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Demonstration of Fayoumi Chicken Breeds along with Their Package at Arsi Negele District, West Arsi Zone, Oromia Region, Ethiopia

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Abstract

The primary aim of this study was to improve rural farmers' income through demonstrating semi-scavenging improved poultry packages. Demonstration on farmers' research group was the method adopted, a total of four FRG (farmers Research Group) was established following the FRG principles and the trial was hosted by four farmers (one from each group). A total of 138 day old grower chickens were distributed to the farmers with recommended male to female ratio. All possible poultry management activities were undertaken. Accordingly the introduced poultry breed and packages were positively affected the income and livelihood of rural farmers. Farmers' feedbacks indicate that the frequent existence of new castle disease was found to be the bottle neck of sustainable poultry production. In addition, lack of well adapted breed, lack of adequate package delivery and supply system and low motivational impulse along with lack of adequate capital in intensive poultry production system in the area is among the observed problems. The project experience concludes that small scale semi-scavenging poultry production in the study area is economically feasible along with facilitated sustainable breed improvement strategy, veterinary service delivery and input supply. There is a need to enhance awareness both for farmers and micro finance institution to enhance the sector contribution to per capital income and further facilitate the adoption of poultry technology. Further, the future focus of research has to be genetic improvement of local breed for productivity and disease resistance through either cross breeding or frequent selection.

***Key words**: Income, Livelihood, Package, Poultry, Rural, Semi scavenging.*

Introduction

Ethiopia is one of the African countries with a significantly large population of chicken, estimated at 44.9 million (Central Statistical Agency [CSA], 2012). However, the number of chicken flocks per household in most Ethiopian rural communities is small; constituting an average of 7–10 mature chicken, 2–4 adult hens, a male bird (cock) and a number of growers of various ages (Dessie & Ogle, 2001). The impact of village chicken in the national economy of developing countries and its role in improving the nutritional status, income, food security and livelihood of many smallholders is significant owing to its low cost of production (Abdelqader et al., 2007; Abubakar et al., 2007). Furthermore, it provides employment and income generating opportunity and is a priority animal for holy day and religious sacrifices (Gueye, 2002). Village chickens also play a role in converting household leftovers, wastes and insects into valuable and high quality protein.

In a number of African countries, approximately 80% of the chicken flocks are owned, largely controlled and managed by rural women. In male headed households, the wife and husband are co-owners of the chickens but sometimes children own some chicken in the flock and are allowed to sell their chicken and eggs to cover expenses for school or to purchase clothes. According to Tadelle et al. (2003) in Ethiopia, village chicken production systems are characterized by low input–low output levels. A range of factors such as suboptimal management, lack of supplementary feed, low genetic potential and high mortality rate are the major causes for the low productivity of poultry. Due to this, it is important to introduce poultry technologies for small scale farmers. Following the importance and availability of improved and better adaptable breed in ATARC this activity was initiated to satisfy the observed gap with available better poultry breed. Therefore, this study aims to demonstrate and evaluate the performance of improved poultry packages thereby improving income of farmers in the area.

Methodology

Study/Demonstration site selection

The study was conducted at selected *Kebeles* of Arsi Negele district in 2015/16 year. One *Kebele* (Rafu Hargisa) was selected purposively based on the accessibility of the *Kebele* for monitoring purpose both for researchers and development workers.

Description of the study area

Arsi Negele is one of the districts found in West Arsi zone, Oromia, Ethiopia. The altitude of this woreda ranges from 1500 to 2300 meters above sea level with 915mm and 17.7^{o}c of average annual rainfall temperature respectively. There are 33 Kebele's in the distict. Arsi Negelle is bordered on the south by Shashemene zuria district on the southwest by Lake Shala which separates it from Shala, on the west from the Southern Nations, Nationalities and Peoples Region, on the north by East Shewa with which it shares the shores of Lakes Abijatta and Langano, and on the East by the Arsi Zone.

Farmer Selection and Group Formation

Farmers were selected in collaboration with Subject Matter Specialists (SMS), Development agents (DAs), and *Kebele* leaders. These selected farmers were organized into FRG group. FRG approach and principle was employed at all processes of group formation. Community meetings were also undertaken to screen farmers and form FRG groups A total of four FRG groups were organized, each having group leader and secretary. Group leaders were selected based on literacy level, acceptance in the community and willingness to serve the position. Regular monitoring was also undertaken by Adami Tulu Agricultural Research Center (ATARC) researchers and DAs. Consequently one host farmer from each FRG was selected. Host farmers were selected based on willingness to accept the technology, willingness to do in groups, willingness to construct poultry house, willingness to participate on community meeting, visits and training, willingness to contribute for some costs of inputs, Final community meeting was also

undertaken before embarking on the activity at Farmer Training Centers (FTCs) to develop participatory action plan and sign memorandum of understanding

Capacity Development

At the initial phase of the activity, after group formation, different capacity development activities were undertaken. It was undertaken based on need assessment. Farmers and DAs were invited and trained at ATARC. Field visits were made at ATARC poultry site to increase farmers' knowledge and skills on feeding and housing management. The training program encompasses feeding management, health management, group management and record keeping. A consecutive training was also provided for farmers and DA's at FTC found in the study areas.

Poultry Management Approach

Host farmers constructed house as per the recommendation from local materials. Almost all of construction materials were supplied by farmers. All other feeding and watering equipment was supplied by ATARC. Chickens were multiplied at ATARC and feed commercial feeds to for two months until they are ready for distribution and until housings are ready by the host farmers. After poultry house is constructed, a total of 138 fayoumi chickens were distributed for the host farmers following the male to female ratio. Some amount of commercial feeds was also distributed to farmers for demonstration purpose i.e. to show them ration formulation and to increase the adaptability of the chickens to the environment. Farmers were also trained on how to formulate poultry feed from locally available materials and health management aspