.71</td>
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<tr>
<td>Mean</td>
<td>204.3</td>
<td>5.3</td>
<td>129</td>
<td>19.3</td>
<td>160.64</td>
<td>21.30</td>
<td>131.5</td>
<td>298.22</td>
</tr>
<tr>
<td>LSD</td>
<td>11.96</td>
<td>3.35</td>
<td>7.63</td>
<td>2.2</td>
<td>21.6</td>
<td>6.37</td>
<td>13.44</td>
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</tbody>
</table>

Farmer's perception
Farmers were also participated in evaluation of the varieties using their own criteria like number of suckers per plant, number of fruits per bunch, fruit size, days to maturity and total yield per plant. Farmers preference were towards those varieties with more number of suckers per plant, large number of fruits per bunch, larger fruit size, early in maturing, medium height and strong stem that tolerate falling during fruit bearing and with higher total yield. Therefore farmers gave rank for the selected criteria from 1-8. Finally the overall average rank were computed for all the 8 varieties including local as indicated in table 2.

<table>
<thead>
<tr>
<th>Varieties</th>
<th>Plant Height</th>
<th>Fruit length</th>
<th>Stem Strength</th>
<th>Sucker/ plant</th>
<th>Fruit/ bunch</th>
<th>Earliness</th>
<th>Taste</th>
<th>Average</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Williams-1</td>
<td>7</td>
<td>6</td>
<td>5</td>
<td>7</td>
<td>6</td>
<td>7</td>
<td>5</td>
<td>6.2</td>
<td>7</td>
</tr>
<tr>
<td>Grand nain</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>5</td>
<td>3</td>
<td>2</td>
<td>2.0</td>
<td>2</td>
</tr>
<tr>
<td>Robusta</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>1.8</td>
<td>1</td>
</tr>
<tr>
<td>Butazua</td>
<td>4</td>
<td>7</td>
<td>4</td>
<td>5</td>
<td>7</td>
<td>2</td>
<td>1</td>
<td>5.4</td>
<td>5</td>
</tr>
<tr>
<td>Poyo</td>
<td>6</td>
<td>5</td>
<td>8</td>
<td>4</td>
<td>4</td>
<td>1</td>
<td>4</td>
<td>5.4</td>
<td>6</td>
</tr>
<tr>
<td>J/Cavandish</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>5</td>
<td>4</td>
<td>8</td>
<td>3.0</td>
<td>3</td>
</tr>
<tr>
<td>Dwarf cava</td>
<td>5</td>
<td>4</td>
<td>6</td>
<td>6</td>
<td>1</td>
<td>8</td>
<td>7</td>
<td>4.4</td>
<td>4</td>
</tr>
<tr>
<td>Local</td>
<td>8</td>
<td>8</td>
<td>7</td>
<td>8</td>
<td>8</td>
<td>6</td>
<td>6</td>
<td>7.8</td>
<td>8</td>
</tr>
</tbody>
</table>

Almost all farmers perceived that all the varieties introduced to the area are better than local. The top most three varieties selected by farmers were Robusta, Grand nain and Jiant Cavandish respectively. The opinion of farmers, DA’s and experts were collected on the improved varieties. Finally it was concluded that all the improved varieties are better than local. Therefore, due to shortage of planting material it was recommended that all the varieties should be multiplied and promoted to the farmers in the study area.

**Technology promotion**

To accelerate the promotion process, farmers to farmers’ seedling distribution, 60 seedling producer farmers having 12 female members were selected from the four kebeles and trained on banana production management for one day. Due to shortage of planting material only 23 from (15 Dello Mena and 8 from Barbare district) received the suckers during 2012/13. A total of 161 seedlings were distributed to the farmers during this period. In the year 2013/14, about 210 seedlings were distributed to the remaining 30 farmers in the two districts. Moreover over 400 seedlings were also distributed informally from farmer to farmer distribution system. Supervision and follow up were made to see whether the farmers planted and managed their banana according to the recommendation. Those farmers who properly managed their banana farm through timely irrigation, the use of compost and hoeing were more benefited than others. Finally the feedback were collected from the farmer. As a result farmers indicated that all improved banana varieties introduced to the area are well adapted and have better potential over local cultivar. They also indicated that shortage of land for multiplication and absence of organization for planting material and absence of irrigation facilities at Dello Menna research sub-site were the major problems for the expansion of banana in the study district.

**Exit Strategy**

Training were given to 60 farmers, 12 DAs and 8 experts from Dello Menna and Barbare districts on Banana sucker multiplication techniques, production and management, post-harvest handling and marketing. Finally the activities started on the FTC and farmers field were handover to the agricultural development offices of the respective districts.

**Conclusions and Recommendations**
Conclusions

The analysis result showed that there is significant difference among the varieties. All improved banana varieties introduced to the area were well adapted and have better potential over local cultivar in parameters like number of suckers per plant, number of fruits per bunch, fruit size, earliness and total yield per plant. The varieties Robusta, Grand nain and Giant cavandish were ranked by farmer from 1-3 respectively. According to the sampled farmers, production and productivity of banana can be enhanced by management practices particularly time of irrigation, the use of compost and hoeing frequency. It was clearly understood that multiplication and promotion of banana is very easy where there is irrigation facility but given less priority due to absence of high yielding improved varieties. Shortage of land for multiplication of planting material, absence of irrigation facilities at research sub-sites, absence of organization that produce and distribute the selected varieties were the major challenges that hinder multiplication and distribution process.

Recommendations

Based on the result the following recommendations are given.

- All the banana varieties introduced to the area are better than that of local. Therefore all of them have to be multiplied and distributed to the farmers in the area.
- Demand for improved banana varieties is beyond the capacity of research, therefore multiplication of planting materials need collaboration of different stakeholders such as District Agriculture Development Offices, Irrigation Authority, Research Institutions, NGOs, Farmers and others.
- Establishing new farmers group and strengthening the capacity of the existing ones on multiplication and distribution of banana planting materials as well as production of banana fruits for market is vital.
- Provision of training crop management practices such as time of irrigation, the use of compost and hoeing frequency and organizing exchange visit and field days would help to improve production and productivity of banana.
- Improving irrigation facilities in the FTCs and research sub sites is crucial to enhance seedling multiplication.

References


Multiplication, Evaluation & Promotion of Improved Pepper Varieties to Dello Menna District of Bale

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Abstract

The study aimed to multiply, evaluate and promote improved pepper varieties to farmers in Dello Menna district of Bale zone. Two kebeles, Chiri and Erba, with better pepper production potential were purposively selected from Dello Menna district with the help of Woreda agricultural development office. Eighteen active and interested farmers were selected from each kebele and participated in the evaluation, training and promotion process. Seed of four improved varieties of Pepper were given to the selected farmers and evaluated by the farmers themselves. Agronomic data were also collected from the varieties and analyzed using SAS statistical software. According to farmers' preference as well as statistical analysis result, Mareko Fana and Malka Eshet varieties were selected for their better red pod and green pod production respectively. During second year training were given to 44 farmers, 12 DAs and 8 experts from Dello Menna districts on pepper production, management, post-harvest handling and seed production techniques. Finally a total of 8500 seedlings were distributed to the 44 farmers through farmer to farmer seedling distribution. The activity were finally handover to district agricultural development office for further scaling up.

Key words: improved variety, evaluation, multiplication and promotion

Introduction

Vegetables are high potential crops both in terms of productivity and value. They are very important sources of food to country like Ethiopia where population experiences malnutrition due to heavy dependence on cereal crops. Vegetables like hot pepper and onion are used for flavoring local dishes. This indicates that a considerable population of Ethiopian drives their livelihood from growing vegetables (Lemma, 2003). According to CSA (2012) report, Pepper (hot and green) is the major vegetable crop produced in Ethiopia both in area coverage (115776ha) and in annual production (3,052,209 Quintals). It is the most important vegetable crop in Ethiopia. Hot pepper is used in daily meal for flavoring local dishes in the country (Fikadu, 2006). It is rich in vitamin even more than tomatoes, especially in Vitamin A and C (Rai and Yadav, 2005). It is also good source of B-Carotene.

Pepper is the major vegetable crops produced in Bale zone. Over 37,000 households in Bale zone are engaged in pepper production (CSA, 2012). It is widely produced in Agarfa, Gololcha, Sinana, Barbare and Dello Menna districts of Bale zone. However its production and productivity is low. Among the factors contributing to the low production and productivity is lack of improved varieties that are high yielding and tolerant to disease with wide adaptability. To alleviate this, about four varieties pepper varieties were introduced from Melkasa Agricultural research center and tested for adaptability at Dello district of Bale zone. Consecutively, two well adapted varieties were selected and multiplied at the chiri FTC, Dello-Menna. A total of 8500 seedlings were distributed to the target farmers with the objective of promoting improved hot pepper varieties for improved production and productivity.
Objective

To multiply and promote improved pepper varieties to Dello Menna district of Bale Zone.

Methodology

Study district

Dallo Mena is located in Bale zone. The capital of Dallo Menna is located at 555km and 125km from Addis Ababa and Robe respectively. The mean annual temperature of the Dallo Mena district is 29.5°C. The lowest temperature is 21°C and highest is 38°C respectively. The mean annual rainfall is 701.5 mm whereas the lowest and highest rainfall is 628mm and 775mm respectively. Welmele, Yadot and Dumal rivers are the major sources of irrigation. Area under irrigation increasing from time to time. Maize, teff, sesame, haricot bean, coffee, vegetables (pepper, onion and tomato) fruits, and spices are the major crops grown in the district (BZFEDO, 2008).

Site and farmer Selection

Dello Menna district were purposively selected for its irrigation as well as pepper production potential. Two PA’s (Chiri and Erba) with better pepper production were purposively selected from the district with the help of Woreda agricultural development office. Eighteen active and interested farmers were selected from each kebeles with the help of development agents and agricultural experts. Training were given to the farmers on pepper seed production and management practices. Six trial hosting farmers were selected by the farmers.

Research design

Four improved pepper varieties were used in the study. The trial were planted on six trial farmers on 2mx2m plot size each as single plot design and farmers as replication. All management practice were made according to the recommendation.

Data collection

- Farmer perception on the improved varieties were assessed using their own criteria.
- Identification and prioritization of problems through discussion with farmers
- Agronomic data such as plant height, branches per plant, pods per plant, pod length and total yield per plant were also collected

Data analysis

Simple descriptive statistical analysis was used to analyze farmers’ opinion about improved varieties. Agronomic data were analyzed using SAS statistical software.

Results and discussions

Agronomic Performance

Agronomic data such as plant height, branches per plant, pods per plant, pod length and total yield were collected and analyzed using SAS statistical software. Based on the result obtained there is significant different among the treatment at 5% significant level in all parameters except plant height. Green pod yield of Melka Eshet is significantly higher than all the rest varieties. Final yield (red pods) is significantly higher for Mareko Fana followed by Malka eshet. But there is no significant difference between the other two varieties.
Table 1. Summary of pepper adaptation trial in Dallo Menna.

<table>
<thead>
<tr>
<th>Treatments (varieties)</th>
<th>Plant ht (cm)</th>
<th>1st branches per plant</th>
<th>Pods/plant</th>
<th>Pod length</th>
<th>Green pods (kg/ha)</th>
<th>Red Pods (kg/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mareko Fana</td>
<td>89.5</td>
<td>5.42</td>
<td>18.08</td>
<td>10.06</td>
<td>2968.7</td>
<td>1400.5</td>
</tr>
<tr>
<td>Melka Eshet</td>
<td>70.42</td>
<td>2.92</td>
<td>24.00</td>
<td>10.91</td>
<td>4244.3</td>
<td>1175.8</td>
</tr>
<tr>
<td>Melka Zala</td>
<td>87.08</td>
<td>8.17</td>
<td>21.75</td>
<td>9.03</td>
<td>3039.7</td>
<td>1051.6</td>
</tr>
<tr>
<td>M/Awaze</td>
<td>78.92</td>
<td>6.83</td>
<td>19.79</td>
<td>8.95</td>
<td>2757.8</td>
<td>906.1</td>
</tr>
<tr>
<td>Mean</td>
<td>81.48</td>
<td>5.83</td>
<td>20.91</td>
<td>9.74</td>
<td>3252.6</td>
<td>1133.49</td>
</tr>
<tr>
<td>LSD</td>
<td>NS</td>
<td>2.69</td>
<td>2.00</td>
<td>1.40</td>
<td>964.41</td>
<td>283.43</td>
</tr>
<tr>
<td>C.v. (%)</td>
<td>9.52</td>
<td>23.11</td>
<td>4.8</td>
<td>7.22</td>
<td>14.84</td>
<td>12.52</td>
</tr>
</tbody>
</table>

Farmers' Preference

The experiment was evaluated by 18 farmers selected from the study area. Farmers first set their own criteria for selection such as plant height, branches per plant, pods per plant, pod length, total yield and pod color and gave rank (1-4) for each criteria. Finally the average result was computed and changed to rank. According to farmers' preference, Mareko Fana and Malka Eshet were selected for their better red pod and green pod production respectively.

Table 2. Summary of farmers’ perception about the varieties

<table>
<thead>
<tr>
<th>No</th>
<th>Varieties</th>
<th>Plant height (cm)</th>
<th>No of pods/plant</th>
<th>Pod length (cm)</th>
<th>Green pods (kg/ha)</th>
<th>Red pods (kg/ha)</th>
<th>Pod colour</th>
<th>Average</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Mareko Fana</td>
<td>1</td>
<td>4</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>2.00</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>Melka Eshet</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>1.67</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>Melka Zala</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>2.50</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>M/Awaze</td>
<td>4</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>3.83</td>
<td>4</td>
</tr>
</tbody>
</table>

Promotion of the selected varieties

During 2013/14, the two selected varieties namely: Malka Eshet and Mareko Fana were used in promotion activity. Each trial farmers were linked to three farmers so that the seed multiplied on the trial farmers were distributed to the eighteen farmers in the group. Moreover, due to shortage of improved seed, seedlings of both varieties were raised on two seed beds having 1mx10m area each and a total of 8500 seedlings were distributed to other 20 none participating farmers in the selected kebeles. Totally 38 farmers were addressed by the promotion process. According to the feedback collected from the farmers, limited number of improved varieties, unavailability of basic seed, shortage of seed multiplication site, disease (wilt) and insect (cut worm) problem and wild animal damage were the major challenges faced by farmers during production.

Training

Training were given to 38 farmers, 4 DAs and 2 experts from Dello Menna districts on pepper production, management, post-harvest handling and seed production techniques, to speed up farmers to farmers technology dissemination. Finally the activities started on the FTC and farmers field were handover to district agricultural development offices.
Conclusions and Recommendations

Conclusions

Hot Pepper is one of the important horticultural crops in the study area. Agro-ecology and irrigation potential of Dello Menna and Berbare districts are suitable for pepper production. Among four varieties demonstrated to the farmers Mareko Fana and Melka Eshet were performed better than the others. According to the analysis result and farmers’ preference, Mareko Fana and Malka Eshet were selected for their better red pod and green pod production respectively. Green pod yield of Melka Eshet is significantly higher than all the rest varieties. Final yield (red pods) is significantly higher for Mareko Fana followed by Malka Eshet. Consecutively, the selected varieties: Melka Eshet and Mareko Fana were multiplied on trial farmers’ field as well as on sub site and distributed to 38 farmers. Training were given to 38 farmers, 4 DAs and 2 experts from Dello Menna districts on pepper production, management, post-harvest handling and seed production techniques, to speed up farmers to farmers technology dissemination. According to the feedback from the farmers, unavailability of basic seed, shortage of seed multiplication site, disease (wilt) and insect (cut worm) problem and wild animal damage were the major challenges they faced during production.

Recommendations

Based on the results the following recommendations are given

Access of farmers to seed should be improved through strengthening irrigation facilities of research sites and FTCs. Moreover small farmers’ producer group should be established and/or the existing should be strengthened. On the other hand, breeders, pathologists and entomologists should give due emphasis for the development of high yielding pepper varieties, identification and control of the disease and insect pest respectively. Collaboration of different stakeholders working in the study area is vital for the sustainable production.

References


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Participatory Promotion of improved Pulse crops Technologies in Bale highlands
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Abstract
Participatory pulse crops technology promotion was carried out at Sinana, Goba, Agarfa, Gasera and Goro districts of Bale zone in Oromia region for two consecutive years in both Gena and Bona seasons of 2012-2013/14. Major pulse crops used in this technology promotion were; Faba bean, Field pea, Lentil and chickpea. For successful completion of the project, relevant stakeholders identification, awareness creation through organizing workshop and participatory training and organizing farmers in research groups (FRGs) were done. The involved stakeholders were ICARDA, SARC, Farm Africa, District offices of agriculture and Farmers. ICARDA supported in provision of grant for the implementation of the activities. Sinana Agricultural research center (SARC), Farm Africa and woreda agricultural office took over the responsibility of organizing farmers in group, provision of training and seed distribution. Consecutively, basic seeds of Faba bean, Field pea, Lentil and chickpea (62.12qt, 41.75qt, 2.9qt and 18.76qt) respectively were distributed for those selected districts. A total of 752 farmers and 45 experts were also trained. Extension events, such as mini-field days were organized at each respective site in which different stakeholders were participated and experiences were shared. Finally, in this pre-scaling activity revolving seed system was used in which each farmer refund the amount of seeds collected in the previous year and re-distributed for other farmers in the next season. In general, the on farm participatory technology demonstration, evaluation and transfer with well-organized farmers groups working together with research and extension has proved a valuable interactive approach for quick technology evaluation and dissemination. Hence, research and extension activities need to capitalize on farmers’ group approach as it ensure an appropriate coverage of local socioeconomic situations, offers reflective learning environment for all actors involved and helps to exert influence to reach out more farmers sharing similar experiences and create strong demand pull on institutions to make most preferred technologies accessible. Hence, in this participatory pulse crop technology promotion a total of 752 farmers and 45 experts were participated in different extension events and training organized. Moreover, basic seeds of Faba bean, Field pea, Lentil and chickpea (62.12qt, 41.75qt, 2.9qt and 18.76qt) respectively distributed for those selected districts. Finally, in this pre-scaling activity, revolving seed system was used in which each farmer’s were refunded amount of seeds they collected in the previous year and re-distributed for others in the next season.

Key words: Technology promotion and revolving seed system, farmers’ research groups

Introduction
Agriculture and rural development programs sometimes reach only a limited number of people, have a minimal impact on poverty, and are difficult to sustain over the long term. Better identification of participants that have demonstrated economic, social and environmental benefits at the community level, together with policies and programs that support the spread of these practices, stand to benefit rural people, economies and environment (SARD Policy Brief 2007). Such practice and operational frameworks won’t happen by themselves until a purposeful partnership is built and sustained at the grass root level. As part of the general trend towards involving the target group more in development and research activities, participatory approaches are being used more frequently.

Participatory technology development has been advocated as the only research and development process applicable to resource poor, marginal and complex farming system such as those found in semi-arid area of sub-Saharan Africa. Empowerment of the participants, increased confidence of farmers and local people in their own knowledge, improved capacity and client to innovate and
experiment, and an enhanced ability to cope with change are often claimed to be achievable using participatory methods than through traditional technology transfer (Mellis et al. 1999). The past two decades have seen an increased recognition of the importance of participation by beneficiaries and a wide range of stakeholders in decision-making. This has led to the development of various participatory approaches, tools and methods that facilitate innovation development and application in divers’ contexts. Experience has shown that participation improves quality, effectiveness and sustainability of development actions. Various participatory extension techniques have been used in planning, implementation and evaluation of projects (Anandajayasekeram et al. 2008).

Researchers and extension workers working with properly selected groups of farmers on the dominant expressions/techniques of participation. Group approach provides multiple advantage viz., coverage whereby divers circumstances are modestly represented, learning environment for both outsiders and insiders, and influence it exerts on many other copy farmers. In fact, multidisciplinary research team based participatory research and extension activity with farmers is, basically, a requisite while working with our farmers who mainly operate in a complex environment facing variety of constraints at a time. This paper presents the experience of pulse crops where Farmers Research Groups (FRG) approach is being utilized on the one hand, to jointly promote pulse crops technologies in the highlands of Bale zone, and on the other, as a learning ground where the social capital is built through developing and nurturing farmers’ capacities to innovate the experiment.

Leguminous crops are good fixers of N\textsubscript{2}. Experiments conducted in Arsi and Bale highlands gave substantial amount of atmospheric N\textsubscript{2} fixed by faba bean. Faba bean precursor crop increased soil NO\textsubscript{3} and NH\textsubscript{4}. Green manure cropping system has a multiple benefits: provision of ground cover to reduce erosion, and a "break" crop effect to reduce weed population and disease cycles for the subsequent cereal crops. The N\textsubscript{2} benefits to crops grown after grain legumes was due to a lower uptakes of soil N\textsubscript{2} by legumes relative to cereals and a carry-over of N\textsubscript{2} from the legume residue, both factors leading to a greater uptake of soil N\textsubscript{2} by subsequent crops (Genene et al. 2001). Pulse crops, an essential part of the dietary requirement for most Ethiopians, are grown mostly by private peasant holdings under rainfed conditions. They contribute about 8% to total daily calorie intake of the Ethiopian diet against 63% of cereals and about 17% of potatoes and other tubers. On the other hand, the animal products contribute only 1.9% of the total daily calorie intake. In developed countries, the contribution of cereals to the daily calorie intake is 20% while that of the pulses and nuts is about 2.3% against 29.1% of animal products (FAO, 1996). Moreover, pulse crop plays important role in soil fertility restoration and controlling disease epidemics to the area as a suitable rotation and break crop where cereal mono cropping is dominant at areas such as Bale and Arsi highlands.

In Bale highlands, monoculture of wheat or barley is the dominant practice. This rotation system cereal after cereal can result in: Reduction, particularly where soil fertility and weed control practices are sub-optimal and soil borne diseases are common, often common incidence of persistent pests (diseases, rusts on wheat, weeds and insect pests). The current cereal monoculture practiced in the cereal-based cropping systems put sustainable crop production system of the area at risk. It may, result in serious agricultural problems, like pathogen infestation and total crop loss unless corrective measures are taken (Amanuel 2001). Monoculture practices are enhanced yellow rust and stem rust diseases, which are the most important constraint to wheat production and prevailing from season to season in Bale highlands. These diseases epidemics are always severe in the meher season than belg season. Crop losses due to wheat rusts are not limited to Ethiopia but are widespread over the world. As a result of yellow rust infestation, grain yield loss of 50.7-52.5% (av. 52%) and 18.8-20.8% (av. 20%) was registered on susceptible Dashen and ET-13A, respectively. The levels of grain yield loss for local cultivator that is highly susceptible to stem rust and less susceptible to yellow rust ranged from 38.3-54.6% with average of 47%. Farmers consider continuous cereal cropping as a potential threat to sustainable crop production (Bekele H., 2000).

The small farm sizes limit crop rotation opportunities, which provide optimum conditions for the buildup of high populations of soil borne pests and diseases. Growing of crops in Monoculture stands may also increase the incidence of pest and disease damage. (ICRA, 2001). Effort has been made by National and Regional Agricultural Research institutes to develop new technologies of pulse crops in
the country. However, the newly released variety of those pulse crops is not well popularized and
scaled up for those end users. The activity was carried out in for two years (2012-2013); in which both
Gena and Bona seasons were used. In executing the activity two FRGs per district were established in
five districts. Therefore, in this project valuable effort were made by different stakeholders’ to scale
up major pulse crop technologies in the highlands of Bale zone with the following specific objectives.

Objectives

- To Promote improved Pulse crops technologies to highlands of Bale zone
- To improve farmers’ knowledge and skill of pulse crop production and management through
  training
- To enhance and strengthen informal quality seed production and exchange system.
- To strengthen the linkage and collaboration of relevant stakeholders in promotion of crop
diversification.

Research Methodology

Stakeholder linkage

Technology scaling up was conducted at five potential districts of Bale zone (Sinana, Agarfa,
Gassera, Goba and Goro). In order to make pulse crop technology scaling activity more effective
different level of awareness creation and stakeholder linkage strengthen was undertaken. So that, the
entry point for this pulse crop technology promotion activity were organizing inception workshop at
zonal level in which different relevant stakeholders from regional and national research centers and
respective districts extension officers and zonal agricultural office expertise were participated. As a
result in the first phase of project implementation, inception workshop was organized at zonal level in
which different relevant stakeholders were participated like: Zonal and woreda agricultural expertise,
scientists form ICARDA, Farm Africa and researchers form SARC. In this inception workshop over
all objectives of the project was introduce for participants and role and responsibility of all
stakeholders were identified and agreed up on its implementation.

In this pulse crop technology promotion activity, the promotion activity was focused on four major
pulse crops namely: Field pea, Faba bean, chickepea and Lentil. The required seeds were funded by
ICARDA projects. Sinana Agricultural Research Center and Farm Africa took over the responsibility
of farmers’ selection, organizing farmers in groups, training them and seed distribution. In each
district 2-3 representative kebeles’ were selected and improved seeds of indicated pulse crops were
distributed for selected farmers.

The activity was carried out for two years (2012-2013), in both Boon and Gena seasons. The two
seasons were used for technology promotion since Bale zone is known by its bimodal rainfall.
Moreover for ensuring seed availability the activity was implemented with an agreement of revolving
seed system approach among farmers in which distributed seeds were collected and re-distributed for
an addressed farmers’ in the next season.

In the 2nd phase of project implementation theoretical training was also organized for Development
Agents and SMS on the overall objectives of the project, production and management of pulse crops
and their role in improving the income of farming communities and how to select hosting farmers and
organize farmers research group for facilitation of pulse crop technology dissemination. Therefore,
appropriate site and hosting farmers were selected with active participation of development of the area
and kebele administrative. Participatory training on pulse crop production techniques and agronomic
practices where organized for selected farmers, development agents and subject matter specialist at all
sites.
Organizing Farmers Research Groups (FRGs)

In the execution of activity, participatory extension approaches were used. For the successful implementation of the project though the involvement of farmers and other stakeholders is crucial, establishing of FGR was the principal point for the success of the project. Among participatory extension approach establishment of farmers research groups were one of the approach used to facilitate the promotion of pulse crop technologies. As a result, about ten FRG (two per district) were organized based up on the principles of farmers’ research group guideline. Besides organizing the groups, technical training on pulse crop production and principles of team approach was given for the members.

Data collection

The following data were collected

- Amounts of seed distributed and produced
- Number of farmers participated in training, field visit and mini-field days
- Farmers, development agents and expertise perceptions on the role of pulse crop in improving farmers income and cereal mono-cropping.

Data Analysis

The collected data was analyzed using SPSS (descriptive statistics were used to analysis the data).

Results and discussions

Training

Prior to the commencement of the activity theoretical training on pulse crops production packages, on the important production constraints on faba bean, field pea, lentil and chick pea and their control options have been given for SMS, Developmental Agents and zonal cooperative Agency in order to capacitate their knowledge in pulse crop production system.

Furthermore, theoretical oriented training on pulse crops production packages, on the important production constraints on faba bean, field pea, lentil and chick pea and their control options have been given for purposefully selected representative farmers of the study area. This training was organized with active collaboration of development agents of the area Farm Africa and multidisciplinary team of researcher joined from Sinana Agricultural Research Center.

Table 1: Number of farmers participated on 1st round training across selected districts

<table>
<thead>
<tr>
<th>No</th>
<th>District</th>
<th>Kebele</th>
<th>Farmers Male</th>
<th>Female</th>
<th>Das Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sinana</td>
<td>Gamora</td>
<td>30</td>
<td>6</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Selka</td>
<td>16</td>
<td>9</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>Goba</td>
<td>Alloshe</td>
<td>31</td>
<td>7</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sinja</td>
<td>29</td>
<td>11</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>Agarfa</td>
<td>Ilani</td>
<td>42</td>
<td>8</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>Gassera</td>
<td>Nake</td>
<td>38</td>
<td>12</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ballo</td>
<td>49</td>
<td>6</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>Goro</td>
<td>Dayyu</td>
<td>186</td>
<td>48</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Chefaman</td>
<td>193</td>
<td>31</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>Total</strong></td>
<td>614</td>
<td><strong>19</strong></td>
<td><strong>6</strong></td>
</tr>
</tbody>
</table>
Table 2. Number of farmers and DAs participated on 2nd round participatory training

<table>
<thead>
<tr>
<th>No</th>
<th>District</th>
<th>Kebele</th>
<th>Farmers</th>
<th>DA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Male</td>
<td>Female</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Male</td>
<td>Female</td>
</tr>
<tr>
<td>1</td>
<td>Goba</td>
<td>Sinja</td>
<td>40</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Alloshe</td>
<td>38</td>
<td>11</td>
</tr>
<tr>
<td>2</td>
<td>Sinana</td>
<td>Selka</td>
<td>25</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Gamora</td>
<td>36</td>
<td>12</td>
</tr>
<tr>
<td>3</td>
<td>Agarfa</td>
<td>Illanii</td>
<td>50</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>Gassera</td>
<td>Ballo-</td>
<td>55</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Amigna</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Nake</td>
<td>50</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Nagawo</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dayyu</td>
<td>234</td>
<td>52</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Chefa-</td>
<td>65</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>mana</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>593</td>
<td>147</td>
</tr>
</tbody>
</table>

Basic seed distribution

Following the identification of the best varieties by the respective FRG farmers and the awareness and interest created on the varieties among the surrounding farmers as a result of extension events (such as field days), arrangement was made to produce the seed on farmers’ field thereby improve access to the technology by surrounding farmers.

To respond to the demand created for the best performing varieties, farmer based seed production activity was launched in the same season. Participatory trainings were organized on quality seed production and management for those members and non members of farmers’ research groups and development agents of some selected districts. During participatory training and group discussions farmers and extension workers expressed that, pulse crops production in the area was constrained by use of poor quality seeds, little or no use of fertilizers, no weeding due to less attention given to the production of pulse crops do to cereal mono cropping system and low market price. In addition, lack of awareness on improved management practices and new technologies available on pulse crop production was also mentioned.

Farmers’ organization and seeds distribution was undertaken by active collaboration of Sinana agricultural research center and Farm Africa. So that, the seeds was distributed for end users in both Bona and Gena seasons. Including those non FRG members, a total of 251 farmers were addressed by this seed distribution channel in each site were provided with initial seeds as revolving seed on those four major pulse crops, i.e. (29 farmers on faba bean, 103 farmers on field pea, 36 farmers on lentil and 83 fanners on chickpea) were address in the seed distribution system. Therefore, in this major pulse crops seed distribution system there were a total of 125.53qt of pulse crops (62.12qt of Faba bean, 41.75qt of Field pea, 2.9qt of Lentil and 18.76qt of Chickpea) were distributed for selected farmers in the first year of 2012/2013 Bona season (table 3).

Monitoring and Evaluation

Monitoring and evaluation is fundamental to analyses the whole agricultural research and any development approach, especially to describe, analyses and understand what sets of technologies are selected by farmers of the area, why they were selected, how the technologies were adapted and what the characteristics of farmers in the interest groups are. This information is essential for better understanding how to enhance the adaptation and integration of promising institutional and technological innovations by smallholder farmers in that target area and in others areas. This process should also ensure that interactions take place between institutional and technological work when...
needed. Therefore, a group of researchers were selected from pulse and oil crops case team and agricultural Research Extension team of Sinana Agricultural Research Centre to visit and evaluate the field performance of distributed seeds of those improved pulse crops namely (Faba bean, Field pea, chickpea and lentil varieties). As a result, the group of researcher and expertise were visited some of the accessible farmers filed in each district.

Field visit and evaluation were conducted at different crop stage with active participation of researchers, DAs, districts agricultural experts and gust from funding organization. In addition, during the evaluation meeting, farmers also showed special interest to produce pulse crops and understood the importance of pulse crop in alleviating cereal mono cropping system of bale highlands. During field visit farmers of Goro district Dayu Abargada kebele reported that, chickpea variety called Harbu was affected by disease. Based on farmers report we also visited some of the Helds and observed on the verity such a wilting nature before maturity date.

Extension Events

In an attempt to provide for interaction between FRG and non FRG farmers thereby create wider interest and awareness on the varieties, field days, attended by respective stakeholders (zonal and woreda agricultural office, development agents, funding organization, Farm Africa and multidisciplinary team of researchers from Sinana Agricultural Research Center and surrounding farmers in each trail sites, were organized and actively participated. Phase I of Gana 2012 Season, mini-field days was organized at Sinana (Gmora PA) & Goro district to demonstrate improved varieties of lentil, chickpea, faba bean and field pea. On this mini-field day about 52 farmers, 6 DA, and 2 experts were participated.In 2012 Bona season mini field days were also organized at Agarfa district on field pea, faba bean and lentil crops demonstration and model farmers experience sharing. In this mini-field days, about 46 farmers, 3 DA and 2 SMS were participated. On the occasion, model farmers were shared their best experience on grass weeds management and the role of crops rotation for the sustainable crop production and productivity where cereal mono cropping issue was the bottleneck of crop production in bale highlands.

Similarly in 2012 of Bona season, mini field days were organized at Goro district (Dayu-Abargada and Caffaa Amana kebele) to demonstrate model farmers field of chickpea, Lentil, field pea and Faba Bean in which a total of 42 farmers, 6 DAs and 2 SMS were participated and on spot free discussion were conducted with experts and researchers on major production constraints of pulse crops in the area and farmers indigenous knowledge and best experience were shared. In 2013 Bona season, field days was organized at Goro and Ginnir districts demonstrate and popularize those improved chickpea and lentil varieties in which about 46 farmers and 6 DA, and 4 experts were participated. Similarly, mini-field day and demonstration was also organized at Agarfa district of Illani peasant association on Faba bean. In this extension event farmers of the area, development agents, district agricultural office expertise and groups of researchers were participated. Here, on the participatory field visit and demonstration of faba bean, awareness were created on the role of pulse crops production in improving soil fertility, reducing grass weeds and soil born disease.

In general, on spot training and awareness creation about the threat of cereal mono cropping in bale highlands and specific to their locality in particular, purpose of pulse crop production in alleviating mono cropping problem and its role in sustaining production and productivity of crop production. Moreover, such opportunities can create a chance for farmers to forward their production constraints and seek a solution from experts and it’s a two way communication style in which both parts were learned from each other on field through group discussion and field observation, by doing so farmers can search further information on the available technologies for pulse crop production. During filed visit participant farmers were raised different questions like; availability of fungicides for aphids, timely distribution of seeds and importunacy of training on pulse crop production and management. Moreover, the visit created an opportunities for farmers to exchange their experiences and learn from each other and ask expertise and researchers what they are not clear with it.
Meanwhile, the discussion also gave a chance for researchers to identify researchable topics and question to be answered by management team. During field visit feedback and farmers assessment were also collected through group discussion and personal interviews, accordingly, farmers of the area were very impressed by the performance of those improved pulse crop varieties distributed. During group discussion, farmers indicated that, most of the pulse crops varieties distributed to them performed well in all area as compared to local varieties. The varieties were superior by their yielding potential, their reaction to diseases and adaptability of the area. Some of the point raised during group discussion and field visit was; how to preserve their own seed and share and exchange locally the seeds of improved pulse crops.

Bale highland is known by its cereal mono cropping (wheat after wheat, barley after barley or wheat after Barley). Such types of cropping system become bring irreversible crop loss through intensification of grass weeds, inoculation of diseases and degradation of soil fertility. During group discussion after field visit participant farmers of the day raised about the severity of mono cropping system in the area and as a solution they discussed and convinced on crop rotation and hand weeding, moreover some of them also indicated that they already stated to practice such cropping system in order to reduce the impacts of mono cropping. Similarly, on the occasion expertise and researchers were provide a pieces of advice for the participant farmers on the importance of pulse crops, such as improving soil fertility, how it can reduce the intensity of grass weed infestation and disease inoculation, the role of pulse crop in generating cash for family welfare and improving also their food diet and nutritional contents. In addition to expertise and researchers advice there was a great achievement from the gathering in exchanging their long life indigenous knowledge and best practices on pulse crop production and management.

During group discussion after filed visit, almost all participant farmers agreed to multiply those pulse crops in the next Gena and Bona seasons on their field and also agreed to provide seeds of those pulse crops for their neighbor through local seed exchanges system. Similarly experts and researchers agreed up on to work together closely to overcome the threat of mono cropping system in Bale highlands in active cooperation with relevant stakeholders like ICARDA and Farm Africa by supplying of improved seeds, training and advice farmers of the area on crop diversification and also support them in providing available information on how to access farm inputs and market information. Finally, for the sustainability of the promotion of pulse crops technologies informal seed exchange approaches were established among farmers’ research groups and participant farmers of the study area understood the role of pulse crop production in improving soil fertility and reducing the impacts of cereal mono-cropping in their farming system.

**Conclusions and recommendations**

**Conclusions**

Participatory pulse crops technology promotion was carried out at five districts of Bale zone for consecutive two year with active collaborative different stakeholders. The activity was focused on four major pulse crops namely: Faba bean, Field pea, Lentil and chickpea. In the implementation of the activities stakeholders’ identification, awareness creation through organizing workshop and participatory training and organizing farmers’ in research groups (FRGs) were some of the approach used.

Some of the key actors in the implementation of the project were, ICARDA, SARC, Farm Africa, District offices of agriculture and Farmers. ICARDA played a great role in financing the overall activities the project whereas the rest actors were contribute in implementing the activities on the ground. Therefore basic seeds of Faba bean, Field pea, Lentil and chickpea (62.12qt, 41.75qt, 2.9qt and 18.76qt) respectively were distributed for those selected districts. A total of 752 farmers and 45 experts were also trained. Extension events, such as mini-field days were organized at each respective site in which different stakeholders were participated and experiences shared. Finally, in this pre-scaling activity revolving seed system was used in which each farmer refund the amount of seeds collected in the previous year and re-distributed for other farmers in the next season.
Recommendations

As an extension approach forming a group of farmers as FRG should be done with maximum care considering important factors of variations (sex, education, age and wealth status) and physical proximity between member farmers and accessibility to regular follow up. However, the criteria need to be flexible to consider the realities in the target sites, thus should not necessarily be the same across in participatory technology promotion and dissention ensuring active participation of relevant stakeholders like; farmers, development agents (DAs), respective district agricultural officers and multi-disciplinary team of researchers through formal and informal arrangement is critical in sustaining the out puts of participatory extension approaches.

It is essential to ensure, from the beginning, clear understanding of FRG approach to actors (farmers, Extension workers, researchers and others). The idea of cost sharing and capacity development should have a clear and strong footing early in the beginning to facilitate psychological preparation against the notion of free gift and dependency. In order to ensure and sustain availability of seeds of the preferred varieties in quantity and quality through farmer based seed production there should be formally organized seed producers farmers cooperatives on pulse crops and also strong informal seed exchange system. In addition to this, there should be viable storage technologies, extension materials such as manuals/guidelines on features and control mechanisms of important major pulse crop disease and pest.

In general, the on farm participatory technology evaluation and transfer with well-organized farmers groups working together with research and extension has proved a valuable interactive approach for quick technology evaluation and dissemination. Training is the catalyst of creating innovative farmers for enhancing wider diffusion of the proven impacts of the pulse technologies to the other areas. Women and male-headed households, and house- wives should be provided with continuous technical trainings on agronomic practices and production technologies.

References


Pre-Scaling-Up of Improved Soybean Variety in Selected Districts of West and Kellem Wollega Zones

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Abstract

Soybean play greater role in ensuring food security in west and kellem Wollega zone. Therefore, the study was designed to promote and disseminate improved variety of soybean in the study area. The operational sites of the study includes Guliso district from west wollega zone whereas Hawa Gelan, Dale Sedi and Dale Wabera districts were from kellem wollega zone. Selection of farmers was made purposively based on their representativeness of the majority of farmers, their interest in earning out the recommended management practices, land ownership and other important socio economic variables. After farmers selection, each farmer was given Didesa variety of soybean seed which covered 1/4 of a hectare. Training given on soybean importance, necessary management practices, food processing and utilization methods covered a total of 215 people; among whom 77 were female and 138 were male. The study were addressed a total of 227 farmers of the study area. A total of 5600 quintal of Didesa variety of soybean was harvested from 277 farmers. Finally, Haro Sebu Agricultural Research Centre was disseminated this soybean technology for consecutive three years and addressed may farmers. However, it is impossible to address all the farmers only by the effort of the centre. Hence, Woreda Agricultural Bureau in collaboration with Zonal Agricultural Office should hold the turn to scale up the technology in wider scale.

Key Words: pre-scaling up, Didesa variety, Grain Yield, dissemination.

Introduction

Soybean grows in areas where haricot bean and common beans are grown. Depending on the variety, the crop can be grown from 0-2200m altitude and under rainfall ranging from 300 to 1200mm. Altitude influence temperature that in turn affects the initiation of flowering and maturity. At very high altitudes, flowering may not occur and the crop remains vegetative. Soybean is therefore a crop that requires warm climates and is suitable for low to medium altitudes (Ogema et al., 1988). The presence of Rhizobium japonicum in the roots of soybean enables the crop to fix nitrogen in the soil contributing to improved soil fertility (Kassa et al., 2000). Soybean is an alternative protein source to the rural families and can be utilized at home in various forms and the surplus can be sold to other consumers and manufacturers for income. It has an average protein content of 40% and is more protein-rich than any of the common vegetable or animal food sources. Soybean seeds also contain about 20% oil on a dry matter basis, and this is 85% unsaturated and cholesterol-free (Dugje et al., 2009).

Soybean flour made from Soya meal can be mixed with wheat and tef meal flour to prepare bread and 'enjera' respectively. Moreover, it is also used in the making of candies and ice cream. The mature seeds can also be processed to give Soya milk, curds and cheese. Soybean has a number of health related advantages as well. It has been found to be excellent for a number of different conditions such as high blood pressure, diabetes related diseases and many others. It is very useful in improving the menu of malmnourished children and revitalizing heart and breast cancer patients (Development Studies Associates, 2008). West and Kellem wollega zones are the potential areas for soybean production.
However, farmers of the area had been produced unknown variety of soybean in a very small amount by purchasing from the local market. Hence, the yield of farmers had been gained from soybean remained very low. This may be due to inaccessibility of the farmers to newly released improved soybean variety. By recognizing this fact, Haro Sebu Agricultural Research Centre adapted different variety of soybean by taking the variety from Bako Agricultural Research Centre. Finally, Didesa was performed better and it gave 22 quintal per hectare. Therefore, this study intended to promote and disseminate improved variety of soybean in the study area. The study was initiated to disseminate the already proved and verified productive soybean variety, to provide farmers with alternative improved high yielding soybean variety, to introduce different soybean meal utilization methods via training.

**Methodology**

The operational sites were West and Kelem Wollega zones which includes Guliso district from west wollega zone whereas Hawa Gelan, Dale Sedi and Dale Wabera districts from kelem wollega zone. Before starting the field work, selection of farmers was made purposively based on their representativeness of the majority of smallholder farmers, their interest and motivation in carrying out the recommended management practices, land ownership and their commitment to deliver the technology to other farmers by considering the gender balance and other important socio economic variables.

After farmers selection had made by the researchers and DAs in respective peasant associations, each farmer was given Didesa variety of soybean seed that can grown on a gross area of 2500m² for three consecutive years of production (i.e. 2012-2014). The study were addressed a total of 227 farmers in the three years of the project span. Training were given to the experts and farmers on soybean production, utilization methods and management practices. Field days also were organized in some project areas to create awareness by participating larger numbers of farmers and other stakeholders. Yield data was collected through regular interview and analyzed using SPSS soft ware.

**Results and Discussions**

**Performance of Didesa and yield harvested**

Within the three years of the activity span, farmers obtained mean grain yield of Didesa variety of soybean in average 20.2 quintal per hectare. A total of 5600 quintal was harvested from 277 farmers.

**Training on Soybean Production, Management Practices and Food Processing & Utilization**

The farmers of the project area were shown and trained about all the necessary management practices required for soybean production and monitored properly in collaboration with DAs. Training on soybean production, management practices and food processing & utilization methods were given in 2005 and 2006. This includes both theoretical and practical types of training. The following table illustrates the number of farmers and experts participated on the training.

<table>
<thead>
<tr>
<th>Year</th>
<th>Experts (DA + SMS)</th>
<th>Participants</th>
<th>Subtotal</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
<td>Female</td>
<td>Total</td>
</tr>
<tr>
<td>2005</td>
<td>7</td>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td>2006</td>
<td>10</td>
<td>5</td>
<td>15</td>
</tr>
<tr>
<td>Grand total</td>
<td>10</td>
<td>8</td>
<td>18</td>
</tr>
</tbody>
</table>

As it is indicated in above table the training given in 2005 and 2006 six covered a total of 215 peoples. Among them 77 were female and the remaining 138 were male. After the training the skill of
the farmers on soybean management, food processing and utilization methods were increased. Correspondingly the number of farmers engaging in soybean production become increasing.

Farmers' Feedback Assessment

Farmers' feedback assessment was conducted in collaboration with DAs and researchers. Farmers provided different feedback for different variety of soybean. Farmers evaluate the Didesa soybean variety as high yielder, resistant to major disease with good taste. On the other hand, they criticize as it is late maturity.

Conclusions and recommendations

Conclusions

Soybean is a crop which can prepared in different forms in home for household consumption like milk, bread, enjera and wot. Soybean milk is a source of protein and totally free from cholesterol. It has been found to be excellent for a number of different conditions such as high blood pressure, diabetes related diseases and many others. It is very useful in improving the menu of malnourished children and revitalizing heart and breast cancer patients (Development Studies Associates, 2008) Didesa gave the mean grain yield of 20.2 quintal from a hectare. This resulted a total of 5600 quintal of soybean from a total of 277 farmers. Training given on soybean importance, necessary management practices, food processing and utilization methods covered a total of 215 people; among whom 77 were female and 138 were male. After the training the skill and demand of the farmers for soybean production become increased.

Recommendations

As it was raised by the farmers during feedback assessment, lack of recommended herbicide for soybean weed controlling is one of the problem which hinder soybean production. So, alternative ways of controlling soybean weed infestation should be devised for better yield and quality. Finally, Haro Sebu Agricultural Research Centre was disseminated this soybean technology for consecutive three years and addressed may farmers. However, it is impossible to address all the farmers only by the effort of the centre. Hence, Woreda Agricultural Bureau in collaboration with Zonal Agricultural Office should hold the turn to scale up the technology in wider scale.

References


Pre scaling up of Improved Bread Wheat Technologies in Jarso and Kurfa-Chele
Districts of East Haraghe Zone, Oromia Region, Ethiopia

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Abstract

The study was conducted in Kurfa-Chele and Jarso districts of East Hararghe Zone during 2013 and 2014 cropping season. Three improved wheat varieties (Mada-walabu, Dure and Digalu) were pre-scaled on farmers’ field to enhance wheat productivity and income of smallholder farmers through wider dissemination of improved production technologies in the area. Training and mini field day were organized to create awareness among farmers and sharing experience and knowledge on the varieties and their management practices. A total of 85 farmers were addressed with area coverage of 16.53 hectares and a total of 20.67 quintal of seeds was disseminated. A total of 434.9 quintals of wheat seeds were produced. The varieties were preferred by the farmers due to their resistance disease (rust), good grain filling and yield potential, as a result, the farmers were interested for the varieties. As a result, the farmers were benefited from the technologies, and high demand was created for these varieties in the area. Hence, wider dissemination of the technologies for similar agro ecology and establishing sustainable seed system and market linkages will result in high productivity and livelihood improvement for the wheat farmers in the area.

Keywords: Pre-scaling, improved, bread wheat, technologies

Introduction

Wheat is one of the most important cereals cultivated in Ethiopia. It ranks fourth after Teff (Eragrostis tef), Maize (Zea mays) and Sorghum (Sorghum bicolor) in area coverage and third in total production. The crop is a major cereal crop in Ethiopia, which is largely grown in the highland parts of the country. At the national level, wheat is cultivated on 1.63 million ha of land with a total grain production of 3.43 million tonnes (CSA, 2013), and the country is considered the largest producer of the crop in sub-Saharan Africa. Bread wheat (Triticum aestivum L.) accounts for about 60% of the total wheat production in the country whereas durum wheat (Triticum aestivum L.) accounts for the remaining production (Hailu, 1991). Bread wheat is preferred to durum wheat by farmers in Ethiopia owing to its high yield potential, relatively higher economic returns, and good bread making to the other food crops (Tanner et al., 1993).

In highlands of eastern Ethiopia, Hararghe highlands in particular have suitable agro-ecological conditions for wheat production. Farmers grown wheat on their fields for home consumption and marketing in the wheat growing districts of Eastern Hararghe. However, one challenge faced in wheat production in the country is low productivity per unit area of land. The national average yield of the crop is estimated at 2.11 tonnes ha⁻¹ (CSA, 2013), which is very low compared to the world’s average yield of 3.09 tonnes ha⁻¹ (FAOSTAT, 2012). Low productivity of the crop is attributed to the use of old and low-yielding varieties, depletion of soil nutrients, poor weed management practices, prevalence of aggressive and virulent crop pathogens (Tanner et al., 1993). Similarly, cultivation of low yielding and disease-susceptible varieties and poor agronomic practices are major constraints to wheat production in the highlands of eastern Ethiopia (Nigussie et al. 2012). Shortage of improved wheat varieties is among the major constraints to the wheat growing farmers in the target areas. In
addition, yellow rust is the severe disease which affects yields and efforts of farmers in the highlands of eastern Hararghe.

To alleviate the problem, five improved highland wheat varieties (Dure, Mada Walabu, Tussein, Digalu and Millennium) were introduced to the area for demonstration and evaluation under farmers' condition in the area. Three improved varieties (Dure, Mada Walabu, Digalu) were found to be high yielding, and disease resistant, and highly preferred by farmers due to resistance to rust, yield, uniform maturity and relative early maturity. Therefore, by taking these parameters into consideration, it was necessary to widely promote these varieties so as to scale up improved bread wheat varieties in the highlands of eastern Hararghe zone and to strengthen linkages among different stakeholders in order to reach large number of farmers. Hence, based on the evidences generated during demonstration, this activity was initiated for up scaling of preferred improved varieties for wider farming communities to boost production and productivity of the crop in the area.

Methodology

Description of study area

This activity was conducted in Jarso and Kurfa-Chale districts of the East Hararghe Zone of the Oromia Regional State during 2014 and 2015 cropping seasons. Relatively, both districts are located in the highlands with high potential for wheat production in the area. The climate of the districts is suitable for wheat cultivation. These areas are generally characterized by a mixed crop-livestock farming system. Farmers in the study area produce mostly staple crops, namely, sorghum, maize, wheat, barley, potato, and faba bean.

Site and farmers' selection

Site and farmers selection were done jointly with district agricultural offices and development agents (DAs) based on wheat production potentials. Farmers were selected mainly based on their willingness and interests in participating in the promotion of wheat varieties and also availability of the required plots of land. Accordingly, Afgug and Jiru-balina Kebeles were selected from Jarso and Kurfa-Chale districts, respectively. These kebeles are known in wheat production potentials. The farmers were selected in collaboration with development agents for the activity so as to provide a plot of land (at least 0.125 hectares) for scaling up and do all field management, based on their potential and interest. Improved seeds of Mada-walabu, Dure and Digalu varieties were provided by the Fedis Agricultural Research Center to the targeted farmers.

Technology dissemination/popularization approach

For the effective implementation of the activity, practical training provided for farmers, experts and DAs on planting methods, input application, and also the general agronomic practices to be followed. In addition, different information dissemination techniques such as mini-field day, field visit, farmers to farmer dissemination, and printed media such as leaflet were used as technology dissemination approach or wider dissemination of the technology in the target area. The information dissemination mechanisms had created awareness for the farming community in the area as well as other stakeholders. These enhance farmer to farmer learning and experience sharing among farmers and other stakeholders.

Data collection

Quantitative data such as number of farmers participated, quantity of disseminated seed, area of land coverage, yield and income were collected using checklist. In addition to, qualitative data such as disease, farmers' perception, and feedback were collected.
Data analysis

The statistical analysis of means, ranges, and variances of yields of each variety was done using SPSS statistical software and means variation were tested by the test of homogeneity of variances. And, qualitative analysis of disease susceptibility, farmers' perceptions and feedback were also carried out.

Results and discussions

Training of farmers and other stakeholders

Awareness created during the demonstration and evaluation of the improved wheat varieties assisted the smooth implementation of scaling up activity. Farmers in target districts showed great interest in use of the improved wheat production technologies. Prior to implementation, training was provided to farmers, development agents and experts on planting methods, input application, and also the general agronomic practices to be followed. Accordingly, a total of 96 farmers (92 male and 4 women), 2 DAs and 2 experts attended the training organized in the target areas.

Technology dissemination

Jarso and Kurfa-Chele districts were potential wheat producing from East Hararghe Zone of Eastern Oromia. Because of this three improved varieties of wheat were pre scaled up to improve its production and productivity. The pre-scaling up of three improved wheat varieties (Mada-walabu, Dure and Digalu) which were introduced for demonstration and preferred by farmers for their productivity and disease resistance ability were scaled up. A total of 85 farmers were selected in collaboration with development agents for the activity so as to provide a plot of land for scaling up and do all field management tasks, based on their potential and interest to do so. From these farmers, 61(72%) farmers were addressed from Afgug Kebele of Jarso district and the remaining 24(28%) farmers were from Jiru-balina of Kurfa-Chele district.

The pre-scaling up of was conducted in two ways: through direct supply of seed and technical support, and also through supply of seeds by farmers (farmers to farmers) and technical support from experts. Accordingly, a total of 20.67 quintal of seeds improved wheat varieties and associated production technologies were scaled on 85 farmers over 16.53 hectares of land in the two districts. From the total seeds disseminated, about 50.67% of the total seed disseminated (20.67 quintal) was directly from Fedis Agricultural Research Center and the remaining 49.33% was through farmer to farmer seed delivery system. Seeds were disseminated from farmers to farmers is common during second year. From the scaled up varieties, Mada-Walabu shared 52% of the total seed distributed, Dure variety constitutes about 28% of the delivered seed and the remaining share is Digalu variety.

Role of farmers and other stakeholders in technology dissemination

The scaling up of wheat production technologies were implemented by involving farmers, experts from district offices of agriculture and development agents. District offices of agriculture were actively involved during pre-scaling of wheat technologies because it is a potential stakeholder in further dissemination of the technologies through its extension system by strengthening the linkage between research-extension, farmers and other stakeholders. The offices of agriculture were primarily responsible for selection of sites and farmers, activity implementation, organizing field days, capacity building, and information dissemination. In all these processes, experts from office of agriculture and DAs have played facilitation role. Activities including site selection, farmer selection, training, planting, and monitoring were done in collaboration with experts and DAs in both districts. The DAs were the key actors that facilitation and organizing the farmers and pave the way for promotion of the improved highland bread wheat technologies.
Fedis agricultural Research Center also play a significant role in coordination and facilitation of experts, farmers, and experts for effective implementation of the pre-scaling up of improved wheat technologies, provision of improved wheat technologies, provision of training in capacity building and supervision, and organize field visits to share experiences. The farmers also play a significant role in input allocation (land, labour, fertilizer) in collaboration with DAs, experts and researchers for effective implementation of the pre-scaling up of improved wheat technologies in both districts. Accordingly, farmers were allocate a minimum of 0.125 ha and the allocated land was prepared by the farmers themselves and three improved varieties (Dure, Mada-Walabu, Digalu) were sown on the prepared farm land in accordance with agronomic practices under direct supervision of experts, DAs and researchers. Prior to land preparation up to yield harvesting, the farmers had managed all activities based upon the training they took at the beginning of the implementation of the pre-scaling.

Yield performance of the varieties

In 2013 and 2014 cropping season, a total of 434.9 quintals of wheat seeds were produced by the farmers from the total area of land covered by the improved varieties. The result yield assessment indicated that the average yield of improved variety was 26.26 quintals per hectare with the range of 24 quintals to 72 quintals per hectare. The analysis of market price assessment shows that price for improved varieties is Birr 900.00 to 1000.00 per quintal while price for local varieties is Birr 700 to 750 per quintal at both Kurfa Chale and Jarso districts. The participant farmers earned a total of Birr 391,410.00 to 434,900.00 from the pre-scaled improved wheat varieties in the two districts.

Farmers' reaction/feedback

The farmers’ awareness was improved through training, field visit and farmer to farmer technology transfer/learning from each other. As a result, the farmers provided their feedback on the pre-scaled improved wheat varieties. The farmers’ feedback indicates that the varieties were preferred by the farmers due to their resistance disease (rust), tolerant to moisture stress, good grain filling and yield potential, as a result, the farmers were interested for the varieties and because of this high demand created for these varieties, especially for Mada-Walabu variety.

Conclusions and recommendations

The study was conducted in Kurfa-Chelc and Jarso districts of East Hararghe Zone. Three improved wheat varieties (Mada-walabu, Dure and Digalu) were pre-scaled on 85 farmers’ fields with area coverage of 16.53 hectares and a total of 20.67 quintal of seeds were disseminated for farmers in two districts. A total of 434.9 quintals of wheat seeds were produced by the farmers from the total area of land covered by the improved varieties. Training and mini field day were organized to create awareness among farmers and sharing experience and knowledge on the varieties and their management practices. The varieties were preferred by the farmers due to their resistance disease (rust), tolerant to moisture stress, good grain filling and yield potential, as a result, the farmers were interested for the varieties. Therefore, these varieties should be scaled up to address more farmers in the target areas and other areas with similar agro ecology.
References


Farmers Based Seed Multiplication and Promotion of Early maturing Sorghum Varieties in Hawi Gudina, Daro Lebu, Oda Bultum & Doba districts of west Hararghe zone, Oromia National Regional state

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Abstract

This activity was conducted in four (4) districts of west Hararghe zone for two consecutive years. The objective of the experiment was to multiply seeds of early maturing sorghum varieties on farmer's field and promote dissemination and adoption of technologies through farmer-to-farmer networking & improve farmer's skills and knowledge on sorghum production and management in order to improve food insecurity situation in the study area. A total of 9 (nine) PAs (peasant associations) were selected with collaboration with district agricultural offices and DAs. From all districts a total of 81 representative farmers were participated for promotion purpose. Two early maturing sorghum varieties (Girana-1 & Misikir) were used for promotion & sown on a total of 10 hectares of farmers land. Field days were arranged for surrounding farmers to create awareness and facilitate dissemination process. The result indicated that the varieties were promising and shows better performance. The field day result also showed that farmer's preference and reflection for the varieties was also good and positive. The farmers selected the varieties in terms of good head performance, early maturity, seed colour and good for 'injera' and 'kita'. In addition, awareness of farmers on the varieties was improved; availability of improved early maturing of sorghum varieties was improved in the community through farmer to farmer networking. Finally, farmer's skill and knowledge on sorghum agronomic management practice was also improved. The findings recommended that these two varieties (Girana-1 and Misikir) should be scaled up in the similar agro ecology areas.

Key words: Promotion, Seed multiplication, early maturing sorghum, Injera

Introduction

Sorghum [Sorghum bicolor (L) Moench] is a monocotyledon crop belonging to the family Gramineae. It is naturally self-pollinated short day plant with the degree of spontaneous cross pollination, in some cases, reaching up to 30% depending on panicle types (Poehlman and Sleper, 1995). Although sorghum is cultivated both in tropical and temperate climates, it is best known for its adaptation to the drought-prone semi-arid tropical (SAT) regions of the world (Poehlman and Sleper, 1995; Tuinstra et al., 1996). Sorghum grain is as nutritious as other cereal grains: contains about 11% water, 340 k/cal of energy, 11.6% protein, 73% carbohydrate and 3% fat by weight (Hiebsch and O’Hair, 1986). It serves as a staple food for more than 500 million people in the semi-arid tropics of Africa and Asia. It is also used for preparing traditional beverages. Both the grain and the stover are also used as animal feed. Industrial use of sorghum for making sugar, starch, syrup, alcohol and molasses is increasing (Doggett, 1988; House, 1995; Duncan, 1996). With the frequent and cyclical occurrence of drought and erratic rainfall, it could be an insurance crop to the small-scale resource-poor farmers constituting the majority of the rural farming community in Ethiopia (Abdissa, 1997).

Sorghum is the preferred cereal after teff for preparing flat bread (injera), which is stable food in Ethiopia. It is the dominant cereal crop grown in Western Hararghe zone. As it is adapted to a wide range of environments it is largely produced in the highlands, medium and lowland regions. It is used in various way, grains are used for human consumption and beverage such as porridge, nifro, tella, arek and also leaf and the stalk are used for animal feed and stalk are used for construction of house, fence and as fuel wood. However, due to different factors influencing sorghum production in the area
the yield that harvest from their farm was very low. Those factors which contribute to low productivity of this crop are such as lack of improved seed, drought, disease and pest infection, weed etc. In 2010 cropping season demonstration was conducted in two districts Daro Labu (on FTC and farmers' field) and Doba (on FTC) and Girana-1 and Misikir were preferred by the farmers. Therefore, this activity was initiated to multiply and promote those preferred improved varieties.

**Objectives**

- To multiply seeds of early maturing sorghum varieties on farmer's field and promote dissemination and adoption of technologies through farmer-to-farmer networking;
- To improve farmers skill and knowledge on sorghum production and management practice

**Methodology**

**Farmers and Site Selection**

This activity was conducted for two consecutive years. It was carried out in four (4) districts (Daro Labu, Doba, Hawi Gudina, & Oda Bultum) of west Hararghe zone. Selection of major sorghum producing PAs and farmers was carried out together with the district Agricultural Office. Accordingly, a total of 9 (nine) PAs were selected from all districts. Finally, a total of 81 representative farmers were participated for promotion.

<table>
<thead>
<tr>
<th>Districts</th>
<th>PAs</th>
<th>No. of farmers</th>
<th>Area sown (hectares)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daro Labu</td>
<td>Milkave and Gadullo</td>
<td>47</td>
<td>6</td>
</tr>
<tr>
<td>Hawi Gudina</td>
<td>Mersu-chiro and Mersu-mesela</td>
<td>8</td>
<td>1.5</td>
</tr>
<tr>
<td>Doba</td>
<td>Lenca-wedesa, Lubu-dhaqab and Tokuma</td>
<td>18</td>
<td>1.75</td>
</tr>
<tr>
<td>Oda Bultum</td>
<td>Odabaso and Burka Misoma</td>
<td>8</td>
<td>0.75</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>81</strong></td>
<td><strong>10</strong></td>
<td></td>
</tr>
</tbody>
</table>

**Material Used**

To conduct the activity on selected farmer's field material like improved variety of sorghum (Grana-1 & Miskir) and fertilizer (DAP and UREA) were used. A total area of 10 hectare of land and 81 farmers were participated on multiplication the seed on their field.

**Methods of Data Collection and Analysis**

Data like yield data and farmers’ selection criteria were collect through supervision on prepared data collection sheet by researchers and DA of the PA. Organizing field day was also another way to collect farmer's attitude toward provided technology in relation to their agro ecology. The collected data (quantitative data) was analyzed by using average while qualitative data were analyzed through qualitative interpretation.

**Results and Discussions**

**Seed Multiplied on farmers fields**

During the life time of the activity seed was multiplied on farmer's field to enhance the seed availability of drought resistance and early maturing sorghum in the local area. The summary of seed multiplied in each district summarized in table below.
Table 2: Summary of seed produced per district

<table>
<thead>
<tr>
<th>Districts</th>
<th>Area sown (hectares)</th>
<th>Average seed harvested in kuntal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dáro Labu</td>
<td>6</td>
<td>144</td>
</tr>
<tr>
<td>Hawai Gudina</td>
<td>1.5</td>
<td>36</td>
</tr>
<tr>
<td>Dobá</td>
<td>1.75</td>
<td>42</td>
</tr>
<tr>
<td>Oda Bultum</td>
<td>0.75</td>
<td>18</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>10</strong></td>
<td><strong>240</strong></td>
</tr>
</tbody>
</table>

In line with seed multiplication, the study indicated that both varieties sorghum were well performed under shortage of the rainfall and showed better performance than locally used sorghum variety. Field day was organized to create awareness on the promotion of the varieties and showed that farmer’s preference and reflection for the varieties was also good. The farmers selected the varieties in terms of good head performance, early maturity, drought tolerance, seed colour and good for ‘injera’ and ‘kita’. Moreover, through farmer to farmer networking availability of improved early maturing sorghum varieties was improved in the community.

**Conclusions and Recommendations**

The study conducted with the objective to multiply seeds of early maturing sorghum varieties on farmer’s field and promote dissemination and adoption of technologies through farmer-to-farmer networking and improve farmers’ skill and knowledge on sorghum production and management practice. Site and farmer selection was done in collaboration with district agricultural Offices. Continuous supervision and follow up, orientation to farmers and DAs was done to implement the activities. Accordingly, the result showed that the varieties performance on the farmers land was good and encouraging in the target area to improve food security at household level. It is also concluded that farmer’s preference and reflection for the varieties was also positive with different criteria’s like good head performance, early maturity, seed colour and good for ‘injera’ and ‘kita’ making. In addition, through farmer to farmers networking awareness of farmers on the varieties among the community was improved. Therefore, these two varieties should be further scale up in wide geographical areas in order to bring impact at farmer’s level.

**References**


**Promotion of Improved Finger Millet Variety (Bonaya) in Habro District, West Hararghe Zone, Oromia National Regional State**

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Abstract

This activity was conducted in Habro District of West Hararghe zone in 2012 with the objective to promote improved variety of finger millet on farmer’s fields. A total of 4 (four) PAs were selected from the district and from those PAs a total of 35 representative farmers were selected with collaboration with district agricultural offices and respective DAs. One improved Finger millet variety (Bonaya) was used for promotion & sown on 2.5 hectares of farmers land. The result study indicated that the variety performed well on farmer’s field. Farmers preferred the improved variety because it has 9-11 fingers as compared to local variety which has 6-7 fingers which showed more yield than local ones. Therefore, further popularisation and scale up of these varieties (Bonaya) is very crucial in the mandate area in order to bring impact at household level.

Key Words: Finger millet, Farmers, promotion, Habro district

Introduction

In Ethiopia Finger millet (Eleusine coracana) is one of the most important food crops which is cultivated on about 304,758 hectares with a grain yield of 3.05 million metric tons and its per hectare productivity is below one tone, although it has a potential yield of up to three tons per hectare (CSA, 2004/05). The cultivation of Finger millet is relatively easy and it has been found to be reliable under circumstances where other cereal crops would have failed due to drought or would have given negligible yield (CSA, 2006). The nutritional value of the grain is high and it is used as an important staple food and generally consumed as porridge.

In 2008 and 2009 cropping seasons some released varieties of Finger millet have been brought from Bako Agricultural Research Center and evaluated for adaptation and demonstration trial at Mechara Agricultural Research Centre. Among them, Boneya showed good yield as compared to the other varieties including local check. Accordingly, this variety was recommended for further promotion in the target area.

Methodology

Description of the Study Area

Habro district was located at 404 km of east Addis Ababa, capital city of Ethiopia and 75 km of south Chiro, West Hararghe Zone town. The district boarded with Guba Koricha district in west, Boke in east, Daro Lebu in south and Oda Bultum in north. The altitude of the district ranges between 1600-2400 m a.s.l with maximum and minimum temperature of 16°C and 20°C, respectively. The district receives annual average rainfall of 650mm to 1000mm (Aman Tufa & Anteneh Temesgen, 2010). Major food crop grown in this district were maize, Sorghum and haricot bean while coffee and Khat were major cash crop grown by smallholder farmers.

Site and Farmers Selection Procedure

The activity was conducted in Habro district of West Hararghe zone. Selection of major finger millet producing PAs and farmers was carried out together with Agricultural office and respective DAs. Four (+) peasant associations (PAs) were purposively selected from the district based on production potential and accessibility to road. All necessary agricultural inputs were supplied to the target farmers as per plan. Finally, a total of 35 farmers were participated for promotion purpose and a total of 2.5 hectares of land was covered by finger millet.

Results and Discussions
The result confirmed that though rainfall is available in the area during planting time the variety on few farmers was not germinated. During site selection, few farmers allocate marginal lands for promotion purpose which in turn result in low performance of the variety due to poor fertility of the land. This is due to land shortage in the area and less importance of the variety compared to sorghum and maize in the study area. It is also confirmed from the finding that the variety was not equally performed on the farmer’s field due to unequal management practice done by the farmers which is below recommendation level.

The findings indicate that due to limited logistic capacity of the centre, necessary supervision and follow up were not done as well as important data like yield data was not collected. Moreover, it is also indicated that field day was not arranged due to aforementioned reason which would play significant role to bring impact for rapid knowledge circulation among community. It is observed from researcher observation and limited follow up result that the performance of the variety on some farmer’s field was satisfactory and farmer’s perception was very good.

Table 1: Summary of the activity

<table>
<thead>
<tr>
<th>Crop</th>
<th>Variety</th>
<th>Districts</th>
<th>PAs</th>
<th>No. of Fs</th>
<th>Area sown (hectares)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Figer millet</td>
<td>Boneya</td>
<td>Habro</td>
<td>Garbi-goba</td>
<td>9</td>
<td>0.625</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Lege-bera</td>
<td>8</td>
<td>0.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Oda-Anani</td>
<td>10</td>
<td>0.875</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Lugo</td>
<td>8</td>
<td>0.5</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td>35</td>
<td>2.5</td>
</tr>
</tbody>
</table>

Conclusions and recommendations

This study revealed promotion of improved finger millet (Boneya) varieties in selected districts of west Hararghe zone with the objective to disseminate and accelerate adoption process rapidly. Site and farmer selection was done in collaboration with district agricultural Offices. Continuous supervision and follow up, orientation to farmers and DAs was done to implement the activities. Accordingly, the result shows that the varieties performance on the farmers land was good and encouraging in the target area to improve food security at household level. It is also concluded that farmer’s preference and reflection for the varieties was also good with criteria’s like high numbers of fingers than the local ones, early maturity and drought tolerance. In addition, through farmer to farmers informal networking awareness of farmers on the varieties among the neighbouring community was improved. It is also confirmed that farmer’s skills and knowledge on agronomic practices was capacitated. Therefore, this variety should be further scale up in wide geographical areas in order to bring impact at farmer’s level.

References


Pre-scaling up of ‘Chefeka’ Hive and Ant Protection Technology in Guraghe Zone

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Abstract

Pre-scaling of chefeka hive technology package is the research extension activity implemented in Guraghe Zone in Cheha, Enemorina Eaner and Mihor Na Akil, Woredas. The purpose of this activity was to increase income of target beneficiaries through pre-scaling of Chefeka hive technology package and build local capacity in applying beekeeping technologies. Purposive sampling was employed to identify potential Woredas, Village Administration and beekeepers. Two pre scaling up sites at each Woreda and 10 beekeepers per site selected and FREG established. FREG members, development agents and experts trained on technology package and on average three chefeka hives with its full package used for technology demonstration and popularization. Quantitative data collected using semi structured interview schedule and data collection sheets and analyzed using descriptive statistics. Qualitative data was also collected using personal observation group discussion and key informant interview and analyzed using concept explanation method. The result of the research showed that on average 10.2 kg of crude honey per hive per season and when processed 7.5 kg pure honey per hive per season and 0.32 kg pure beeswax honey per hive per season harvested and processed in the selected Woredas. Regarding the benefit of chefeka hive technology package, ETB 195.60 per hive per season achieved over the traditional bee hive. It can be concluded that the technology performed better than the traditional hive and it is strongly proposed to be more popularized for the wider community.

Key words: Pre-scaling up, Chefeka bee hive, beekeeping technology, FREG, Package

Introduction

Currently, the role of beekeeping in diversifying and increasing the incomes of the farming communities and as source of foreign exchange earnings for the nation has been well realized. It contributes to sustainable rural livelihoods not only through production and sale of honey and its by-products, but also through connection between beekeeping and watershed protection, soil and biodiversity conservation and increase in crop production through bee’s pollination services (Lietaer, 2009). Accordingly, emphasis has been given to expand the beekeeping conditions of the country more than ever.

The thematic problem that is observed on our beekeepers are producing low yield and low quality of honeybee products from traditional hives, inability to afford the price of machine made top-bar, box hives, casting mold, inadequate use of ant protection methods. The maximum yield obtained from a traditional beehive is on average to be below 7 kg/hive but more than 15 kg/hive crude honey can be produced if chefeka hive is used (Nuru and Eddesa, 2002). Chefska hive made from locally available materials is important for our farmers as it is inexpensive and it is possible to use hand-made chefeka hives and frames from locally available materials (Bamboo, (Arundinaria alpina), shembeko (Arundinaria donax), shimel(Oxytenathera abyssinica) and eucalyptus), (Nuru and Eddesa, 2002). Workneh (2007) study has also confirmed as the technology properly works under farmers. Farmers often accept that the experience of on farm demonstration, which is similar to their own situation (Ban, 1996).

Beekeeping is much more productive and profitable if and only if proper management is undertaken. Fulfilling the requirements of the honey bee colonies as soon as possible strengthening and protecting them from diseases, pests and predator are the major ones among the honey bee management

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practices. Beekeeping is one of the major income generating activity for many household of Gurage Zone, is one of the highest population densities in Ethiopia (Aynalem Adugna, July 2014). Since beekeeping can be undertaken with little or no land, it would be one of the development option and comparative advantages for such areas with high human population density and limited farm land.

Gurage Zone of Southern Nations Nationalities and Peoples Regional State has a potential for development of apiculture. It is good for its diversified natural and planted trees and shrubs species and cultivated crops which flower at different times of the year that provide sufficient forage for bees. However, the honey production potential has not been exploited much. In addition to this fact, adoption of improved honey harvesting, processing and storage systems are limited contributing to poor quality marketable products. Thus, the beekeepers are not benefiting from this economic activity as expected. Some of the problems are limited skills and knowledge of beekeeping, lack of appropriate beekeeping technologies and the beekeepers cannot afford to invest in high cost technology. Beekeeping sub sector of the zone can be developed if affordable and productive beekeeping technologies available and disseminated. Hence, the aim of this project was proposed to increase income of target beneficiaries through pre-scaling up of ‘Chefeka’ hive technology packages and to build local capacity in applying beekeeping technologies.

Methodology

Description of Study Areas

Cheha Woreda

Cheha Woreda located 180 km from Addis Ababa and 30 km from Wolkite, the capital of Gurage Zone, Southern Nations Nationalities and Peoples (SNPP) region of Ethiopia. It is bordered on the South by Enemorina Eaner Woreda, on the West by Oromia region, on North by Wabe River which separates it from Abeshge Woreda and Kebena Woreda, on the East by Ezha Woreda, and on the Southeast by Gumer Woreda and Geta Woreda. Elevation in this Woreda ranges from 1900 to 3000 meters above sea level. The Woreda’s total population is 115,951 out of this 7.76% are urban dwellers (Wikipedia, 2016). The subsistence agriculture in Cheha Woreda is primarily based on enset, together with corn, sorghum and chickpea, as well as some annual root crops like yams and taro. Important crops include teff and Niger seed.

Enemorina Eaner Woreda

Enemorina Eaner Woreda is located 209 km from Addis Ababa and 59 km from Wolkite, the capital of Gurage Zone. It is bordered on the South by Hadiya Zone, on the Southwest by Yem special Woreda, on the West by Oromia Region, on the North by Cheha Woreda, on the East by Geta Woreda, and on the Southeast by Endegagn Woreda. The Woreda’s total population is 167,951 out of this 7.76% are urban dwellers (Wikipedia, 2016).

Muhor Na Aklil Woreda

Muhor Na Aklil Woreda is located 230 km from Addis Ababa and 60 km from Wolkite, the capital of Gurage zone. It is bordered on the South by Ezha Woreda, on the Northwest by Kebena Woreda, on the North by Kokir Gedebano Woreda, and on the East by Meskane
Woreda. The Woreda’s total population is 87,756 out of this 0.82% are urban dwellers (Wikipedia, 2016).

**Site and Farmers Selection**

This pre-scaling up activity was conducted by selecting three Woredas from Gurage zone from 2003-2005 E.C. For this study, purposive sampling was employed to select Woredas that were conducive for the pre-scaling up purpose, identify Village Administration and individual beekeepers. Consequently, Cheha, Enemorina Eaner and Muhor Na Aklil Woredas were selected. From each Woreda, 20 beekeepers by considering male, female and youth selected, two pre-scaling up sites selected and two farmers research extension groups (FREG) established and used as a center for demonstration and popularization of the technology package.

**Technology Transfer Approaches and Methods used for pre-scaling up of chefeka hive technology package**

FREGs were used for technology dissemination and at each pre-scaling up sites one FREG which contain 10 beekeepers was established. All the activities in the technology dissemination process were undertaken with these FREG members. As to the method, practical training was given twice in the first and second years on selection of materials for construction, construction of hives, top bar preparation, hive standing making, colony transfer, follow up of established colony, protection of pest and predators, pre and post harvest handling of bee products. After training, on average three chefeka hives with ant protection constructed at each pre-scaling site, honey bee colonies transferred to them and regular honey follow up activities (inspection, feeding, inserting/removing partition, honey harvesting and processing) were undertaken at each season for three consecutive years by Holeta Bee Research Center (HBRC) technical staff in partnership with FREG members, Development Agents (DAs) and Woreda level experts. On the other hand, each FREG member constructed at least two chefeka hives at their backyard for wider dissemination of the technology and with the intention of exercising what they learned from common pre-scaling up sites.

**Method of Data Collection**

Primary data on Honey yield, pure honey and beeswax, number of bee colonies owned, number of chefeka hives accepted by honeybees, attitudes of farmers towards to the technologies and number of farmers and stakeholders involved in capacity building were collected from beekeeping beneficiaries using semi structured interview schedule, key informant discussion and observation of backyard. Secondary data also collected from respective Woreda livestock office, literatures, research reports and internet search.

**Method of Data Analysis**

Quantitative data analyzed using descriptive statistics like mean and percentage and presented in table. SPSS version 20 was also used to analyze quantitative data. Any data that cannot be captured through quantitative analysis was analyzed qualitatively using explanation of ideas and opinion.

**Results and Discussion**

**Training of Farmers and other stakeholders**

The project key stakeholders from communities and government line offices actively participated in the project implementation. And the capacity of beekeepers and other stakeholders at selected Woredas and Village Administrations built through three rounds on spot practical training given for five days and demonstration and popularization of technology package for three years. Beekeepers, DAs experts, researchers, technical and field assistants were the main participants of dissemination of technology package. Generally, a total of 139 stakeholders (60 FREG Members 42 follow farmers, 15 DAs & 22 bee experts) were on the training and capacity building of technology package (table one).

<table>
<thead>
<tr>
<th>No</th>
<th>Woreda</th>
<th>FREG members</th>
<th>DA</th>
<th>Expert</th>
<th>Non-FREG members</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>M</td>
<td>F</td>
<td>T</td>
<td>M</td>
</tr>
<tr>
<td>1</td>
<td>Cheha Woreda</td>
<td>18</td>
<td>2</td>
<td>20</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>Enemorina Ener</td>
<td>19</td>
<td>1</td>
<td>20</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>Muhor Na Aklil</td>
<td>16</td>
<td>4</td>
<td>20</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>53</td>
<td>7</td>
<td>60</td>
<td>12</td>
</tr>
</tbody>
</table>

Source: own data computation

**Technology Dissemination**

With this pre-scaling up activity, 60 beekeepers addressed with training and demonstration of technology package on 6 model beekeepers backyard which used as a center for technology dissemination and popularization. After FREG members trained practically on hive making, they were expected to construct at least two chefeka hives at their backyard. Accordingly, data collected shows that 110 chefeka hives on the second year and 128 chefeka hives on the third year of the activity constructed by FREG members. With regard to number of occupied chefeka hives with honey bee colonies after construction, 85.71% at Cheha Woreda, 75.68% at Enemorina Eaner Woreda and 91.84% Muhor Na Aklil Woreda were occupied with honey bee colonies. Moreover, from these occupied hives, 14.29% at Cheha Woreda, 24.32% at Enemorina Eaner Woreda and 8.16% Muhor Na Aklil Woreda absconded. (table two). The probable reason for high absconding rate at Enemorina Eaner Woreda might be shortage of bee forage while transferring and seasonal management problem.

<table>
<thead>
<tr>
<th>Woreda</th>
<th>Number of chefeka hives constructed by year</th>
<th>No of hives Occupied by honeybees in 2005 E.C %</th>
<th>Absconding rate%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Moreover, 42 follow farmers visited apiary of pre scaling up sites and achieved awareness on basic improved beekeeping practices. Group discussion conducted with FREG and follow farmers also showed as, the income of FREG members from beekeeping after using chefeka hive improved and follow farmers started beekeeping by constructing the hive and harvested honey.

**Honey yield and Benefit**

Yield data on performance of the hive collected from colonies established for demonstration and popularization of the technology package for two years. Based on the result of data collected, 11.7 kg of crude honey per hive per season on average harvested at Muhur Na Aklili Woreda. Honey yield from pre scaling up colonies at this Woreda was higher than the other Woredas due to the probable reason that the Woreda is more potential than the other two Woredas. After applying post handling and value addition, the crude honey processed to table honey and pure beeswax. Accordingly, 9.27kg of table honey and 0.37kg pure beeswax obtained. Processing the crude honey added additional value to the price of honey from ETB 60 to ETB 100 per kilogram and 0.37 kg wax which is equivalent to ETB 66.60(ETB ISO/kg) is additional source of income. As a result, ETB 291.60 per hive per season achieved over the traditional bee hive due to chefeka hive technology package (table three).

### Table 3: Yield performance of chefeka hive at the pre-scaling up sites

<table>
<thead>
<tr>
<th>Woreda</th>
<th>Pre Scaling up sites</th>
<th>Yield in kilogram per hive per season</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Crude honey</td>
<td>Table honey</td>
<td>Crude beeswax</td>
<td>Pure beeswax</td>
<td></td>
</tr>
<tr>
<td>Cheha</td>
<td></td>
<td>9.75</td>
<td>6.85</td>
<td>2.9</td>
<td>0.29</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Yefecterek wedro</td>
<td>9.5</td>
<td>6.55</td>
<td>2.85</td>
<td>0.32</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Gubre</td>
<td>9.6</td>
<td>6.72</td>
<td>2.88</td>
<td>0.30</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Average</strong></td>
<td><strong>9.61</strong></td>
<td><strong>6.75</strong></td>
<td><strong>2.88</strong></td>
<td><strong>0.31</strong></td>
<td></td>
</tr>
<tr>
<td>Enemorina</td>
<td></td>
<td>8.9</td>
<td>6.23</td>
<td>2.67</td>
<td>0.30</td>
<td></td>
</tr>
<tr>
<td>Eaner</td>
<td>Terihogne</td>
<td>9.6</td>
<td>6.72</td>
<td>2.88</td>
<td>0.29</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Average</strong></td>
<td><strong>9.25</strong></td>
<td><strong>6.50</strong></td>
<td><strong>2.78</strong></td>
<td><strong>0.30</strong></td>
<td></td>
</tr>
<tr>
<td>Muhor Na</td>
<td></td>
<td>12</td>
<td>9.3</td>
<td>2.7</td>
<td>0.36</td>
<td></td>
</tr>
<tr>
<td>Aklil</td>
<td>Mokerker</td>
<td>11.4</td>
<td>9.23</td>
<td>2.17</td>
<td>0.37</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Average</strong></td>
<td><strong>11.7</strong></td>
<td><strong>9.27</strong></td>
<td><strong>2.44</strong></td>
<td><strong>0.37</strong></td>
<td></td>
</tr>
</tbody>
</table>

Source: Own data computation

### Beekeepers’ Attitudes towards Technology Package

It was found important to identify perceived relative advantage and disadvantage of chefeka hive technology package. This helped to assess beekeepers attitude on technology packages. As criteria to assess their response, high yield, easy for inspection, easy for harvesting and produce quality honey relative to traditional hive used for data collection (table).
Table 4. Perception of FREG members on chefeka hive technology package (N =60)

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Five point scale measurement</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Very low (1)</td>
<td>Low (2)</td>
<td>Medium(3)</td>
<td>High(4)</td>
<td>Very high(5)</td>
</tr>
<tr>
<td>High yield</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>40 (66.6%)</td>
<td>20 (33.3%)</td>
</tr>
<tr>
<td>Ease for inspection</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>4 (6.67%)</td>
<td>56 (93.3%)</td>
</tr>
<tr>
<td>Ease of harvesting</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2 (3.3%)</td>
<td>58 (96.67%)</td>
</tr>
<tr>
<td>Quality honey</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1 (1.67%)</td>
<td>59 (98.3%)</td>
</tr>
</tbody>
</table>

Source: own data computations

As shown on the above table, the majority of FREG members give high and very high value for technology packages and no value on medium, low and very low points. This can show as the perceived technological attributes/attitude is positive and pave the way for further scaling up of the technology package.

**Conclusion and Recommendation**

Chefeka hive made from locally available materials with technology package accepted and replicated by the target beneficiaries after they got practical training and demonstration of technology packages. Cost wise the cost of chefeka hive is affordable under farmers condition due to the reason that materials that can be used for the construction is from locally available materials. This in turn, brought about household annual income increments and improved livelihoods on average by ETB 195.60 per hive per season achieved over the traditional bee hive in the selected Woredas. In general, the advantages of using chefeka hive beekeeping technologies highly accredited by the users and their attitude on the technology package is also positive. As to recommendation, it is realized that these farmer beekeepers are transforming their beekeeping production system from ordinary to improved beekeeping management practices. Therefore, respective Woreda livestock agency should use this opportunity to further scaling up of technology package.

Currently, the beekeepers in the study area have been practicing crude honey processing into pure honey and pure beeswax for income generation. It is realized that pure beeswax could yield more income from a number of hives. And it is necessary to increase hive number in order to obtain ample amount of beeswax. Therefore, the beekeeping extension, NGOs and Development Practitioners can do more to utilize the existing beeswax of the area through provision of training on how beekeepers able to increase their hives number and boost hive products. It needs collaboration among the cooperative office of the Woreda, Livestock development and health Agency and NGOs to strengthen the existing beekeepers to establish beekeepers cooperative as they can be a learning environment for the similar areas. Improved beekeeping management practice is profitable for beekeepers and therefore, needs more popularization of the technology along with intensive basic beekeeping training.
References


Dessalegn Begna & Amssalu Bezabeh (2001). Survey of honeybee pest and pathogen in south and southwest parts of Ethiopia. The 16th proceedings of Ethiopian Veterinary Association


Scaling up of ‘Chefeka’ hive technology Packages in West Shoa Zone

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Abstract

Pre scaling of chefeka hive technology package conducted in Adaberga, Gindeberet and Jeldu Woreda with the main objective of disseminate technology package. As to the method, these Woredas selected purposively based on potentiality of the Woredas in beekeeping and non addressed areas with technology dissemination activity. Farmers research and extension groups (FREG) were used for technology dissemination. One FEG which contain 10 beekeepers established at each pre-scaling up site and there is one site in each selected Village Administration. Accordingly, two sites at Adaberga, four at Gindeberet and four at Jeldu Woreda selected. Backyard of model beekeepers used as center of learning and technology dissemination. At each sites, farmers development agents and experts trained, four chefeka hives with ant protection constructed, honey bee colony transferred to it and continuous honey bee colony follow up activities undertaken in partnership with FREG member, DAs and experts. Quantitative data collected for three honey seasons and analyzed using descriptive statics such as percentage and mean and presented in table. Qualitative data also collected and analyzed through explanation of idea, opinion and concept explanation method. As to the result, honey yield which ranges from 10.25kg/hive/season to 37kg/hive/season was harvested from pre-scaling up colonies and mean honey yield per hive per season at Adaberga, Gindeberet and Jeldu Wored was 16.25kg, 19.82kg and 17.25kg respectively. It can be concluded that yield per hive at beekeeper's backyard can be improved if chefeka hive package used. Therefore, livestock office should give attention to the dissemination of technology package.

Keywords: Pre scaling up, Chefeka hive, package, FREG, improved beekeeping

Introduction

The Ethiopian economy is largely based on subsistence agriculture, which is almost entirely rain fed. Among the rural population, 87% of the household receive their income from agriculture (World Bank, 2006). The agricultural sector accounts for 40% of national growth domestic product (GDP), 90% exports, 85% of employment and 90% of the poor (World Bank, 2007). From agriculture, livestock contribute up to 20% to Ethiopia’s GDP and livelihoods of 60–70% of the population. Beekeeping, which is one of the important livestock subsectors, contributes significantly to the improvement of the livelihoods of the nation’s population (Aklilu, 2002).

Ethiopia has a potential in beekeeping as the climate allows growing of different vegetation and crops which are a good source of nectar and pollen for honeybees. Large and diverse botanical resources combined with suitable climatic conditions make it conducive for the beekeeping business (Nuru et al., 2001). Due to this suitable natural environment, large honeybee colonies, which are estimated to be about 10 million, exist in the country (Workeneh, 2007). Moreover, about 5,207,300 hives exist in Ethiopia out of which about 95.96% was traditional, 1.06% transitional and 2.98% frame hives (Central Statistical Agency [CSA], 2013). Ethiopia stands eighth by producing about 21% of the total world and about 21.7% of total African honey production (Tigray Agricultural Marketing Promotion Agency [TAMPA], 2007).

In most cases Ethiopian beekeepers are observed to use traditional hives which is very difficult to manage honeybees and to produce honey and honey products in the required quality and quantity. The maximum yield obtained from a traditional beehive so far is estimated on average to be below 7 kg /hive. However it has been observed as more than 20kg / hive crude honey can be produced if top-bar hive is used. Chefeka hive made from locally available materials is important for our farmers as it is
extremely inexpensive and equally important as that of machine made top bar hives. As study report of Nuru and Edessa 2002 indicates, it is possible to use hand-made top-bar hives and frames from locally available materials (bamboo, Arundinariaptina), shembeko (Arundinariadonax), shimelel(Oxytenathera abyssinica) and eucalyptus). This hive does not also require accessory equipment like casting mold and honey extractor, which is not easily available in local area and study conducted by Workneh 2007 confirmed as the technology properly works under farmer’s condition. Varies participatory approach studies showed that an improved technology that is based on farmers’ participation is easily transferable and applicable. Farmers often accept that the experience of on farm demonstration, which is similar to their own situation. Therefore the main intention of this activity is to pre-scale up chefeka hive technology package in Adaberga, Gindeberet and Jeldu Woreda and to build beekeepers capacity in applying beekeeping technologies.

Methodology
Description of the Study Areas

Adaberga Woreda

Adaberga Woreda is one of the Woredas in West Shoa Zone, Oromia Region. It is located at 64 km North west of Addis Ababa on the road of Mugher cement Enterprise and located at 9° 12’ to 9° 37’ N latitude and 38° 17’ to 38° 36’ E longitude (Oromia Bureau of Finance and Economic Development [OBoFED], 2011). Demographically, Woreda’s total population is estimated to be 185,129, out of these 90% settled in rural area whereas 10% is urban dweller (OBoFED, 2011). Agro-ecologically, the Woreda divided into 3 zones namely highland ranging from (2500-3180) meter which comprises 29% of the total area and having range of temperature (10-15) °C, Mid high land having elevation of (1500-2500) meter which comprises 34% of the total area and having range of temperature (16-20) ° C and finally Low land that covers an elevation <1500 meter above sea level which comprises 37% of the total area having range of temperature (21-29) ° C (OBoFED, 2011). Three types of soil texture exist in the Woreda. These are, Black covers (44%), Red (39%) and Black sandy (17%) (OBoFED, 2011). The total live stock population of this Woreda was estimated at 125,929 cattle, 47,035 sheep, and 47,035 goats. Regarding beekeeping, there are 234 box hives and 17803 traditional hives (OBoFED, 2011).

Gindeberet Woreda

Gindeberet Woreda is also one of the Woredas in West Shoa Zone, Oromia Region. It is located to the South west on 137 Km from Ambo and 213 Km from Addis Ababa to the West. Demographically, Woreda’s total population is 204,413 out of these 3.82 were urban dwellers (Wikipedia, 2016). This Woreda is divided in to two agro-ecological zones namely mid which comprises 40% of the total area and has an altitude ranging between 1500-2604 meters above sea level and lowland which comprises 60% area and has an altitude between 1000-2500 meters above sea level (Wikipedia, 2016).
Jeldu Woreda

Jeldu Woreda is one of the Woredas in West Shoa Zone, Oromia Region. It is located to the East on 72 Km from Ambo and 115 Km from Addis Ababa to the West. Demographically, Woreda’s total population is 214,502. Three types of soil texture exist in the Woreda. These are Verty soil (42.1%), Nito soil (36.83%) and Sandy soil (21.05). The highest rainfall is 1270mm and the lowest is 700mm (OBoFED, 2011).

Site and Farmer Selection

This pre-scaling up activity was conducted from 2003-2005 E.C in target areas. Adaberga, Gindeberet and Jeldu Woredas were selected for pre-scaling up of chefeka hive technology package based on the assumption of potentiality of the sites, non addressed areas and close follow up. Ten pre-scaling up sites (two at Adaberga, four at Gindeberet and four at Jeldu were selected purposively based on convenience of the sites to disseminate the technology package. Ten beekeepers were selected purposively as members of FREG and one FREG established at each pre-scaling up sites. A total of 10 FREG, 100 beekeepers, established for pre-scaling activity. Apiaries of model beekeepers were used as center for learning and technology dissemination. Selection of the site and beekeepers was carried out in close consultation with the respective Woreda livestock offices.

Technology Transfer Approaches and Methods used for pre-scaling up of chefeka hive technology package

FREGs were used for technology dissemination and at each pre-scaling up sites one FREG which contain 10 beekeepers was established. All the activities in the technology dissemination process were undertaken with these FREG members. As to the method, practical training was given twice in the first and second years on selection of materials for construction, construction of hives, top bar preparation, hive standing making, colony transfer, follow up of established colony, protection of pest and predators and pre and post harvest handling of bee products. After training, four chefeka hives with ant protection constructed at each pre-scaling site, a total of 40 chefeka hives and 10 hive stands constructed, honey bee colonies transferred to them and regular honey follow up activities (inspection, feeding, inserting/removing partition, honey harvesting and processing) were undertaken at each season for three consecutive years by Holeta Bee Research Center (HBRC) technical staff in partnership with FREG members, Development Agents (DAs) and Woreda level experts. On the other hand, each FREG member constructed at least two chefeka hives at their backyard for wider dissemination of the technology and with the intention of exercising what they learned from common pre-scaling up sites.

Data collection

Primary data on numbers of sites and farmers selected; FREGs established; farmers, development agents and experts trained; hives and stands constructed; honeybee colonies transferred from traditional to chefeka hive; honeybee colonies absconded; frequency of inspection, feeding, inserting and removing partition; honey and beeswax harvested; processed honey and beeswax and number of stakeholders involved collected and documented. Secondary data also collected from respective Woreda livestock office, literatures, research reports and internet search.
Data Analysis

Quantitative data collected from pre-scaling up colonies analyzed using descriptive statistics such as percentage, mean and tables. SPSS computer software was also used to compute raw data. On the other hand, qualitative data was analyzed through explanation of idea, opinion and concept explanation method.

Results and Discussions

Under this topic, main results on training of farmers and stakeholders, technology dissemination, honey yield and economic benefits of the farmer in the pre scaling up discussed.

Training of Farmers and other stakeholders

Capacity of the beekeepers, DAs and experts to apply chefeka hive technology package built through two rounds theoretical and practical training conducted at respective Woreda. Training given mainly focused on beekeeping practices in Ethiopia; construction and use of chefeka hive, top bar and hive stand making; bee forages and apiary improvement; biology of honey bees, managing honey bee colonies in active and dearth periods, protecting honey bee colonies from pests, predators and diseases; pre and post harvest handling of bee products and honey bee queen rearing. Besides the training, FREG members, DAs and experts were participated on regular honey bee follow up activities such as feeding, inspection, inserting/removing partition, honey harvesting and processing according to the season at each pre-scaling up sites for three consecutive years. As shown on table one below, capacity of 94 beekeepers, 10 DAs and 7 experts built through 5 days training and practical demonstration of the technology package. In addition, technical staff of Holeta bee researcher, six researchers, four technical assistants and five field assistants took part in pre-scaling up of the activity in establishing colony, feeding, inspection, harvesting and processing of honey from pre-scaling up colonies at pre-scaling up sites for three consecutive years

Technology Dissemination

With this pre-scaling up activity, 94 beekeepers addressed with training and demonstration of technology package on 10 model beekeepers backyard which used as a center for technology dissemination and popularization. Construction and use of the hive with top bars is one component of chefeka hive technology package. After FREG members trained practically on hive making, they were expected to construct at least two chefeka hives at their backyard. A total of 214 chefeka hives with its top bars constructed at Gindeberet and Jeldu districts. There is no report on Adaberga Woreda on construction of hive and its top bars at FREG members backyard which showed problems in appropriate beekeepers selection and no follow up at their backyard after training. Mean construction of hive with its top bars was 2.9 hives per FREG member during the first year of the activity. When Woredas compared, mean construction of the hive per FREG member was greater at Gindeberet Woreda than Jeldu Woreda which was 3 and 2.5 hives per FREG member respectively. With regard to number of occupied chefeka hives with honey bee colonies after construction, 53.33% at Gindeberet and 42.86% at Jeldu were occupied with honey bee colonies. Moreover, from these occupied hives, 4.17% at Gindeberet and 16.67% at Jeldu absconded. (Table 1). This result shows follow up of FREG members by DAs and experts of respective Woredas after training at their backyard is very low which resulted in low dissemination of the technology package at FREG member’s backyard.
Table 1. Number of chefeka hives constructed by FREG members and occupied with honey bees.

<table>
<thead>
<tr>
<th>Woreda</th>
<th>Number of chefeka hives constructed by FREG members</th>
<th>No of hives Occupied by honeybees in %</th>
<th>Absconding rate in %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adaberga</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Gindeberet</td>
<td>3</td>
<td>53.33</td>
<td>4.17</td>
</tr>
<tr>
<td>Jeldu</td>
<td>2.5</td>
<td>42.86</td>
<td>16.67</td>
</tr>
</tbody>
</table>

*No data

Source: own data computation

**Honey Yield and Economic Benefit**

In this study, only honey yield obtained from pre-scaling up colonies established at model beekeepers apiary for three active seasons was used to compute the results. Honey yield which ranges from 10.25kg/hive/season to 37kg/hive/season was harvested from pre-scaling up sites. Mean honey yield 16.25kg/hive/season, 19.82 kg/hive/season and 17.25 kg/hive/season harvested at Adeberga, Gindeberet and Jeldu, respectively. Higher Mean honey yield, 27.13kg/hive/season, was recorded at Damota site than the other nine sites (Table 2).

Table 2. Average honey yield/hive harvested from pre-scaling up colonies

<table>
<thead>
<tr>
<th>Woreda</th>
<th>Name of Site/PA</th>
<th>Average honey yield/hive/season (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adaberga</td>
<td>Canco Biratte</td>
<td>16.5</td>
</tr>
<tr>
<td></td>
<td>Redjinekoda</td>
<td>16</td>
</tr>
<tr>
<td>Gindeberet</td>
<td>Bakebella</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Damota</td>
<td>27.13</td>
</tr>
<tr>
<td></td>
<td>Gemeda</td>
<td>21.23</td>
</tr>
<tr>
<td></td>
<td>Harobirbabo</td>
<td>15.92</td>
</tr>
<tr>
<td>Jeldu</td>
<td>Chilanko</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>Edensa Gelan</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Kollugelan</td>
<td>23.6</td>
</tr>
<tr>
<td></td>
<td>Tullubultuma</td>
<td>11</td>
</tr>
</tbody>
</table>

Source: own data computation

As shown on table 2 above, mean honey yield at pre-scaling up sites in Gindeberet Woreda is greater than Jeldu and Adaberga Woredas. This result shows Gindeberet Woreda has better potential in honey than the other two Woredas. Regarding the benefit, beekeepers were benefited from sell of honey on average of ETB 1,056.25 (50 ETB/kg), ETB 991.00 (65 ETB/kg) and ETB 1125.25 (65 ETB/kg) per hive per season at Adaberga, Gindeberet and Jeldu Woredas respectively.

**Conclusion and Recommendations**

It can be concluded that yield per hive at beekeeper’s backyard with minimum cost can be improved if chefeka hive is with its package, knowledge and skill of the beekeeper upgraded and continuous follow up assured by DAs and experts. There was also strong challenge in adopting post harvest handling package (processing) by FREG members particularly at Gindeberet Woreda and this needs works on awareness creation. The overall finding of this study mainly underlined the importance of extension support to the beekeepers in giving technical back till the beekeeper develop confidence on the technology package. Therefore, livestock office respective Woredas should give strong attention to the improvement delivery of extension service given to the beekeepers. Works on awareness
creation and convincing beekeepers and consumers on value added bee products should be done by all stakeholders at Gindeberet Woreda.

References


Pre-scaling up of Improved Forage Grasses and Legumes Under Rain Fed and Irrigation Conditions in East Shoa Zone

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Abstract

This activity has been conducted in Fentale and Adami Tulu Jido Kombolcha districts of East Shoa Zone with the objective of improving farmers' knowledge and skill of application of the improved forage technology through training, convincing the merits and increase confidence on the forage technologies, thereby to facilitate dissemination and adoption of the technologies through farmer-to-farmer extension approach and collect feedback/farmers' opinion on the performance of the forage technology. A total of 67 pastoralists (52 from Gidara and Dire Saden kebeles of Fentale district and 15 from Abjata Shula kebele of Adami Tulu Jido Kombolcha district were participated in pre-scaling up of forage varieties. Practical training on how to utilize forages as green feed, hay and silage was given on forage development and management for all participating farmers. About 5 hectares of Chloris gayana cv. massaba, 2 hectares of Pennisetum purpureum and 1 hectare of Lablab purpureus 147 were sown. Less technology gap and technology index was found for Chloris gayana cv. massaba than the other accessions. Farmers harvested the forages and used as green feed, hay and silage for their cattle and for seed production. As such in Gidara and Desta Abjata kebeles farmers sold 2000 ETB for one batch harvest of chloris gayana cv. massaba forage/seeds. Farmers mean knowledge score had increased by significantly increased by 32.75 after implementation of pre-scaling up activity. Majority of the respondent farmers expressed medium (50%) to the high (43.75%) level of satisfaction for extension services and performance of technology under pre-scaling up. Farmers are really impressed to this technology and in Fentale still producing Pennisetum purpureum and Chloris gayana cv. massaba in large. Generally it can be concluded pre-scaling up of Pennisetum purpureum and Chloris gayana cv. massaba is advisable especially at irrigation sites like Fentale and even Chloris gayana cv. massaba for ram fed if it is used for cut and carry. Therefore it is recommended that doing pre-scaling up activity to similar kebeles is advisable so as to benefit farmers in large and the activity has to be further strengthened and scaling up of this technology is expected from Livestock and Fishery office of each district and any stake holder that is why at this time Livestock and Fishery office is extending this activity to neighboring farmers.

Key words: Pre-scaling up, Forage Grasses, Forage legumes, Agro-pastoral, Stakeholders

Introduction

Livestock production is an important economic activity in mixed crop-livestock and pastoral production systems of East Africa region in general and Ethiopia in particular. Ethiopia, with its diverse climate and topography, is a country with wide resources and traditional skill and experience in livestock rearing (Ayana, 1999). The main feed resource for livestock in Ethiopia are natural pasture and crop residues, which are low in quantity and quality for sustainable production (Alemhayehu, 2004). Feed for livestock in Fentale and Adami Tulu is derived mainly from grazing natural pasture and crop aftermath and or crop residues. Natural pasture provides about 50% of total annual feed supply depend on availability of alternatives (crop residues). The natural pasture or grazing land comprises of permanent grazing land, shrub land, fallow lands, lands unsuitable for cultivation such as water logged, flooded areas, steep slopes, and road sides. In addition, some of the forested, bush lands provide some feed to browsing animals (Alemayehu, 2005).

These feed sources are reported as low in digestible energy and protein content and as such do, not meet requirement for production (Alemayehu, 2005). Proper feed conservation practices such as in the
form of hay and silage are not common in the project districts. Though there is crop residue, harvesting and storage techniques are not adequately done. The uses of by-products from cereal milling factories and oil processing plants are limited to urban area where it is available and quantity extracted is small and cannot be extensively used (Alemayehu, 2005). Similarly improved forages are new introductions in some villages of the project area. Their coverage is insignificant though there is the intention to extend them in many parts (data from livestock agency of the districts). The rapid increase of human population has forced the farming to reserve more land for crop production, and the areas available for animal grazing is diminishing.

As a result forage development as an input for animal production and productivity improvement is the best option in these districts. The yield of demonstration of improved forage was promising and beneficial to pastoralists/agro-pastoralists. Based upon this promising and fruitful achievement, initiation was created for further pre-scaling up and feed technology transfer work to be undertaken in at Fentale and Adami Tulu Jido Kombolcha districts.

Objectives

- To improve farmers’ knowledge and skill of application of the improved forage technology through training
- To convince the merits and increase confidence on the technologies, thereby to facilitate dissemination and adoption of the technologies through farmer-to-farmer extension approach,
- To collect feedback/farmers’ opinion on the performance of the forage technology (farmers’ feedback assessment)

Materials and Methods

Description of the study area

The pre-scaling up activity was carried out in Fentale and Adami Tullu Jido Kombolcha districts, East Shoa zone, Oromia regional state. Fentale is one of the districts located in mid rift valley which faces short and highly variable rain fall with mean annual rain fall of 550 mm. The mean minimum and maximum monthly temperature are 17.4 and 32.7 °C. The district is bordered on the southeast by the Arsi Zone, on the southwest by Basset, on the northwest by the Amhara Region, and on the northeast by the Afar Region. Livestock production still remains the main source of income in the district. However, now days there are also pastoralists who started producing some horticultural crops as a result of the newly constructed irrigation scheme.

Adami Tullu Jido Kombolcha district is also located in the mid rift valley, 167 km south of Addis Ababa on Awassa road. It lies at latitude of 7° 9' N and 38° 7' E longitude. Its altitude is about 1650 meters above sea level with an average annual rainfall of 760 mm. It has a bimodal rainfall from March to April (short rain) and July to September (long rains) with a dry period in May to June, which separates short rains from long rains (Teshome et al., 2012).

Site and farmer selection

Discussion was conducted with the district pastoral or Agricultural office, kebele chairman, development agents and supervisors on the issue of pre-scaling up of forage development. The discussion made clear that upon the recognition of the previous Adami Tulu Agricultural Research Center successful establishment of forages in the two kebeles, strong initiation was created among other pastoralists to be included in the program. After thorough discussion with leaders of Fentale district, two pastoral kebeles were selected namely Gidara and Dire Saden. These pastoral kebeles were selected because of their access for the government irrigation water scheme, their willingness to participate the pre-scaling up activity and having common land. Fifty two (52) pastoralists, twenty two (22) members from Gidara and thirty (30) members from Dire Saden were participate and both
theoretical and practical training was given on forage development and management. The source of the seed for all activities was from Adami Tulu Agricultural Research Center.

**Trial establishment and management**

Forage accessions, *Chloris gayana cv. massaba, Pennisetum purpureum* and *Lablab purpureous* 147 and were used at Fentale (Gidara and Dire Saden kebeles). While *Chloris gayana cv. massaba* were also used at Desta Abjata kebeles of Adami Tulu Jido kombolcha district. In each pastoral kebeles, three hectares of land were allocated for developing different forage species in 2010/11. In the year (2011/12), the pre-scaling up of the forage activities was further undertaken in Fentale at Gidara and Dire Saden. 5 kg *Chloris gayana cv. massaba* for each kebele was planted on a 50 x 100 m plot which was adjacent to the forage site of the previous year. Besides, this activity was undertaken in Adami Tulu Jido Kombolcha district at Desta Abjata kebele using rain following a questionnaire survey of feed resource in the village. Here ten farmers were selected after discussing with the farmers and training was given to them on forage production, they planted *Chloris gayana cv. massaba*. The land which varied from 0.0625-0.25 ha per individual farmer (1 ha for the ten farmers) was ploughed with oxen twice. The seeds were sown in June at seeding rate of 10 kg per hectare.

Before seeding the seeds were mixed with sand/soil and sown in the direction of the wind. Then, the sown seeds were covered with soil by dragging with tree branches. In the year 2012/13, five new farmers entered into the pre-scaling up of the forages land size ranging from 0.0625 to 0.5 ha per individual farmers and sow *Chloris gayana cv. massaba*. Thus making the participating farmers 15 with a 2ha allocated total area for forage development. In general, about 8 hectares of land was allocated for forage development within three years. The land preparation and agronomic activities like weeding, irrigating and guarding was undertaken for all forage development activities by the agro-pastoralists and pastoralist themselves.

**Training of farmers' and other stakeholders**

Both practical and theoretical training was given for the participant farmers, DAs for each kebele and livestock expert from both district before the actual experiment was done to create awareness. Totally 137 farmers, 3 DA's and 2 experts were trained throughout the pre-scaling up activity.

**Field day organized**

Actually there is no field day organized by the researchers, however, Fentale district pastoral office takes farmers from other kebeles and teach them and takes the area as a model for forage development from the district and different pastoralists takes the initiatives from this activity and tries to develop their own forage in their lands.

**Data collection**

Data on Harvesting of total forage yield per meter square were undertake at its 10 - 50% flowering stage. The fresh weight was taken in the field using a top-loading field balance. Fresh subsamples were taken from each plot and each plant species separately then, weighed and chopped into short lengths (2-5cm) for dry matter determination. The weighed fresh subsample (FWss) was oven dried at 65 °C for 72 hours and reweighed (DWss) to give an estimate of dry matter yield. The dry matter yield (tone/ha) was calculated as (10 x TotFW x (DWss / HA x FWss)) (Tarawali et al., 1995).

Where: TotFW = total fresh weight from plot in kg
DWss = dry weight of the sample in grams
FWss = fresh weight of the sample in grams.
HA = Harvest area meter square and
10 = is a constant for conversion of yields in kg m² to tone/ha
To study the impact of pre-scaling up, out of 67 participating farmers, a total of 16 farmers were selected as respondent through proportionate sampling. Production data for pre-scaling up forage accessions were collected and analyzed. The technology gap and technology index were calculated using the following formulas as given by Samui et al. (2000): Technology gap = Potential yield – Pre-scaling up yield
Technology index = Potential yield – Pre-scaling up yield / Potential yield × 100.

Knowledge level of the farmers about improved production practice of improved forages before pre-scaling up implementation and after implementation was measured and compared by applying t-test. Further, the satisfaction level of respondent farmers about extension services provided was also measured based on various dimensions like training of participating farmers, timeliness of services, supply of inputs, solving field problems and advisory services, fairness of scientists, performance of variety pre-scaling up and overall impact of pre-scaling up activities. The selected respondents were interviewed personally with the help of a pre-tested and well structured interview schedule. Client Satisfaction Index was calculated as developed by Kumaran and Vijayaragavan (2005). The individual obtained score
Client Satisfaction Index = \frac{\text{The individual obtained score}}{\text{Maximum score possible}}

Data analysis

The data collected on dry matter yield was analyzed by simple descriptive statistics. Impact and satisfaction levels were tabulated and statistically analyzed by SPSS to interpret the results.

Results and Discussions

Technology dissemination

The technology was disseminated through giving theoretical and practical training for Livestock experts, DA's and farmers in selected kebeles on forage development and utilization in which 2 experts, 3 DA's and 67 farmers were participated and provided with seeds/cuttings of the forage. The experts and DA's were playing a great role in the dissemination by assisting the researchers during land preparation, distribution of seeds, follow up of the activity and teaching other farmers. Farmers have also contributing a lot for the dissemination of the technology through providing seeds/cuttings for other farmers nearby them. Through this forage species Chloris gayana cv. massaba, Pennisetum purpureum and Lablab purpureous 147 were distributed and sown at Fentale (Gidara and Dire Saden) covering 2.5 hectare of land in each peasant association in 2010/2011 as a pre-scaling up activity. Here 52 farmers were involved in total. Later on in 2011/2012, 2 hectare of Rhodes grass (Chloris gayana cv. massaba) were distributed and sown at Adami Tulu Jido Kombolcha district (Desta Abjata) and Fentale district (Gidara and Dire Saden) kebele. Here again a total of 62 farmers, 52 farmers from the Gidara and Dire Saden in Fentale and 10 farmers from Adami Tulu Jido Kombolcha District, Desta Abjata kebeles, were benefited. Finally in 2012/2013 1 hectare of Chloris Gayana cv. massaba were distributed and sown at Adami Tulu Jido Kombolcha district (Desta Abjata kebele) and again 10 additional farmers were benefited from this project.

Forages sown in 5 hectares and 1 hectares of land in Gidara and Dire Saden in 2010/2011 and 2011/2012 respectively were grown in good manner since it is supplemented with good irrigation. From this farmers are producing green forage, hay, silage for their own animals and seeds for next seeding. Of the ten farmers from Adami Tulu Jido Kombolcha district, 5 of them managed properly in 2010/2011. Among the five farmers, two of them produced 50 kg of seeds each. The rest of the farmers used the forage as hay to fed their animals and fatten oxen. In the year 2012/13, five new farmers entered into the scaling up of the forages total becoming 10 farmers (land size 0.0625-0.5 ha totaling two hectares of land). Two of the farmers added 0.25 hectares each and they used their own seeds. One farmer has also gave seed to one from his previous harvest. The rest of the farmers
obtained the seed from Adami Tulu Research Center. All the ten farmers harvested Chloris gayana cv. massaba for hay making but because of the shortage of rainfall, the plants did not set seeds. Here in general sense farmers are able to produce green forage, hay, silage and seeds from this technology. Besides this 60 farmers were given training on forage development and establishment without providing them forage seeds.

**Dry matter yield of improved forages**

The yield of improved forages sown for pre-scaling up activity was measured for each districts and kebeles. Accordingly, the highest dry matter yield of forage species of Chloris gayana cv. massaba (11 t/ha), Pennisetum purpureum (18.6 t/ha) and Lablab purpureus 147 (9.3 t/ha) forage accessions were recorded at Gidara site where ample amount of irrigation and proper management by farmers was found than Dire Saden and by rain fall at Desta Abjata where forages are harvested once a year. The dry matter yield of those forages were almost above the on station performance where 10.5 t/ha, 14.5 t/ha and 9.3 t/ha recorded for Chloris gayana cv. massaba, Pennisetum purpureum and Lablab purpureus 147 respectively by using rain. This result is almost higher than the finding of (Aklilu et al., 2014, unpublished) similar works done at Amibara and Awash Fentale districts which is 7 t/ha, 12 t/ha for Chloris gayana cv. massaba, Pennisetum purpureum respectively but lower for Lablab purpureus 147 which they found dry matter yield of 15 t/ha. The difference is may be due to the availability of irrigation throughout the growing season, management of the field trials and soil factors.

The on-farm and potential yield of the improved forages were compared to estimate the yield gaps which were further categorized into technology index(Table 1). The technology gap shows the gap in the pre-scaling up yield over potential yield and it was 321, 315 and 754 kg ha⁻¹ for Chloris gayana cv. massaba, Pennisetum purpureum and Lablab purpureus 147 forage accessions. The observed technology gap may be attributed to dissimilarities in soil fertility, salinity and erratic rainfall and other attributes of weather conditions in the area and management practices. Hence, to narrow down the gap between the yields of on station and on farm performance proper management of the forage at farmers level is essential. Technology index shows the feasibility of the variety/accessions at the farmer’s field. The lower the value of technology index more is the feasibility. Table 2 revealed that the technology index values were 2.21, 13.33 and 81.07 for Chloris gayana cv. massaba, Pennisetum purpureum and Lablab purpureus 147 forage accessions respectively. Therefore Pennisetum purpureum was more feasible than the rest accessions in the area. The finding of the present study are in line with the findings of (Aklilu et al., 2014, unpublished)

Table 1: Yield, technology gap and technology index of pre-scaling up activity

<table>
<thead>
<tr>
<th>Forage types</th>
<th>Yield in kg ha⁻¹</th>
<th>Technology gap (kg ha⁻¹)</th>
<th>Technology Index (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pennisetum purpureum</td>
<td>14179</td>
<td>321</td>
<td>2.21</td>
</tr>
<tr>
<td>Chloris gayana cv. massaba</td>
<td>10297</td>
<td>203</td>
<td>13.33</td>
</tr>
<tr>
<td>Lablab purpureus 147</td>
<td>8546</td>
<td>754</td>
<td>81.07</td>
</tr>
</tbody>
</table>

Ha = hectare and Kg = kilogram

**Economic benefit to the farmers**

Fentale pastoralists at all used forage grass as cut and carry, hay and silage for their cattle. By selling forages (Pennisetum purpureum and Chloris gayana cv. massaba) they improve their income. The farmers involved in pre scaling up of improved forages in Fantale Gidara site used the forage they developed for fattening of animals. In Fantale Gidara site one pastoralist sell Rhodes grass for 2000 ETB at one cutting. At Adami Tulu Desta Abjata PA 10 farmers participated in the development of Rhodes grass were prepared hay and fed to fatten animals and selling forages seeds (80 Birr/kg). Two farmer sold 50kg of Chloris gayana cv. massaba seed for 4000 ETB.
Change in level of knowledge and skill of participating farmers

Knowledge level of respondent farmers on various aspects of improved forage production technologies before conducting the pre-scaling up and after implementation was measured and compared by applying dependent ‘t’ test (Table 2). It could be seen from the table 3 that farmers mean knowledge score had increased by 32.75 after implementation of pre-scaling up activity. The increase in mean knowledge score of farmers was observed significantly higher. As the computed value of ‘t’ (1.205) was statistically significant at 5% probability level. It means there was significant increase in knowledge level of the farmers due to pre-scaling up activity. This shows positive impact of pre-scaling up activity on knowledge of the farmers that have resulted in higher adoption of improved forage. The results so arrived might be due to the concentrated educational efforts made by the researchers. Here in general sense farmers are able to produce green forage, hay, silage and seeds from this technology. Through this there is a transformation of knowledge and skill to the farmers.

Table 2: Comparison between knowledge levels of the respondent farmers about Improved forage pre-scaling up (n=16)

<table>
<thead>
<tr>
<th>Mean score</th>
<th>Calculated ‘t’ value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before pre-scaling up implementation</td>
<td>After pre-scaling up implementation</td>
</tr>
<tr>
<td>35.06</td>
<td>69.81</td>
</tr>
</tbody>
</table>

* Significant at 5% probability level.

Farmers’ satisfaction and feedback

The level of satisfaction of respondent farmers on the performance of the technology was measured by Client Satisfaction Index (CSI) and results presented in table 3.

Table 3: Extent of farmers satisfaction on the technology (n=16)

<table>
<thead>
<tr>
<th>Satisfaction level</th>
<th>Number</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>1</td>
<td>6.25</td>
</tr>
<tr>
<td>Medium</td>
<td>8</td>
<td>50</td>
</tr>
<tr>
<td>High</td>
<td>7</td>
<td>43.75</td>
</tr>
</tbody>
</table>

It is observed from table 3 that majority of the respondent farmers expressed medium (50 %) to the high (43.75 %) level of satisfaction on the performance of technology under pre-scaling up. Whereas very few (6.25 %) percent of respondents expressed lower level of satisfaction. The medium to higher level of satisfaction with technologies demonstrated indicate stronger conviction, physical and mental involvement in the pre-scaling up activity which in turn would lead to higher adoption. This shows the relevance of pre-scaling up activity. Farmers are really impressed to this forage development and this type of activity should be promoted further to cover large area. Farmers in Fentale are still producing *Pennisetum purpureum* and *Chloris gayana cv. massaba* in large.

Monitoring and Evaluation

The activity has been monitored majorly by researchers and Live stock and Fishery office of the districts which they represented by the DA’s in the kebele. The development agents (DA’s) see and monitore the activity day to day since they are near to the farmers and also give technical assistant to the farmers. When the experiment was finished the activity was given to the Livestock and Fishery office of the districts so as to go further for the adoption of this technology to other neighboring farmers.

Conclusions and Recommendations
Conclusions

The pre-scaling up activity was conducted in irrigated area of Fentale with pastoralists and agro pastoral communities and at Adami Tulu Jido Kombolcha district, Desta Abjata kebeles. Theoretical and practical training were given for Livestock experts, DAs and farmers in these kebeles on forage development and utilization in which 2 experts, 3 DA's and 67 farmers were participated. Forage species Chlorella gayana cv. massaba, Pennisetum purpureum and Lablab purpureus 147 were distributed and sown on 5, 2 and 1 hectares of land respectively in three districts throughout the project year covering 0.0625-0.25 land size for each farmer. Less technology gap and technology index was found for Chlorella gayana cv. massaba. The farmers were able produce green forage, hay, silage for their cattle and fattening purpose and seeds. They acquire the knowledge of selling fresh forage and seeds and generate income of 2000 ETB from sell of one batch cutting/seeds at each pre-scale up site. Farmers mean knowledge score had increased by significantly increased by 32.75 after implementation of pre-scaling up activity. Majority of the respondent farmers expressed medium (50 %) to the high (43.75 %) level of satisfaction for extension services and performance of technology under pre-scaling up. Farmers are really impressed to this technology and in Fentale still producing Pennisetum purpureum and Chlorella gayana cv. massaba in large. Generally it can be concluded pre-scaling up of Pennisetum purpureum and Chlorella gayana cv. massaba is advisable especially at irrigation sites like Fentale and even Chlorella gayana cv. massaba for rain fed if it is used for cut and carry.

Recommendation

From this it was recommended that doing pre-scaling up activity to similar kebeles is advisable so as to benefit farmers in large. This activity has to be further strengthened and scaling up of this technology is expected from Livestock and Fishery office of each district and any stake holder

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Pre Scaling Up of Crop Residue Treatment Technology for Improving Quality and Nutritive Value of Crop Residues for Fattening in West Arsi and East Showa Zone of Oromia Regional State, Ethiopia

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Abstract

Pre scaling up of crop residue treatment technology for improving quality and nutritive value of crop residues for fattening was conducted under market oriented crop-livestock production system of East Shoa and West Arsi zones of Oromia Regional state during the dry season (January to March). The study was undertaken in two kebeles of Adami Tulu Jido kombolcha and one kebele of Arsi Negele district, Anano shisho, Desta Abjeta and Kersa Itala, respective with the objectives of to convince the merits and increase confidence on the technologies, thereby to facilitate dissemination and adoption of the technology; to collect farmers’ opinion on the performance of the technology; to improve farmers’ knowledge and skill of application of the improved technology through training and to increase local capacity for future scaling-up or out of the technology. Maize is the major crop residue at Adami Tulu Jido kombolcha whereas, wheat, barley & teff straws are the major crop residue used for fattening at Arsi-Negale. Amount of ingredients used were Straw (200kg), Water (200L), Urea (5kg) for single pit (1m*1m*2m) with a capacity of 200kg of urea treated straw. Totally about 5800kg straw was treated by urea in selected kebeles and provided for fattened animals. Biological and economical data were analyzed by using descriptive statistics. Twenty nine oxen were fattened by twenty nine farmers in selected kebeles. The end result of the study revealed that daily weight gain of animal was 0.54 kilogram per day within net return of 1474 Ethiopian birr per animal in ninety days. Therefore this technology should be further scaled up by stakeholder body in area where at molasses and crop residues are available.

Key word: Urea treated straw, pre scaling up, stakeholder, Arsi oxen, Crop residue

Introduction

Treatment of crop residues with ammonia using fertilizer grade urea has received much attention, especially in Asia. Urea-ammonia treatment of straw is a technically effective and feasible on-farm technology to improve the nutritive value of fibrous crop residues. The feeding of urea treated straw alone will lead to some increase in production, but the full potential will only be realized when the correct supplements are added. A supplement of bypass protein is the most important. In most of the Asian countries, especially Bangladesh, China, India and Pakistan, programs have been launched by combining alkali treatment and appropriate supplementation leading to practical rice-straw-based feeding systems and extension of these technologies to the target groups (Dolberg 1992; O'Donovan et al 1997; Tengyun 2000; Sharma et al 2004; Roy and Rangnekar 2006). As a follow up of global experience, national efforts are also underway in Ethiopia to evaluate and refine these interventions under local situation. Despite availability of scientific information and technology both locally (Mesfin and Ledin 2004) and globally, feed production and utilization in rural community has remained traditional. Efforts made to demonstrate and popularize feed technology in the country were very much limited to the sites around research centers or limited to participants of extension packages. Increases in animal productivity come from the development and transfer of improved feed technology and feed use.

The Mid rift valley area of Ethiopia is characterized by mixed crop livestock farming systems where the crop and livestock sub-systems complement each other. This area is inhibited by large human and livestock population. The area of land allocated to grazing land is progressively declining through
time due to expansion of cultivation. As more and more land is put under crop production, livestock feed becomes scarce and crop residues particularly cereal straws remain the major feed source for animals particularly during the dry period of the year. The use of crop residue can reach up to 80% during dry seasons of the year (Solomon, 2004; Berhanu et al., 2009; Ahmed et al., 2010). However, crop residues are known by their high cell wall and low protein, energy and mineral contents (Solomon et al., 2008). As a result, their intake is limited and they hardly fulfill even the maintenance requirements of animals for essential nutrients (Zewdie et al., 2011). This suggests the need for exploring alternative supplementation strategies that would help to enhance the quality of these low quality feeds.

The concept of urea straw treatment is to increase digestibility of organic nutrients, voluntary intake, protein content, productivity of livestock and animal performance, palatability, storage duration, reduce feed wastage and refusal during feeding. Untreated maize husk which is fed as a sole diet contained 5.76% CP, which is less than the marginal CP required for maintenance of the animal, particularly at high temperature and high relative humidity. Urea treated straw has higher quality, in addition it needs low costs (P B O'Donovan, et al., 1997). Untreated straws has 2-4 % CP and Treated straw has 7-12% CP which is sufficient for maintenance of live weight (Ghadaki et al., 1972). Therefore this study was undertaken to pre scaling up of crop residue treatment technology for improving the nutritive quality of crop residues on farm condition.

Objectives

- To convince the merits and increase confidence on the technologies, thereby to facilitate dissemination and adoption of the technology
- To collect feedback from farmers' opinion on the performance of the technology (farmers' feedback assessment)
- To improve farmers' knowledge and skill of application of the improved technology through training
- To increase local capacity for future scaling-up/out of the technology
- To strengthen stakeholders linkage and collaboration

Material and Methods

Description of Study Area

Pre scaling up work was conducted under market oriented crop-livestock production system of East Shoa and West Arsi zones during the dry season (January-March) at two kebeles (Anano Shisho and Desta Abjata from East Shoa and Kersa Hala from West Arsi zone), Mid rift valley of Ethiopia. Geographically, it extends from 7°09'N to 8°45'N and 38°32'E to 39°17'. The valley has about 40-60km width and bound by highland plateaus. The altitude ranges from 500 to 2000msl and has semi-arid type of climate. Its temperature ranges from 10.8-25°C. The area receives an annual rainfall of about 500-9000mm. Cereals (teff, wheat, barley and maize), pulse (haricot bean) and tuber crops (Irish potato) are grown in this area. More attention is given to the livestock production especially dairy and beef. As a result the districts were selected with the view that it could represent the beef production system in the Mid Rift Valley of the country. The kebele's within the districts were selected with the help of extension agents, representing the agro-ecology in terms of climate and market oriented crop-livestock production system.

Farmers' selection

Fifty two farmers were purposely selected with collaboration of Development agent (DAs) based on; Farmers experiences and practiced in cattle fattening activities, Having availability of crop residue,
water availability around homestead, willingness to prepare pit and willingness to accept and disseminate technology. After farmers selected training was provided on methods of improving nutritive value of crop residue, usefulness of urea treated straw, method of feeding, precaution taken during feeding and preparation, entire management of fattening program. Size of pit used for treatment (1*1*2m). Ingredients used in treatment: procedure of preparation and finally crop residue treatment was conducted in the study area by the trainees.

Ingredients and materials used

This technology is biologically and economically feasible at farmer condition. Because of all ingredients are locally available at farmers’ level. Ingredient used in the study area were water, crop residue (wheat, teff, barley straw and maize Stover) and urea. Amount of ingredients used for prepared silo with dimensions of 2m length, 1m width and 1m height (1m *1m*2m), straw (200kg), water(200L) and urea (5kg). The ratio of water urea solution to straw was 1:1 (200L of solution for 200kg of straw) P B O’Donovan, et al.. 1997. Materials used in the study were chopper, weighting balance, pit, polythene plastic sheet(10m), Barrel, Water spray, Sack roller (man power, Shovel, Digging hoe and Indian hoe

Preparation of urea treated straw

The treatment of the straw was done in the ground rectangular silo constructed two pit using pieces of wood, available at the farm on the corner location on their farms. Each pit had dimensions of about 2m * 1m * 1m, with a capacity of 150-200 kg of urea treated straw. The entire wall of the pit was lined with a mixture of soil and dung. A polythene plastic sheet lined the floor and side of the pit. In order to prepare 100 liters of solution, 5kg urea was added to 100 liters of water and stirred very well until the urea dissolves and clumps of urea disappeared from the solution.

The ratio of water urea solution to straw used was 1:1 (200 liters of solution for 200kg of straw). Untreated straw, in batches of ten kg weighed by using a sack, was spread in the silo over a plastic sheet layer. Ten liter of urea solution was sprinkled uniformly over the straw layers using a sprinkler. The treated straw was mixed by using a fork. Further batches were treated following similar procedures. After treating one layer of straw, it was pressed by trampling (compressed) manually before the next layer was placed on top and finally the stack was covered tightly with a plastic sheet to exclude the entrance of oxygen and prevent ammonia from evaporating for adequate fermentation. The stack was loaded with heavy materials with either stones or wood, according to the available materials. The treated straw was opened after three weeks from one side to take out the straw. The urea treated straw was aerated for a minimum of 12 h prior to feeding to facilitate the escape of free ammonia (Misra et al. 2006). The treatment of the straw and feeding were synchronized in such a way that animals got urea treated straw without any interruption during the entire period of experiment.

Animal selection and Feeding

Animals selection was done from their herds they have, based on body frame of animals by the use of heart girth and age of animals were estimated by their teeth. Before feeding selected animals were dewormed from internal parasite by Albendazole (2500mg). adaption period is needed for animals that have not previously consumed urea-treated low quality roughages. This allows them to become familiar with the feedstuff and, in particular, with the ammonia odor. The level of treated low quality roughage fed can be gradually increased over a period of 1-2 weeks and provided by mixing with the feed stuff previously being given for selected oxen. Urea treated straw and water provided ad-libitum. Additionally 0.5 kg of concentrate mixture (mixture of noug-cake and wheat bran in 1:1 ratio) were given by mixing with treated straw to selected animals for three months.
Data collection

Initial body weight, finally body weight, initial price, finally price, feed cost and opinion of the farmers toward the importance of the technology were collected.

Statistical analysis

Data on initial and final body weight, initial and final price and feed cost were analyzed by using descriptive statistics. Initial body weight and final body weight data were taken by heart girth. Total live weight gain (TLWG) = FWG-IW, DWG= TWG/TFD were FW=Final weight gain of animals IW= Initial weight of animals DWG= Daily weight gain, TFD= total fattening days.

Body weight of animals was estimated from heart girth measurement using the regression equation developed by ILRI as cited by Yoseph (1999).

\[
Y = -423.405235 + 4.833697x \quad (R^2 = 0.86; CV= 10\%)
\]

Where, \(Y\) = Estimated body weight, Kg (weight range for prediction was 200-500 kg) and \(x\) = Heart girth, cm

Results and Discussions

Farmers’ training

Training was provided for the farmers on: Awareness creation on the importance of urea straw treatment, Selection criteria of animals to be fattened (based on body frame of the animals), Ingredients to be used for preparation, procedures to be followed for preparation, and Precautions to be taken during feeding.

Table 1: Numbers of farmers trained (involved both Husband and Wife in some households)

<table>
<thead>
<tr>
<th>Districts</th>
<th>Kebeles</th>
<th>Participants</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>ATJK</td>
<td>Desta Abjeta</td>
<td>15</td>
<td>7</td>
</tr>
<tr>
<td>Anano shisho</td>
<td>Kersa Ilala</td>
<td>11</td>
<td>6</td>
</tr>
<tr>
<td>Arsi Negele</td>
<td>Total</td>
<td>35(67.3%)</td>
<td>17(32.7%)</td>
</tr>
</tbody>
</table>

Farmers’ participation

After training was provided for farmers in selected kebeles twenty nine famers had participated in the technology up to the end(Table 2).

Table 2. Total number of participants in three Kebeles

<table>
<thead>
<tr>
<th>District</th>
<th>Kebeles</th>
<th>Number of farmer</th>
<th>Number of animals fattened</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Male</td>
<td>Female</td>
</tr>
<tr>
<td>ATJK</td>
<td>Desta Abjeta</td>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td>Anano Shisho</td>
<td>Kersa Ilala</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>Arsi Nagelle</td>
<td>Overall</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Overall % of</td>
<td>20</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>participants</td>
<td>68</td>
<td>32</td>
</tr>
</tbody>
</table>

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Body weight changes

After feeding the urea treated straw and concentrate feed animals were attained 48.5kg of average body weight gain and the average daily body weight gain of the animal was 0.54kg per day which similar with work done by ATARC unpublished report(Table 3).

Table:3 Body weight changes

<table>
<thead>
<tr>
<th>Kebeles</th>
<th>MIBW/kg</th>
<th>MFBW/kg</th>
<th>MTWG/kg</th>
<th>MDWG/kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Desta Abjata</td>
<td>226.42</td>
<td>270.92</td>
<td>44.5</td>
<td>0.49</td>
</tr>
<tr>
<td>Anano shisho</td>
<td>221.33</td>
<td>262.33</td>
<td>41</td>
<td>0.46</td>
</tr>
<tr>
<td>Kersa Itala</td>
<td>213.75</td>
<td>273.75</td>
<td>60</td>
<td>0.67</td>
</tr>
<tr>
<td>Overall mean</td>
<td>220.5</td>
<td>269</td>
<td>48.5</td>
<td>0.54</td>
</tr>
</tbody>
</table>

Where MIBW= mean of initial body wt, MFBW= mean of final body wt, MTWG= Mean of total wt gain MDIVG= mean of daily weight gain

Treating straw

After training was provided for selected farmers, site was selected around their home stead for pit (silo) preparation and then pit was prepared by 2m*1m*1m size for each farmers. Totally about 5800kg of straws were treated by urea in selected kebeles.

Partial Budget Analysis

Simple calculation was done to determine gross profit using feed cost and animal purchasing price. Estimation of labor cost was difficulty since farmer using his family as labor and gives little time for feeding, watering and other management. The cost of feed per animal was 341.6 Ethiopian birr and average price of animal purchased was 3614 Ethiopian birr. The total cost of production per animal was 3956birr. The farmers were sold the fattened animal at local market with gross margin 1474 Ethiopian birr per animal.

Table :4 Partial budget analysis

<table>
<thead>
<tr>
<th>Items</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Animal purchased price per head</td>
<td>3614.35birr</td>
</tr>
<tr>
<td>Crop residues cost per head</td>
<td>140birr</td>
</tr>
<tr>
<td>Concentrate cost per head</td>
<td>201.6birr</td>
</tr>
<tr>
<td>Total cost per head</td>
<td>3955.95birr</td>
</tr>
<tr>
<td>Gross return/revenue per head</td>
<td>5429.44birr</td>
</tr>
<tr>
<td>Gross margin per head</td>
<td>1473.49birr</td>
</tr>
</tbody>
</table>

Feedback assessment

Almost all the participants reported that, the consumption of treated straw by animals was achieved after a week from when this type of feed has been introduced to the animals. Urea treated straw increase productivity and body weight gain of fattened animals after adaption period. Participants noticed that the benefits of feeding the intervention diet were not visible immediately. It took 2 to 3 weeks depending upon the adaptation of the new diet by the oxen. This types of technology was accessible to us, because of all used ingredients are available in our farm level. They noticed that animals fed urea-treated low quality roughage require lower level of supplemental concentrate feed to
achieve a desired level of animal performance as compared with animals fed untreated low quality roughage.

**Challenge encountered**

Some animals were refused to consume the treated straw for first time of feeding. This challenge was solved by mixing atela and other feeds which were previously fed by animals, for the sake of adaption.

**Conclusions and Recommendations**

**Conclusion**

Urea treated straw is an important source of supplementation which made from local available materials. Maize is the major crop residue at Adami Tulu Jido Kombolcha district Where, whereas, wheat, barley and teff straws are the major crop residue used for fattening at Arsi-Negale district. The fattened animals were attained 0.54kg daily weight gains within net return of 1474 Ethiopian birr per animal in ninety days. As this result showed that urea treated straw improve animal performance, improve quality, increase shelf life of treated crop residues and increase animal body weight gain. As the farmers noticed that animals fed urea-treated low quality roughage require lower level of supplemental concentrate feed to achieve a desired level of animal performance as compared with animals fed untreated low quality roughage.

**Recommendation**

If Urea treated straw is properly disseminated and extended in the study area and other districts of the zones, it will play a vital role for poverty alleviation of poor livestock farmers. Farmers show a enormous interest to exercise further this technology. Therefore, livestock development sectors, local farmer groups and farmer cooperatives should be further scale up this feeding package technology where at molasses and crop residues are available.

**References**


Pre Scaling Up of Urea Molasses Block (UMB) Technology to Fatten Arsi Oxen in West Arsi and East Shoa Zone of Oromia Regional State, Ethiopia

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nbx99@gmail.com

Abstract

Pre scaling up of urea molasses block fattening technology was undertaken in two kebeles of Adami Tulu Jido Kombolcha and one kebele of Arsi Negele districts, Anano shisho, Desta Abjeta and Gembelto, respectively with the objectives of to convince the merits and increase confidence on the technologies, thereby to facilitate dissemination and adoption of the technology, to collect farmers’ opinion on the performance of the technology, to improve farmers’ knowledge and skill of application of the improved technology through training and to increase local capacity for future scaling-up or out of the technology. It was conducted on farm conditions by using Urea molasses block as a supplement to Arsi oxen during the dry period (December-May). The block were made up of different ingredients such as Urea, wheat bran, Molasses, Cement, Mineral (boji), salt and noug cake. Those ingredients were purchased from local market. A total of forty-two farmers and development agents (DAS) were getting practical training about the block manufacturing and method of feeding. Farmer training center (FTC) was used as sites of training and demonstration during technology was conducted. Thirty one oxen were used for this study from all selected kebeles. Biological and economical data were analyzed by using descriptive statistics. The end result of the study revealed that daily weight gain of animal was 0.45 kilogram per day with net return of 1173 Ethiopian birr per animal in ninety days. The result of the study shows that Urea molasses block improve body condition of animals, increase body weight gain and makes farmer profitable. Therefore, this technology should be further scaled up by stakeholder in area where at molasses and crop residues are available.

Key words—urea molasses block, peasant association, pre scaling up, Arsi oxen, crop residues

Introduction

In Ethiopia most of animal feed resource is from natural pasture and crop residues. This types of feed contains low level of nitrogen (Solomon et al. 2008) so that rumen microorganisms unable to show their activity due to lack of necessary amount of ammonia and Amino acids. UMB may be used for supplementation of straw based diet in dairy and meat production of small holder farmers.

Supplementation with straw based diet could increase feed intake daily live weight gain, daily milk yield and longer lactation period (Banerjee G.C, 1982). Besides this it acts as storage feed during critical periods of livestock feed scarcity. UMB is a high protein concentrated feed containing necessary amount of minerals and vitamins. It supplies Non protein Nitrogen (NPN) to the rumen microbes without any risk. It contains sufficient nitrogen and energy for rumen micro-organisms. Urea is a non-protein nitrogen (NPN) product which can be used as a nitrogen source while molasses used as supplementary energy source. The nitrogen from urea is used by the rumen microbes to make microbial protein. Urea Multi Nutrient block (MUB) contains important ingredients i.e. Urea, noug cake, molasses, mineral mix, wheat bran and salt. It was proved to be complete balanced diet for the animals. It enhances the intake of the animal’s especially roughage feeds.

According to the fattening experiment conducted at Adami Tulu Agricultural Research center (ATARC) (Dawit et al. 2008), higher total and average daily gain was observed with Urea
molasses block and maize silage based ration on Arsi oxen. Therefore, this work was conducted to pre scaling up of UMB feeding technologies to the farmers of the selected kebeles.

Objectives

- To convince the merits and increase confidence on the technologies, thereby to facilitate dissemination and adoption of the technology.
- To collect feedback/farmers’ opinion on the performance of the technology (farmers’ feedback assessment)
- To improve farmers’ knowledge and skill of application of the improved technology through training
- To increase local capacity for future scaling-up/out of the technology
- To strengthen stakeholders linkage and collaboration

Material and Methods

Description of study area

The study was conducted on farm conditions using UMB as a supplement to Arsi oxen during the dry period (December-May). The area has erratic, unreliable and low rainfall, averaging between 500 and 900mm per annum. The rain fall is bi-modal with the long rain June to September (Abule et al 1999). The study was undertaken in two kebeles of Adami Tulu Jido kombolcha and one kebele of Arsi Negele district, Anano shisho, Desta Abjeta and Gembelto respectively.

Farmers’ selection

In this three kebeles farmers were purposely selected based on; Amount of crop residue owned, Availability of drinking water around home stead, Proximity to road, Willingness to accept and disseminate the technology and relatively more number of farmers practicing in cattle fattening activity. A total of forty two farmers and three development agents (3DAS) were selected in this three kebeles.

Ingredients and materials used

Many ingredients can be used for making urea-molasses blocks. The choice was depend on their availability, nutritive value, price, easy of handling and the effect on quality of block. Some ingredients used were obtained from agricultural and industrial by products Molasses, water, wheat bran, noug cage, cement, urea, salt and local mineral (boji) were among the ingredients used in these technology. Materials used were molder, weighing balance, bucket and wood poles

Procedures followed

1. Preparation of components
2. Mixing
3. Weighting all ingredients in standard volume or weight based on the formula of block.
4. Molding (for 24 hrs) this made block in acceptable shape and
5. Drying (for 5 day based on weather condition) Blocks were not directly exposed to sunlight, but placed under a shade with good ventilation.
The amount of different ingredients used were depends on the size of block to be manufactured. According and the formula to be used was indicated below in the following table.

Table 1: Composition of the block:-

<table>
<thead>
<tr>
<th>No.</th>
<th>Ingredients</th>
<th>1 kg</th>
<th>5 kg</th>
<th>15 kg</th>
<th>25 kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Molasses</td>
<td>400gm</td>
<td>2kg</td>
<td>6kg</td>
<td>10kg</td>
</tr>
<tr>
<td>2</td>
<td>Urea</td>
<td>100gm</td>
<td>0.5kg</td>
<td>1.5kg</td>
<td>2.5kg</td>
</tr>
<tr>
<td>3</td>
<td>Wheat bran</td>
<td>250gm</td>
<td>1.25kg</td>
<td>3.7kg</td>
<td>6.25kg</td>
</tr>
<tr>
<td>4</td>
<td>Cement</td>
<td>100gm</td>
<td>0.5kg</td>
<td>1.5kg</td>
<td>2.5kg</td>
</tr>
<tr>
<td>5</td>
<td>Noug cake</td>
<td>80gm</td>
<td>0.5kg</td>
<td>1.5kg</td>
<td>2.5kg</td>
</tr>
<tr>
<td>6</td>
<td>Mineral/boji/</td>
<td>10gm</td>
<td>50gm</td>
<td>150gm</td>
<td>250gm</td>
</tr>
<tr>
<td>7</td>
<td>Salt</td>
<td>20gm</td>
<td>100gm</td>
<td>500gm</td>
<td>0.5kg</td>
</tr>
<tr>
<td>8</td>
<td>Water</td>
<td>40gm</td>
<td>200gm</td>
<td>600gm</td>
<td>1kg</td>
</tr>
</tbody>
</table>

Mixing Procedure

A. 1+2(stirred for about 20 minutes)
B. 4+6+7+S
C. A+B
D. C+3+5

Urea molasses block distribution to Farmers

For all sites, Urea molasses block were manufactured at Adami Tulu Agricultural Research Center (ATARC), then distributed to the selected kebeles. Urea molasses block was demonstrated at the time of training and distributed for farmers at interval of 15 days and monitoring was conducted on monthly basis.

Animal selection and Feeding

Animals selection was done from their herds they have, based on body frame of animals by the use of heart girth and age of animals were estimated by their teeth. Selected animals were dewormed and sprayed from internal and external parasite. One kilogram of Urea molasses block was divided into two equal parts and provided for 15 days before starting actual period of fatting. After two weeks 1kg supplied per day. 1kg of concentrate (noug cake +wheat bran) ½ kg in the morning and ½ kg in the evening was given to each animal. Crop residue was offered as ad-libitum daily or used as basal diets. The animals were get water at list twice in a day. The owner of the animals mixed the Urea molasses block with straw to train the animals, when the animal refused to lick the Urea molasses block. The work of fatting was performed by the households especially by women in feeding and frequent watering.

Data collection

Initial body weight, finally body weight, initial price, final price, feed cost and opinion of the farmers toward the importance of the technology were collected.

Statistical analysis

Data on initial and final body weight, initial and final price and feed cost were analyzed by using descriptive statistics. Initial body weight and final body weight data were taken by heart girth. Total
live weight gain (TLWG) = FWG-IW, DWG= TWG/TFD were FW=Final weight gain of animals IW= Initial weight of animals DWG= Daily weight gain, TFD= total fattening days.

Body weight of animals was estimated from heart girth measurement using the regression equation developed by ILRI as cited by Yoseph (1999).

\[ Y = -423.405235 + 4.833697x \] (R² = 0.86; CV= 10%).

Where, Y= Estimated body weight, Kg (weight range for prediction was 200-500 kg)and \( x \) = Heart girth, cm

Results and Discussion

Farmers training

Training was provided for the farmers on; Awareness creation on the importance of urea molasses block, Selection criteria of animals to be fattened (based on body frame of the animals), Ingredients to be used for preparation, procedures to be followed for preparation, Feeding method(lick) and Precautions to be taken during feeding.

<table>
<thead>
<tr>
<th>Districts</th>
<th>kebeles</th>
<th>Participants</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Male</td>
<td>Female</td>
</tr>
<tr>
<td>ATJK</td>
<td>Desta Abjeta</td>
<td>10</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Anano shisho</td>
<td>11</td>
<td>4</td>
</tr>
<tr>
<td>Arsi Negele</td>
<td>Gambelto</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>27</td>
<td>15</td>
</tr>
</tbody>
</table>

Were ATJK- Adami Tulu Jido Kombolcha

Around 77% of farmers were trained at Adami Tulu Jido Kombolcha district. Farmers training centers (FTCs) were used as sites of training and demonstration.

Farmers participated in the activity

A total of twenty three farmers were participated in the study from both East Shoa and West Arsi Zones during the technology performed. Overall 31 oxen were used for the study. A total of 2790kg Urea molasses block was prepared and distributed to farmers.

<table>
<thead>
<tr>
<th>Kebeles</th>
<th>No. of farmers</th>
<th>No. of fattened animals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
<td>Female</td>
</tr>
<tr>
<td>Anano shishoo</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>Desta Abjeta</td>
<td>8</td>
<td>2</td>
</tr>
<tr>
<td>Gambelto</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>18</td>
<td>5</td>
</tr>
</tbody>
</table>

Body weight change

After feeding of Urea molasses block and concentrate for ninety days animals were attained 40.74 kg of average body weight gain. The average daily body gain of the animal was 0.45kg per day.

Table 4: Weight gain during cattle fattening

Kebeles
MIBW = mean of initial body weight  
MFBW = mean of final body weight  
MTWG = Mean of total weight gain  
MDWG = mean of daily weight gain

Partial Budget Analysis

Simple calculation was done to know gross profit using feed cost and animal purchasing price. Estimation of labor cost was difficulty since farmer using his family as labor and gives little time for feeding, watering and other management. The cost of feed per animal was 521.6 Ethiopian birr and average price of animal purchased was 2164 Ethiopian birr. The total cost of production per animal was 2685.06 birr. The farmers were sold the fattened animal at local market with gross margin 1173 Ethiopian birr per animal.

Table 5: Partial budget analysis of Urea molasses block for Arsi cattle fattening.

<table>
<thead>
<tr>
<th>Items</th>
<th>Cost and revenue</th>
</tr>
</thead>
<tbody>
<tr>
<td>Animal purchased price per head</td>
<td>2163.46birr</td>
</tr>
<tr>
<td>Crop residues cost per head</td>
<td>140birr</td>
</tr>
<tr>
<td>UMB cost per head</td>
<td>180birr</td>
</tr>
<tr>
<td>Concentrate cost per head</td>
<td>201.6birr</td>
</tr>
<tr>
<td>Total cost per head</td>
<td>2685.06birr</td>
</tr>
<tr>
<td>Gross return/revenue per head</td>
<td>3857.69</td>
</tr>
<tr>
<td>Gross margin per head</td>
<td>1172.63birr</td>
</tr>
<tr>
<td>Total gross margin (26)</td>
<td>30488.38</td>
</tr>
</tbody>
</table>

Highest profit was obtained in Anano shisho when compared with other kebele. this profit was obtained due to the farmers attend the practical training provided in a good approach.

Feedback Assessment

Almost all the participants reported that, the consumption Urea molasses block by animals was achieved after a week from when this type of feed has been introduced to the animals. Urea molasses block increase intake and improve body condition of fattened animals. Participants noticed that the benefits of feeding the intervention diet were visible immediately. It depending upon the adaptation of the new diet by the oxen. This types of technology was accessible to us, because of all used ingredients are available in our farm level except molasses.
Challenge encountered

Some animals were refused to consume the treated straw for first time of feeding. This challenge was solved by mixing atela and other feeds which were previously fed by animal, for the sake of adaption. scarcity or insufficiency of molasses also the challenge occurred in the time of study.

Conclusions and Recommendations

Conclusion

The use of Urea molasses block for supplementation as catalytic agent of straw based diet in cattle fattening is very much essential for achieve appropriate body weight gain. The fattened animals were attained 0.45kg daily weight gains .The farmers were got 1173 ETB birr gross margin per head in ninety days of feeding. The results showed that it has economic benefits for farmers in a short time fattening (three months).Urea molasses block supplementation increase daily live-weight gain, improve performance of animals and makes farmer profitable.

Recommendation

The importance of supplementary feed using urea molasses multi-nutrient block is increasing palatability and this enhance intake of feed and body weight gain (Table.4) is essential to fattening oxen in a short period feeding is very clear to the understanding economic benefit obtained. If Urea molasses block is properly disseminated and extended in the study area and other districts of the zones, it will play a vital role for poverty alleviation of poor livestock farmers. Farmers show a enormous interest to exercise further this technology. Therefore, livestock development sectors, local farmer groups and farmer cooperatives should be further scale up this feeding package technology where at molasses and crop residues are available.

References


Pre-Scaling up/out of Asella Light Weight Animal Drawn Cart in Arsi Zone, Ethiopia: Lesson from the activity

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Abstract
The activity, "pre-scaling up of Asella light weight animal drawn cart", was initiated with the objectives of creating awareness on rural transportation in general and animal drawn cart in particular on large scale, creating linkage among stakeholders for further extension of agricultural mechanization technologies and to capacitate technology manufacturers to enable them produce rural transportation technologies. To facilitate technology transfer total of seven multipliers were selected and trained theoretically and practically. After training, to create linkage between the three most important bodies (farmers, multipliers and bureau of agriculture), the trained multipliers were convinced to produce the cart by their own cost for the field day organization purpose and two multipliers were able to produce the technology and the rest were not willing because of the fear of demand. A field day on which 112 total farmers of which 15 were female was organized at three PAs and wide technology transfer activity was conducted in Tivo, Digalu-Tijo and Lemu-bilbilo districts at selected three PAs. Need assessment was conducted through discussion from the work done through this activity, it was observed that farmers have huge demand for newly design and demonstrated transportation technology specially the areas where alternative rural transportation mechanism doesn’t exist because of topography and the other thing is that if there is government intervention for facilitating loan and other linkage issues, there are a number of organizations who have capacities both in terms of man power and other workshop facilities and willingness to multiply newly designed animal drawn cart.

Key words: Pre-scaling up, Rural Transportation Technology, Animal Drawn Cart, Stakeholders, Microenterprises, Manufacturers, Linkage

Introduction
Most agricultural activities in Ethiopia are being done manually as the system is subsistence farming. Accordingly, for centuries most of the transport operations are carried out by women and children who physically carry the harvested crop either on their head, shoulder or back. This problem of rural transportation in Ethiopia is unsolved for centuries (Paul Starkey, 1997). Donkeys, horses, mules and oxen also play a significant role in transporting harvested crops or threshed grains within the farm sites and to/from the rural or urban mills and markets. Some studies show that the losses caused during on-farm/off-site transporting operation is estimated to be 2-3% due to the extended utilization of old sacks made of goat skin, sisal, plastics or others.

The mechanism employed to move crops from place to place may vary depending on the level and availability of the technology, i.e., on the back of animals or using sledges and carts and physically carrying of the material for small and medium scale farmers. In the Ethiopia, where agricultures dominate the economy, reducing the work load of farmers is essential by improving the transportation system. In the rural areas where modern farm machines’ are totally and partially absent the only draft power resource is livestock. Therefore, farmers lack means of transporting their grains and farm input from home to field and from farm site to home and usually during market day they lack transportation system, to solve this problem farmers themselves were trying their own options since fifty years before by using sledges (locally constructed of wood and are pulled by a pair of oxen) specially in the central highlands of the country (Arsi and some pockets of Shoa regions) to transport crops from fields to threshing areas (World Bank Country Report 4 Year).
Production and promotion of transport equipment such as Animal drawn cart, donkey cart and wheel barrow is an area where the center (Asella agricultural mechanization research center) has made considerable success. So far the center has managed to produce and disseminate so many animal drawn carts with imported wheel, rim and axle. Even if the cart is efficient on transporting purposes its drawback is made from heavily and costly raw materials which make the cart heavy and not affordable by small scale farmers. The previous activities were also initiated to address existing problem by designing and producing new type light weight animal drawn cart to increase durability and minimize production cost of the cart so as to be afforded by small scale farmers.

Animal drawn carts can play essential agriculture role in moving large amounts of farm products, materials and people, they can be low cost, locally made and able to travel across difficult terrain, without requiring foreign exchange for fuel. By using animal draft power on farms, the farmers work load can be minimized considerably and alone him to accomplish their works more. This means realizing the full potential using his animal for ploughing, ridging and caring (Appropriate technology source book, 1993).

The previous animal drawns cart produced by AAMRC was designed for the carrying capacity up to 15 quintals. But in reality, the animal drawn cart cannot able to carry more than 8 quintals due to the undulation topography, inconvenient road and animal carrying capacity. The other drawback of this cart was the axle is imported and due to this, even though the cart has more demands by farmers it cannot be distributed as interest of farmers. To overcome this problem AAMRC designed light weight animal draw cart of which its all parts can be produced locally. The newly designed, tested, and evaluated animal drawn cart can easily carry up to 8kg load without any problem (Alemneh H. 20012). Therefore, the design of newly developed cart is now ready for production and to transfer the technology to third party for further mass production. The main problem regarding fulfilling the demand of smallholder farmers (users) is absence of external manufacturers of farm implements who are engaged in manufacturing business of the technology at hand.

The natural step to transfer the technology already demonstrated to the end-users, and approved for its acceptance is mass popularization and creation of linkage among stakeholders such as technology owner (the research center), end-users (farmers/investors), technology producers/multipliers (industries, medium and higher microenterprises) and the extension wing of government (ministry/bureau of agricultural development). Hence, taking the above problems into account, the initiation of this proposal is aimed to pre-scale up/out this technology to smallholder farmers on a wider scale and other stakeholders such as Small Micro Enterprises, Agricultural Technical, Vocational, Education and Training (ATVET) and volunteer Private Manufacturers to fulfill the already created farmer’s demand on farm technologies specially on the rural transportation technologies.

Objectives

The main/general objective of this activity was to popularize tested and verified improved animal drawn cart technology for small holders’ farmers and other stakeholders and create strong bond or linkage among potential stakeholders for technology transfer system with the following specific objectives:

☐ To popularize tested and verified improved animal drawn cart technology for small holders’ farmers and other stakeholders found in the study area.
☐ To develop knowledge and skill for the application of the technology (animal drawn cart) to the producers/multipliers.
☐ To improve the knowledge and skills of farmers on animal drawn cart technologies utilization and management.
☐ To strengthen linkage between farmers, extension, research and others key stakeholders to make improved animal drawn cart easily accessible for the users.
Methodology

Description of the Study Area

The research was conducted in three selected districts of Arsi zone namely Lemu-Bibilo, Digalu-Tijo and Tiyo districts. These districts of the zone were selected purposively because of the fact that they are known for their high production potentials of wheat and barley crops. Arsi zone is known as wheat-belt of Ethiopia and these districts, Lemu-Bibilo and Digalu-Tijo are found 56 km, and 25 km to south of Assela the capital of Arsi zone while Tiyo district is around Assela. The main crops produced in these areas are wheat and barley with barley dominating in some high land of Digalu-Tijo and Lemu-Bibilo around the base of mountain Chilalo. Digalu-Tijo has an altitude range of 2500 to 3560 masl and agro ecology of highland 78% and mid-altitude of 22% with temperature range of 10-20°C and bimodal type of rainfall ranging from 800mm to 1200mm. The rainfall is generally high and erosive type. The main crop type of the district is cereal type with wheat and barley domination and where both of the crops are almost equally important (BOFED, 2011).

Lemu-bibilo district has an altitude of 1500 to 3800 masl and characterized by a highland of 80% and mid-altitude of 20% with bimodal, heavy and erosive type of rainfall ranging from 800 to 12000 mm annually. The average annual temperature is around 15°C. Cereals are the major crop type with wheat and barley domination. Tiyo district has a total of 665 km² areas and altitude ranging from 1500 to 4105 masl which enabled the district has four types of agro-ecologies highland 31.7%, mid-highland 42.5%, temperate highland (wirch) 20.1% and lowland of 5.7%. The district is generally characterized by bimodal, heavy and erosive temperate type rainfall with annually ranging from 900 to 1100 mm. Cereals are dominating crop type of which wheat and barley are more important with wheat slightly higher degree (ibid).

Even though these districts are found on high altitude compared to other districts of Arsi zone, they have plain areas on the top of the highlands and the current government policy and development intervention in rural infrastructure created conducive environment for rural transport use in the districts. It is why some farmers who have relatives and other external contacts from other areas are using animal drawn cart of other models and some are using the horse cart which are meant for human transportation in the urban areas.

Materials

Materials needed to conduct this pre-scaling up/out activity were basic research raw materials which are needed to produce/manufacture the animal drawn cart. With all these raw materials, fully equipped workshop facilities and trainers were also considered as necessary condition to undertake this activity.

Methods

To undertake this activity as per the intended level, the activity was classified into two phases. The first phase was preparation phase which comprised two main activities. These are, (1) the first phase which was done in 2012/13 was organizing trainings for different micro-enterprises from Addis Ababa, Bishoftu, Adama and Asella towns on animal drawn cart manufacturing and its benefits. Accordingly, training manual was prepared with full production manual and the trainees were trained both theoretically and practically by producing the whole parts of the machine and assembled it in our center. (2) Conducting intensive demonstration activity to popularize the technology which will help as paving the way for our next activity which is pre-scaling up/out of the technology. Accordingly this activity was done in three districts of Arsi zone namely, Tiyo, Lemu-bibilo and Digalu-Tijo districts.

Under the second phase of this activity, similarly two sub-activities were also accomplished to finalize the main activities. These are 1. Continuous follow up of the trained microenterprises was conducted with necessary technical support/backup to enable them produce/multiply the animal drawn cart and
they were convinced to produce/multiply the animal drawn cart by their own cost for demonstration purpose. 2. A field visit (field day) which comprises all necessary stakeholders (farmers, Micro-enterprises, agricultural development bureau at different level and research centers) was organized at three districts (Tiyo, D/Tijo and Lemu Bilbilo districts). At this field day general discussion was held on major constraints and solutions for agricultural mechanization technologies utilization by farmers. In general, from the whole process it was tried to collect the main bottlenecks of transferring technologies specially the agricultural mechanization technologies.

Results and discussions

At first stage, a demonstration activity more than seventy farmers participated on was conducted in Dhera, Hetosa, Digelu Tijo districts and the farmers compared the newly introduced light weight animal drawn cart with the previous one and found that it is very convenient and even more useful because it reduces the load without the compromising of the load it carries. This feature of the technology make it to be advantageous over the first cart that has been introduced by the center and the other advantage of the new model cart is that previously all parts of the cart except the wooden part were imported from abroad and it was impossible to manufacture the cart in the country because of the parts. Since the parts which have been donated by Italian government were all consumed, the center can manufacture no more carts and the introduction of the new model was the best option technology to make cart production continue. The farmers also understood the whole problem and even preferred to have new carts during the demonstration.

At the second stage, potential agricultural mechanization technologies producers/multipliers were selected from Addis Ababa, Bishoftu, Adama and Asella based on their workshop facilities, machineries, skill and knowledge of the personnel, and willingness to work with research center and interest in multiplication of such technologies. Then Asella-light weight animal drawn cart’s design and production manual were prepared and the trainees were given both theoretical and practical training on rural transportation in general with specific to Asella light weight animal draw’an cart at AAMRC. The trainees were all males. At third stage, the trained trainees were convinced to produce the technology and assisted at their respective workshops through continuous supervision during their work. Regarding this we were able to convince two organizations (AMIO engineering from Addis Ababa and Lion Agri-Mech from Bishoftu) to produce the cart with their own cost for field days purpose. Finally, a field day was organized and farmers, experts, technology multipliers and researchers participated on the field day. At this field day a total of 112 i.e. 17 females (15%) and 95(85%) males participated at each site.

At the end the field day session exhaustive and comprehensive discussion was conducted to identify the main bottlenecks of agricultural mechanization technologies utilization, how to liaise the stakeholders (specially farmers, multipliers, research centers, and bureau of agriculture) in the future and the role and responsibilities of each stakeholder. From the general discussion conducted at Lemu-bibilo, Digelu-Tijo and Tiyo districts with farmers, experts and other government officials, main bottlenecks of the agricultural mechanization technologies were raised and discussed on the way forwards. The farmers raised that it was

The main objectives were to capacitate the skill of technology multipliers and to bridge linkage among technology multipliers, end users, research center, and extension wing of the technology supply. Therefore, both of main objectives were believed to be attained in this activity. The activities conducted so far enabled developed the trust between the farmers and technology multipliers and the farmers started ordering the technology to buy from private multipliers since they have seen the technology produced by those private multipliers produced under the supervision of AAMRC close supervision. The linkage among those stakeholders was also developed throughout the whole activities done by provision of training to manufacturers, supervision during manufacturing in their respective workshops, and finally, by field day organized and wide discussion conducted with those stakeholders during the field day.
Conclusions and Recommendations

Conclusions

From this piece of activity it can be concluded that farmers clearly understood the importance of agricultural mechanization technologies/specially rural transportation or animal drawn cart and they are willing to invest on such technologies specially on animal drawn cart (rural transportation technologies in general). But, they need organizations (multipliers and providers) which they can fully trust to pay such huge amount of money (compared to other agricultural technologies’ investment capital) such as governmental organizations like research centers which they believe that they could not mischief them. From the activities performed so far, we can also that conclude that if there is policy support and attentions to be given from concerned stakeholders; governmental and non-governmental private enterprises working on agricultural mechanization technologies are willing and capable of manufacturing/multiplying these technologies if they are closely supervised by technology origins (research centers).

Recommendations

Therefore, to promote the use of agricultural mechanization technologies (farm implements) in general and OARI-AAMRC light weight animal drawn cart specifically, in the region the following should be done by respective bodies:

1. Strengthening the research capacity of research centers to generate technologies (farm implements) which are economical and socially acceptable by the smallholder farmers. So, there must be a focus on research capacity building such as human and fulfilling research facilities like workshop, laboratory and research sub-sites (field test sites).

2. Massive promotion and awareness creation of the technologies specially postharvest technologies by government bodies. There must be well informed DAs (development agents) about agricultural mechanization technologies at PA/kebele level who are going to deliver training on the importance of light weight animal drawn cart technologies to improve the awareness of smallholder farmers.

3. Liaising concerned bodies like producers/multipliers, farmers and research centers to enable each to play their parts for total utilization of the technologies. The producers/multipliers want to be guaranteed for the purchase of their technology after production and there must be somebody in between who should play a role to communicate the two bodies.

4. Availing credit facilities for such technologies: from its very nature, agricultural mechanization technologies (specifically animal drawn cart) are relatively expensive or capital intensive for most farmers to buy on cash basis individually. So, there must be a means for these farmers to get the technology in credit basis.

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BOFED. 2011. Physical and socio economic profile of Arsi zone and districts


Pre-Scaling up of OARI-AAMRC Model-III Multi-Crop Thresher in Arsi zone, Ethiopia
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Abstract

The pre-scaling up of OARI-AAMRC model-III multi-crop thresher was initiated with the objectives of creating awareness on threshing technologies on large scale, creating linkage among stakeholders for further extension of agricultural mechanization technologies and to capacitate technology manufacturers to enable them produce threshing technologies. The large awareness creation and field-day activity were conducted in three districts of Arsi zone namely, Tiyo, Lemu-bilbilo and Diganu-Tijo districts. Totally, more than 200 (two hundred) farmers participated on demonstration and awareness and linkage creation activity in these districts. To facilitate the exit strategy for pre-scaling up, extensive demonstration was conducted and potential technology manufacturers were trained how to produce the technology. Then to create the linkage between producers and farmers, the trained producers were initiated to produce the technology and a field day was organized on those prototypes to create trust between the two parties and to create linkage among extension service providers and the manufacturers. From the activities conducted so far, it can be concluded that farmers have huge demand for threshing technologies specially the areas where alternative mechanism like combine harvesting is unavailable because of topography and moreover, if there is demand for the technologies, there are potential manufacturers which have both necessary workshop facilities skills and knowledge to undertake production with simple inspections.

Key words: pre-scaling up, multi-crop thresher, microenterprises, manufacturers, linkage, farm implements, technology

Introduction

In traditional method, about 40% of the total labor required to produce crop is extended in harvesting and threshing activities. The person hour per output of the method is very low, varying between 40 and 50 person hour per ton for both animal and manual threshing (Johnson, 1992). In Ethiopia, threshing is traditionally done by animal trampling of harvested crop over the threshing ground or beating manually with stick. However, it is cheap, labor intensive and it takes longer time hence exposed to tremendous loss. The average post-harvest losses of food crops such as Teff, Wheat and Maize are annually 12.9%, 13.6% and 10.9% respectively (Derege A. et al 1989). Among this loss, threshing accounts for large place.

Most of the wheat-barley producing districts’ of Arsi zone like Hetosa, Lodehetsa, Tiyo, and parts of Lemu-bilbilo are known for mechanized farming specially combine harvesting (personal contact with districts’ bureau of agriculture and personal observation). Even though there are associated problems raised by farmers from service renderers such as incorrect estimation of yield, unfair pricing etc which need further studies; it is best solution for labor shortage, unfavorable weather condition (untimely coming rain) in the areas. But majority of the farmers’ of rest districts have no such options and struggling with natural phenomena and subjected to working drudgeries and great losses of their produce (T. Gebiso, 2015).

In order to help and address the problem of small-scale agriculture and develop it into a modern production sector, strengthening the intermediate technology for post-harvest such as engine operated thresher is essential. Farmers have huge demand for threshing technologies specially the areas where alternative mechanism like combine harvesting is difficult because of topography. So, coming up with intermediate technologies for this sector development has no alternatives. In fact, many efforts have been done to replace traditional threshing method with introduction of improved threshers that have
been developed locally or adopted. Different governmental and non-governmental organizations have been involved in developing, testing, modifying and disseminating this technology.

Among these, Assela Agricultural Mechanization Research Center (AAMRC) had modified and tested multi-crop thresher in 1982 and known as Assela model-2 multi-crop thresher. As different performance evaluation indicated, this machine has got 96%, 80-90%, 2.2% and <3% threshing efficiency, cleaning efficiency, un-threshed grain and damage grain respectively for Wheat, Barley and Teff (Elias Zerihun, 2004) and overall average efficiency of 80.81% on threshing varieties of wheat crop at 13.5% moisture content (Birhanu, A, 2006). Survey conducted by the center at different time indicated that the machine is demanded for straw chopping (unique property) and for its minimal breakage of threshed grain specially for pure seed multiplication purpose within small and medium scale farmers which enabled the machine to be preferred over the combine harvesting because of mixing of the grain from other fields.

Asella Agricultural Mechanization Research Center (AAMRC) and other centers, have scaled out/transferred a number of technologies like mould bold plows, spike tooth harrow, treadle pump, modern beehive and so on so far to private and other multipliers with their full design and production manual (unpublished center annual report of different years). Besides, AAMRC has newly developed model-III wheat-barley-teff thresher with a better performance of threshing efficiency (99.14%), threshing capacity (3-5 quintals/hour), cleaning efficiency (98.18%), insignificant grain damage and excellent straw chopping capacity. It is portable and manageable threshing machine, is socially acceptable, technically suitable, economically feasible, likely hood of impact and financial requirements and the prominent one.

Efforts have been done to popularize these technologies to the users’ community. However, our center cannot satisfy farmers demand because the needs are beyond the center’s multiplication capacity. From result of demonstration activities, farmers were asked to rate the machine based on different parameters like threshing capacity, cleaning efficiency, economics of the technology, and the like and most farmers agreed that the technology is the best option for the area and proposed for pre-scaling up/large dissemination of the technology (T. Gehiso, 2015). The natural step to transfer the technology already demonstrated to the end-users, and approved for its acceptance is mass popularization and creation of linkage among stakeholders such as technology owner (the research center), end-users (farmers/investors), technology producers (industries, medium and higher microenterprises) and the extension wing of government (ministry/bureau of agricultural development). Hence, taking the above problems into account, the initiation of this proposal is aimed to pre-scale up/out this technology to smallholder farmers on a wider scale and other stakeholders such as Small Micro Enterprises, Agricultural Technical, Vocational, Education and Training (ATVET) and volunteer Private Manufacturers/multipliers to fulfill the already created farmer’s demand-supply gap for this improved grain thresher technologies.

Objectives

The general objective of this activity was to popularize tested and verified improved multi-crop thresher technology for small holders’ farmers and other stakeholders and create strong bond or linkage among potential stakeholders for technology transfer system with the following specific objectives:

☐ To popularize tested and verified improved multi-crop thresher technology for small holders’ farmers and other stakeholders found in the study area.
☐ To develop knowledge and skill for the application of the technology (multi-crop thresher) to the producers/multipliers.
☐ To improve the knowledge and skills of farmers on multi-crop thresher technologies utilization and management.
☐ To strengthen linkage between farmers, extension, research and other key stakeholders to make improved multi-crop thresher technology easily accessible for the users.
Methodology

Description of the Study Area

This study was conducted in Arsi zone, Oromia region. Arsi Zone is found in the central part of the Oromiya National Regional State. The zone astronomically lies between 6°45' N to 8°58' N and 38°32' E to 40°50' E. It shares borderlines with the Regional State of Nations, Nationalities and People of Southern Ethiopia and also shares borderlines with East Shewa, Bale and West Hararge Zones. According to data from Finance and Economic Development of the zone, it has a total area of 23881km² and divided in to four agro-climatic zones as moderately warm altitude of 500-1500masl, moderately cool with altitude of 1500-2350masl, cool with altitude of 2350-3300masl and cool/cold temperature of having altitude of above 3300masl. Arsi in particular is known as the wheat belt of Ethiopia and the study was conducted in two purposively selected districts of the zone namely, Lemu-bibilbo and Digalu-tijo which area mainly in a problem of threshing technologies relative to other wheat-barley producing areas because of their inappropriateness of topography.

Site and Farmers Selection

As mentioned above the technology was pre-scaled in three purposively selected districts of Arsi zone namely Tiyo, Lemu-bibilbo and Digalu-Tijo. Lemu-Bibilbo is located at a distance of 64km South direction of Asella and Bekoji is the capital town of the district. Digalu-Tijo district is found at 26km distance from Asella and the capital of district is Sagure. Both of them are found on the main road from Asella to Bale-Role. The third district was Tiyo which is a district around the area of Asella town the capital for both Tiyo district and Arsi zone. The three districts were selected purposively because their topography which created difficulty to use the farmers combines harvesting.

Materials

Materials needed to conduct this pre-scaling up/out activity were basic research raw materials which are needed to produce/manufacture the multi-crop thresher. With all these raw materials, fully equipped workshop facilities and trainers were also considered as necessary condition to undertake this activity.

Methods

To undertake this activity as per the intended level, the activity was classified into two phases. The first phase was preparation phase which comprised two main activities. These are, (1) Organizing trainings for different micro-enterprises from Addis Ababa, Bushoftu, Adama and Asella towns on thresher manufacturing and its benefits. Accordingly, training manual was prepared with full production manual and the trainees were trained both theoretically and practically by producing the whole parts of the machine and assembled it in our center. (2) Conducting intensive demonstration activity to popularize the technology which will help as paving the way for our next activity which is pre-scaling up/out of the technology. Accordingly this activity was done in three districts of Arsi zone namely, Tiyo, Lemu-bibilbo and Digalu-Tijo districts. Totally, more than 200 (two hundred) farmers participated on demonstration activity in these districts.

Under the second phase of this activity, similarly two sub-activities were also accomplished to finalize the main activities. These are 1. Continuous follow up of the trained microenterprises was conducted with necessary technical support to enable them produce the machine and they were convinced to produce the machine by their own cost for demonstration purpose. 2. Afield visit (field day) which comprises all necessary stakeholders (farmers, Micro-enterprises, agricultural development bureau at different level and research centers) was organized at three districts (Tiyo, D/Tijo and Lemu Bilbilo districts). At this field day, general discussion was held on major constraints and solutions for
agricultural mechanization technologies utilization by farmers. In general, from the whole process it was tried to collect the main bottlenecks of transferring technologies specially the agricultural mechanization technologies.

In general, after the accomplishment of this activity, technology multipliers were able to get skills and knowledge to multiply this (OARI-AAMRC model-III multi-crop thresher) technology. The researchers on this technology and technical team of the center as a whole approved that the technology they produced were similar to AAMRC’s product in all aspects like threshing capacity, cleaning efficiency, grain breakage and so on. On the other way the awareness of the farmers on the technology was improved through extensive demonstration of the technology done in three districts of Arsi zone (Tiyo, Digalu-Tijo and Lemu-Bilbilo). Moreover, the trust between private technology multipliers and farmers was also developed through the demonstration of thresher produced by those private multipliers.

To create linkage among stakeholders, in addition to those from demonstration sites, experts from Arsi-Robe, Lode Hetosa, Hetosa, Dodota, Sire and Shirka districts were also invited on the field day and introduced with these multipliers and they exchanged their addresses. Regarding the development of awareness perception some farmers immediately ordered the technology from the producers.

Results and Discussion

From the result of demonstration done in 2012 almost all of the farmers who participated on demonstration through the whole process (40 participant farmers) agreed with the idea of wider dissemination of the technology by different means like credit based, cash based, group based and some on individual based purchasing of the technology (Tamrat G., 2013). Based on the result of the first demonstration, pre-scaling up activity was initiated in the area to liaise the farmers and technology manufacturers. Pre-scaling up in this agricultural mechanization technologies sense is wider demonstration (expansion the number of participants in technology demonstration) and creation of awareness, knowledge and skill for manufacturers in different places on the intended technology. Therefore, training was organized for farmers and development agents (DAs) at a selected farmer’s threshing site (hogdi/awudima) in each of the three districts. Accordingly, a total of 180 farmers, 70 from Tiyo, 45 from Digalu-Tijo and 65 from Lemu-Bilbilo districts out of which 22.78% were female, and total of eight DAs were given a one day detail theoretical training on harvest and postharvest handling, contribution of traditional threshing mechanism on postharvest losses, importance of intermediate threshing technologies/OARI-AAMRC multi-crop thresher/ in reducing work drudgery and postharvest loss minimization, and practical training on how to operate and give simple services after use and handling mechanisms of the technology.

The demonstration activities conducted by the center have created huge demand of the threshing technologies and as a result the farmers started requesting the center to purchase the technology in group basis and some even individually. To fulfill farmers’ demand, a total of seven (7) manufacturing organizations (both large and medium enterprises) were selected from Addis Ababa, Bishoftu, Adama and Asella and given one week detail training and they were able to produce the thrasher by themselves.

After production, field day was organized in three districts and all stakeholders from the zones, districts agricultural development offices, NGOs, seed enterprises and representative model farmers from different districts and all farmers of the demonstration sites were participated. Our center agreed with the producers and farmers to give quality assurance of the technologies after production and it was tried to develop trust of farmers that they have on private producers.

What can be driven from this activity is that, there are intermediate technologies which can solve the existing threshing technology problems of the farmers and farmers are willing to use the technologies if the technology is availed either in rental form or for sell. The result of discussion with stakeholders clearly identified that, there is potential technologies, the multiplication is impossible by single body (the research center) and even out of the current mandate of the research institutes, that there are
potential multipliers. Furthermore, it was also discussed that, the attention given from extension side for mechanization technologies were not enough and the linkage with technology multipliers and agricultural mechanization research centers were very week and has to be improved.

**Conclusion and Recommendation**

**Conclusion**

Farmers clearly understood the importance of agricultural mechanization technologies (farm implements) and they are willing to invest on such technologies. But they need organizations which they can fully trust to pay such huge amount of money (compared to other agricultural technologies investment capital) such as governmental organizations like research centers which they believe that they could not mischief them. From the activities performed so far, we can conclude that if there policy support and attentions are given from concerned stakeholders; nongovernmental private enterprises working on agricultural mechanization technologies are willing and capable of manufacturing/multiplying these technologies if they are closely supervised by technology origins (research centers). The transfer of technology can be facilitated by strong linkage among stakeholders specially, farmers-research centers (technology sources), potential technology multipliers, and bureau of agriculture and livestock agencies.

**Recommendation**

Therefore, to promote the use of agricultural mechanization technologies as a whole and OARI-AAMRC model-III multi-crop thresher in particular in the region, the following should be done by respective bodies:

1. Strengthening the research capacity of research centers to generate technologies (farm implements) which are economical and socially acceptable by the smallholder farmers. So, there must be a focus on research capacity building such as human and fulfilling research facilities like workshop, laboratory and research sub-sites (field test sites).

2. Massive promotion and awareness creation of the technologies specially postharvest technologies by government bodies. There must be well informed DA (development agents) about agricultural mechanization technologies at PA/kebele level who are going to deliver training on the importance of multi-crop thresher technologies to improve the awareness of smallholder farmers.

3. Liaising concerned bodies like producers/multipliers, farmers and research centers to enable each to play their parts for total utilization of the technologies. The producers/multipliers want to be guaranteed for the purchase of their technology after production and there must be somebody in between who should play a role to communicate the two bodies.

4. Availing credit facilities for such technologies: from its very nature, agricultural mechanization technologies (specifically wheat and barley thresher) are relatively expensive or capital intensive for most farmers to buy on cash basis individually. So, there must be a means for these farmers to get the technology in credit basis.
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Scaling up of Water lifting devices for micro Irrigation in Western Oromia
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Abstract

Water lifting devices enable the lifting of water from a lower level to a higher one. Water lifting technologies free the farmers from the limitations of inadequate rain during dry seasons, thus raising their capacity to grow crops up to two or three planting annually. The method lifting water to the field for irrigation in the country and in Oromia too are mostly traditional. The water is transported to the field with the help of bucket; water points and area to be irrigated are far apart; the ground and/or river water is at deeper position to convey to area to be irrigated. Therefore, this activity was aimed at scaling up of over flow pump and Rope & washer pumps for micro irrigation. The study was conducted in Four Zones of Western Oromia Namely West Wollega (Najo woreda), East Wollega (Jimma Arjo), H/G/Wollega (Jardagga Jarte) and West Shoa (Tokke Kntaye). Training was organized and delivered for farmers, DAs and SMS in the selected woreda. Totally 10 rope and washer pump and ten (10) over flow pump were distributed. 60 farmers were participated on training of operation and handling of over flow treadle pump and rope and washer pump. Data was collected by: focus group discussions and interview. The collected data was analyzed from feedback/field report and Focus group discussion. The study recommends that Training should be given for extension staffs who work directly with irrigation farmers on Treadle pump operation, maintenance, assembling a pump to highlight technical aspects, the importance of proper installation procedures and maintenance of each component. Woreda Irrigation Development Authority should facilitate field demonstrations with farmers for further scale up Sources of technology should be as close as possible to the farmers. So the respective Woreda Irrigation Development Authority should facilitate for farmers who need these technologies by providing these pumps from the sources.

Key words: Scale up, water lifting Devices, over flow treadle pump, Rope and washer pump, micro irrigation

Introduction

Water is essential for the growth of agricultural crops. In many regions, however, there is insufficient rainfall available to produce a crop with decent yields, and irrigation systems are needed to provide the crop's need for water. Also, provision of drinking water is fundamental for both human beings and livestock, but its transport from the water source to final destination is often required. Water sources can either be under ground water reservoirs, open natural water bodies (rivers and lakes), or artificial water bodies (canals). The use of water lifting devices is crucial to transport water from water source to the field or to the consumer. Water lifting devices can be divided into two groups: (i) devices that are run by muscle power of humans or domestic animals and (ii) devices mechanized by lift irrigation techniques. Devices which are run by muscle power are often very time-consuming in real terms, due to their low productivity. Mechanized lift irrigation techniques, while more efficient, need to be adapted to the local conditions and to the different demand needs. To establish and implement water lifting devices, local people need to be trained on how to use these technologies in water efficient way, as well as how to maintain these technologies in the long run.

Local hydro geological, economic and social conditions, as well as national strategies, e.g. the strategy to standardize the equipment, must be considered in selecting the technology which best fits local conditions. In the end, it is the individual farmer or the benefitting association who should make the final choice. Water lifting technologies free the farmers from the limitations of inadequate rain during dry seasons, thus raising their capacity to grow crops up to two or three planting annually. Thus additional income possibilities for the subsistence economy of the households are provided. In addition, Water efficient technologies such as pumps can bring an improvement to the situation of women by increasing household food security and nutritional variety, as well as decreasing the amount of labor required to obtain water. Most pumps can easily be operated by women.

When comparing the advantages and disadvantages of various water lifting devices, It is important to focus on technical feasibility and sustainability in the context of the respective target region and target group. It is estimated that more than 90% of the food supply in Ethiopia comes from low productivity rain-fed small-holder agriculture. Hence, rainfall or access to irrigation water is the most determinant
factor affecting the food self sufficiency at household level and national food supply. Not only limited access to water has impeded the productivity of farming system but also lack of appropriate means of utilizing the available water more productively.

Appropriate methods of water lifting and distribution are the most important aspects that determine the efficiency and success of an irrigation system. Also in terms of cost, the water diversion, conveyance and distribution systems are the most expensive parts of modern irrigation network. The distribution of modern irrigation development in Ethiopia is mainly concentrated along the plane of perennial rivers. Neither the poor smallholders have the capacity to install the expensive modern irrigation system nor can the already implemented and planned large, medium and small scale irrigation schemes benefit the majority of the poor. From the perspectives of poor farmers alternative methods such as low-cost smallholder irrigation technologies are vital and attractive. Experiences from other developing countries show that coupling of low-cost irrigation technologies with water conservation and harvesting technologies allows better control and management of limited water resources and results in much higher returns to farmers. Small-scale, low-cost irrigation systems that can be easily afforded and managed by poor farmers contribute significantly to the endeavors of ensuring food self-sufficiency at household level.

Over the past decade, a small but significant revolution has been taking place in small-scale irrigation in the developing world with the introduction of the treadle pump. This simple, human-powered device can be manufactured and maintained at low cost in rural workshops in developing countries. The costs of buying, running and maintaining engine-driven pumps for irrigation are prohibitive for most small farmers in the developing world. The majorities rely on traditional human-powered water lifting devices but these too have their drawbacks. Many farmers had problems with the inconsistent weather; they were often battling with lack of rainfall and droughts in unproductive lands. The irrigation pump allows them to have consistent water throughout the year, helping the crops and providing income that is more consistent for the families. The method lifting water to the field for irrigation in the country and in oromia too is mostly traditional. The water is transported to the field with the help of bucket; water points and area to be irrigated are far apart; the ground and/or river water is at deeper position to convey to area to be irrigated.

Therefore, this activity was aimed at scaling up of over flow pump and Rope & washer pumps for micro irrigation.

Objectives of the study

- To improve farmers' knowledge and skill of water lifting devices
- To develop local capacity for future scaling up of the technology
- To strengthen stakeholders linkage and collaboration

Methodology

The study was conducted in Four Zones of Western Oromia Namely West Wollega (Najo woreda), East Wollega (Jimma Arjo), H/G/Wollega (Jardagga Jarte) and West Shoa (Tokke Kutaye). The materials used in this scaling up activity were over flow treadle pump and Rope and washer pump.

Four zones were selected randomly among the mandate area of BAMRC namely West Wollega, East Wollega, H/G/Wollega and West Shewa zones, from these zones one districts, from each district one PAS were selected purposively based on Irrigation potential. From each PAS 15 farmers were selected purposively. DA’s, Irrigation experts, and administration bodies were made selection of progressive farmers for scaling up of the technologies. Data was collected by; focus group discussions and interview. The collected data was analyzed from feedback/field report and Focus group discussion

Results and discussions
Total number of farmers participated in training

A total of 60 farmers were participated on training of operation and handling of over flow treadle pump and rope and washer pump. It is estimated that over 200 farmers have now had exposure to over flow treadle pump technology and rope and washer pump through field visit scale up.

Stakeholder linkage

Training of trainers was given by ATA for our shop crafts men and provided technical training was given for six small micro enterprises manufacturers by those crafts men. Linkage was established between manufacturers and woreda Irrigation authority and the manufacturers have started manufacturing these two technologies up on request.

Benefits due to use treadle pump and rope and washer pumps

The benefits of using the treadle pump and rope and washer pump in farming practices

- Increased land area under irrigation;
- Reduced work time compared with bucket irrigation; full irrigation of fields, resulting in improved crop quality;
- Reduced labor demand
- Reduced workload
- Work time has been reduced compared to bucket irrigation;
- Irrigation used for seed multiplication; examples include coffee and tomatoes
- Women operate treadle pumps without any traditional or religious constraints and see this as an opportunity for empowerment.

Limitation of rope and washer pump

- The installation of the rope pump requires skilled personnel/crafts men
- Traditional rope pumps have a lift of only about 10 m;
- Users need to exercise care when using the pump as it is susceptible to contamination;
- Most problems occur with the rope or washers getting stuck or slipping over the pulley wheel.

Limitation of over flow pump

- Farmers complained about difficulty in priming pumps. This consumes a great deal of their energy, so much that some of them give up the whole process.
- Durability problem

Conclusion and recommendation

Conclusion

The costs of buying, running and maintaining engine-driven pumps for irrigation are prohibitive for most small farmers in the developing world. The majorities rely on traditional human-powered water lifting devices but these too have their drawbacks. Over the past decade, a small but significant revolution has been taking place in small-scale irrigation in the developing world with the introduction of the treadle pump. This simple, human-powered device can be manufactured and maintained at low cost in rural workshops in developing countries.

Recommendation

Training should be given for extension staff who work directly with irrigation farmers on Treadle pump operation, maintenance, Stripping and assembling a pump to highlight technical aspects and the importance of proper installation procedures and maintenance of each component Woreda Irrigation Development Authority should facilitate field demonstrations with farmers for further scale up.
Every 6 months to 1 year, the rope should be replaced. Every few years, the washers should be renewed. The maintenance needs of rope and washer pumps are simple, but frequent, and users need to ensure that they are carried out and that their pump is kept in good working condition. Hygiene is more important than with many other types of pump, particularly when the pump is used communally. In such cases, it is important that the users organize effective measures for ensuring good hygiene practice. Sources of technology should be as close as possible to the farmers. So the respective Woreda Irrigation Development Authority should facilitate for farmers who need these technologies by providing these pumps from the sources.

References


Pre-Scaling up of Horizontal Beehive and Nuclei-box in Jimma and Ilubabor Zones
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Abstract

The study was conducted in Jimma and Ilubabor Zones of Oromia Regional State, Ethiopia. The objective of the study was to promote Horizontal Beehive and Nuclei-box scaling up activities among the rural farming communities. Hosting farmers were selected from two zones at different districts (Mafia, Gechi and Mattu) that the participants trained and sample technologies of the Horizontal Beehive and Nuclei-box were provided at every selected sites such as Gudata Bulaa, Garuke, Doyo Toli, Odo and Gechi for the study purposes where on average fifteen participants were trained and participated in at each site participating on scaling up/out of Horizontal Beehive and Nuclei-box technologies. Following the training program, farmers themselves constructed Horizontal Beehive based on the sample provided to them at every participant household using a participatory approach that the farmers could produce in average three to four quantity of both technology types by themselves from the local materials. The study feed backs showed that it is possible to produce both Horizontal Beehive and Nuclei-box technologies at the farmers’ locality easily from the materials that exist as they stated the production at medium and high level possibility by 30 and 45 percent of the respondents respectively.

Key words: Promote, Horizontal Beehive, Nuclei-box, sample, feed backs, possibility

Introduction

In Africa average annual honey yield per colony is about 8kg (beekeeping in tropic 1991). This amount is low when compared with other’s nation. In Ethiopia there are many bee colonies estimated about 10 million of which 7.5 million confined in traditional beehive (FAO, 2006). Although, Ethiopia is leading honey producer in Africa and fourth in the world, the amount of honey it can export to the foreign market is low. Horizontal beehive which is recently developed by JRTRC is expected to be the remedy for the medium farmers which can be purchased or locally manufactured by low cost.

The existing and inevitably expected problems which are mentioned above enforced us to pre-scale up improved and cost-effective beehive which can be produced at farmer’s locality using their labor and cheap local material. The beehive can solve farmers’ problem in honey production, having the following advantages: Since it can be manufactured from locally available and cheap material using their labor only and since it uses a movable frame which can extracted it may increase our country’s supply of pure honey to the world market. It helps to reduce deforestation caused by need for excessive timber. However, the problems of honey producer farmers cannot be solved only by introducing improved beehives and therefore need to be complemented by other technology packages that help to increase the quantity and quality of the farmer’s honey production. In fact, various substantial works have been done by different concerned body so as to familiarize farmer with modern bee keeping methods by large.

Usually farmers hang beehives on trees to trap bee colony. But the modern beehives are big in size and in convenient to hang them on trees unlike the traditional beehives. The process of transferring the bee colony to the modern hive, and from traditional hive to the modern hive has different problems: In the first place, the process requires skilled man power. Secondly, the comb that already built by bees on tradition hive broken down during transferring resulting in migration of the newly transferred bees from new hive and this work needs a skill. Also the bees need additional time to reconstruct other comb. It is difficult to manage the process especially for women. Hence, transferring bees is somewhat troublesome and difficult.
Therefore, using nuclei box for bee trapper is a remedy for this problem that usually encounters the bee keepers during the bee colony transferring processes. Accordingly, horizontal beehive together with nubile box was introduced to honey producer farmers of the areas through the scaling up activity

Objectives of the study

☐ To introduce and promote Horizontal Beehive and Nuclei-box technologies to the rural farmer
☐ To improve farmers' knowledge and skill on improved technology use through training
☐ To create awareness and improve linkage with agricultural extension and other stake holders

Materials and Methods

Description of Study Area

The study was carried out in Jimma and Illubabor Zones in purposely selected four districts. Sites were selected in two zones. Forty model horizontal beehive sketches that helped the trainee for the manufacturing of the beehive and fifty nuclei box for bee's colony trapping were manufactured in Jimma Agricultural Engineering Research Centre (JAERC) and presented to the farmers for training purposes at the selected sites. The improved horizontal beehives were manufactured right on each of the selected site. Transfer of bee has done and honey harvested. Data was collected through quantitative and qualitative techniques and analyzed by descriptive statistical method.

Results and discussions

Technology introduction and training were made to farmers and DAs. The scaling up involved 40 direct beneficiary farmers from beehive and nuclei box technology and a total of 320 farmers attended the techno display. The bee beekeeping method is still conventional production system by using traditional hives in most of the study areas.

Theoretical and Practical training on horizontal bee hive

Increase of the modern beehive cost and price needs introducing alternative machineries for low cost improved beehive production. As a way out to the above problems, theoretical and practical training was given to farmers, extension workers and DA’s on improved horizontal beehive construction from local materials and utilization of nuclei box for bee colony trapping process. In general, a total of 89 farmers (75 male and 14 females) and 8 DAs have been participated in training. Instruction was given to farmers by multidisciplinary team before the practical training, on local material preparation and production management, bee colony trapping handling. Moreover, leaflets were prepared and distributed to farmers, DAs and experts.

The feedback information after the training has been given to the farmers shows that it is possible to produce the technologies easily from the materials that exist at the farmers’ locality as they stated the production possibility in medium and high level by 30 and 45 percent of the respondents respectively. The participant farmers also stated that the improved horizontal beehive is simple and easily convenient to use, better honey production Maximum 17 and minimum 13 while average horizontal beehive produce 14.58kg. The technology also decreases lumber consumption by 72% (Husen A, 2008). Hence, more than half of the participant farmers confirmed that affordability of the technology is really promising as stated by the local farmers in Table 2 below.

Conclusion and recommendation

The scaling up of the technologies was carried out in four districts of Jimma and Illubabor zones specifically Mana, Dede, Metu and Gechi districts that involved 40 direct beneficiary farmers from beehive and nuclei box technology and 320 participants on training and display activity. The scale up result indicated that the trainings enabled farmers to easily produce the improved technologies from
local materials by using simple hand tools and low costs. During group discussion and farmer site visit, some participants were observed that they could produced the beehives after training and stated that they got a maximum 17 kg minimum 13 while average horizontal beehive produce 14.58kg from single beehive in one season harvest.

The result also showed that it can contribute to poor farmer’s income by producing the beehive using simple hand tools at farmer localities without using costly and complicated machines. The Horizontal Beehive is found to be better than Lang Stroth beehive as it can be constructed at village level or small workshops with locally available & cheap materials, avoids complicated joints, reducers the cost of production and queen excluder by half, decreases lumber consumption, and it can be constructed at different length according to the environment. Since it is of a single box, it can also be hang on a tree, or a pole. This protects it from ants, toads and brush fire. Finally, discussion was made with respective District Agricultural Officers and experts to take responsibility of further extension works of the technologies and capacitate the micro-enterprises and the local carpenters through proper training for production sustainability

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Pre-Scaling up of different Agricultural Mechanization Technologies in Jimma and Ilubabor Zones
Kemeru Dalecha, Mengistu Jifara


Abstract
The study was conducted in Jimma and Ilubabor Zones of Oromia Regional State, Ethiopia. The objective of the study was to promote improved technologies namely manual maize Sheller, fruit harvester & ground nut decorticator among the rural farming communities through scaling up activities. Hosting farmers were selected from two zones at different districts (Nadda, Kersa Mana, Limu and Shebe districts that the participants trained and sample technologies were provided at every selected sites for the study purposes where participants were trained and scaling up of the technologies were conducted. The scaling up activities involved training, display and discussion with the district agricultural experts, development agents, and participant farmers live in the technology demonstration areas. Finally, farmers could be able to practice working by using the technologies at every hosting farmer household sites in groups. The study feed backs showed that it is possible even to easily produce and use the technologies at the farmers' locality from the locally existing materials.

Key words: Improved, Sheller, harvester, decorticator, sample, practice

Introduction
Ethiopian population is growing in more rate than the agricultural product does. This implies that to feed this increasing population the agricultural production should grow accordingly. In order to increase the productivity of farmers, it is crucial to increase the awareness of farmers towards the practice of farm technologies help increase output, saving energy, time and money. Agriculture being the economic back bone of the country is undeniable fact and it is becoming more scientific and more profitable than it was decades ago. Currently the government has given more concern to agricultural production and working a lot for its improvement and profitability as the priority order.

Maize is the most important cereal grain in the world, after wheat and rice, providing nutrients for humans and animals. Maize shelling involves detaching of the maize grain from its cobs (Ashwin & Shai, 2004). Maize shelling is among the major activities involved in the processing of maize like harvesting, drying, de-husking, storing, and milling (Nyongesa, 2004). Maize shelling is needed harvesting because the maize kernels when harvested are firmly attached to the hard cob (Chendake, Patil, Pawar, Salunkhe & Burkul, 2014). Shelling of the dried cobs by majority of farmers is carried out by repeated beating of the cobs with a club while held inside Sacks, open barrels or spreading it over plastered ground floor in the house or outdoor (Dubale, 2011). Other traditional maize shelling technique is rubbing the maize cobs against one another by hand or by direct removal of kernels pressing it between thumb and hand palm. This option is being used and known for low shelling capacity of about 8 kg/hr to 10 kg/hr (John, Iris & Weil 1989).

Though some motorized and manual shellers with a satisfactory shelling performance have already been developed and being used in the country by capable farmers, those who could not afford due to their prices are still using the conventional method. Thus, introducing cost effective hand maize Sheller developed by JAERC is another option compared to costly motorized and other manual Sheller. It is also a worldwide emphasis on the awareness of the health benefits of fruit and vegetable consumption needs to be increased. In addition, accelerated national initiatives are required to produce and efficiently market more affordable horticultural products, while ensuring that they are safe and that fewer losses occur along the post- harvest handling chain (O. Michael, 1983).

Fruits and vegetables are the second priority for the area next to crops. But they are the most perishable and easily venerable agricultural produces for harvest and post harvest loses that need improved techniques for sustainable and profitable production. The Government of Ethiopia has
formulated a national program designed in such a way as to bring about meaningful improvements in productivity and quality of horticultural crops of different species to enhance their competitiveness in the market. Jimma and Illubabor zones are among potential fruit growing areas in the country (CSA 1998). As a result, vegetable and fruits like avocado, banana, orange, and papaya are commonly produced being more widely adopted, primarily to ensure food security and to promote production of high-value crops for the market to improve living conditions of smallholders (J. A. Samson, 1986). The main constraint with regard to fruit and vegetable production is that, because of market and food security concerns, rural farmers prefer to produce cereals and pulses. Other constraining factors include low production and productivity, lack of adequate pest control, poor soil fertility management practices, lack of attention to product quality and prevention of physical damage, as well as the lack of storage and packaging facilities (FAO, 2005).

Local fruit harvesting practices includes mainly hand picking by climbing the tree branches, picking hooks, shaking actions and knocking down fruits with long wooden or sticks for detaching. Dropping the produce down on to the ground after picking exposes the fruits to physical injury or wounding which facilitates entrance and development of rot organisms (A. G. Berlage, 1968). Furthermore, cuts, punctures and bruises to the fruit will usually increase ethylene production, accelerating softening of surrounding fruit causing them to become more susceptible to mechanical injuries, thus, decay (WHO & FAO 2005). Jimma and Illubabor zones have great production of different cereals, fruits and etc agricultural products. Even though different GOs and NGOs have tried to supply different mechanization technologies in to the system, it was not enough to addressing the majority farmers.

The Jimma Agricultural Engineering Research Center has been developing, modifying and verifying harvest and post harvest agricultural technologies used for cereals, fruits and vegetable production. Even though a lot of activities are being under taken in the center to adapt and demonstrate the available technologies in some districts of Jimma and Illubabor zones, there are still farmers who don’t know the existence of these technologies which can contribute much in making difference in the farming system when they adapted and demonstrated for the farmers. Familiarizing the farmers of study area with different proven technologies like manual maize sheller, groundnut decorticator, and fruit harvester holds promise to an increase in production. Therefore this scale up study made on some selected technologies was made the local producer farmers with the following objectives.

Objectives of the study:

- To introduce and promote some improved harvest post harvest agricultural mechanization technologies to the rural farmer
- To create awareness and improve linkage with agricultural extension and other stalk holders.

Materials and Methods

Description of the Study area

The study was conducted in the purposively selected districts of Nadda, Mana, Limu, Shebe, Metu and Gachi from which twelve potential Kebeles two from each districts were purposively selected and 3 hosting farmers from each Kebele were selected purposively so that they can be served as hosting farmers for each technology type as demonstration destination site. Secondary data was collected and supported by primary data on the farmers perception feedback with regard to the technology accessible, convenience, affordability conditions.

Materials required

The sample technologies of the three types (manual maize Sheller, fruit harvester and groundnut decorticator) were produced in Jimma Agricultural Engineering Research Centre (JAERC) and
introduced to the selected farmers that used as hosting farmers for the scaling up activities of the
technologies.

Results and Discussion

Improved technologies such as Adjustable Manual Maize Sheller, Improved Fruit Harvester and
Groundnut Decorticator were scaled up and the results are presented as follows.

Adjustable Manual Maize Sheller

The technology scaling up activities involved training, display and discussion with the district
agricultural experts, development agents, and farmers exist in the pre-scaling up areas. A total of 287
attendants that encompasses 140 female and 147 male farmers were participated in training activities
during scaling up processes of the Adjustable Hand Maize Sheller. The participants stated that the
maize Sheller helped them to use in their daily maize shelling activities as it is easy to manage, very
low cost and could contribute to widespread efforts made by different stalk holders to solve the
problem that rural women faces mainly tiresome activity and physical injury during finger shelling
maize for sell and house consumption.

In addition to this, a total of 320 farmers were reached by pre-scaling up activities during display
work to improve the farmers’ awareness on technology application so as to improve their livelihood.
The Hand Maize Sheller is appreciated by the participants that it could minimizes damage to maize
kernels and physical injury while shelling the maize crop. Adjustable Hand Maize Sheller helped the
users in saving time and energy by decreasing tedious labor works.

Improved Fruit picker

The improved fruit harvester enhanced the traditional and tedious harvesting practice i.e. picking
using hooks, hand picking by climbing tree branches, shaking actions and knocking down the fruits on
to the ground after picking which exposes to physical injury contributing to post harvest loss. Farmer
using improved fruit harvester could minimize physical injury and post harvest losses in relation to
their local experience.

The pre-scaling up activities of the improved fruit harvester reached a total 20 participants that
involved 180 attendants encompassing 54 female and 126 male farmers in the mini display conducted
at the hosting farmers’ sites during the scaling up processes to make more number of the beneficiary
farmers be award of the improved fruit picker technology. The respondent farmers also stated that
the improved frit harvester helped them in saving from challenges of climbing the tree, lighter for operation, easy to manage at medium height and took less time to harvest fruits. The limitation of the technology stated by the participant farmers is that it is difficult when
fruit tree height exceeding 7m for average height person.

The improved harvester users’ were benefited by reducing the fruits vulnerability to injury because
there is no or very few fruits drop on ground while harvesting since it has fruit collecting bucket. The
participants of the study stated that the damage of fruit due to improved harvesting method was low. The improved harvester leave the minimum number of fruits wounded while picking on the fruit skin
that increased market value or its sale ability due to increased demand by minimizing rate of
deterioration. The study participants also stated that they are benefited by using improved harvesters
being free of risks of falling off the tree because one does the harvesting without standing on the weak
points of tree branches and help in minimizing fruit skin breakages upon dropping and risk of falling
off the tree, which they were facing sometimes.

Groundnut decorticator

A total of 135 farmers were attendant of the display set to introduce techniques of decorticating
groundnut by using improved groundnut decorticator machine where 27 female and 118 male groups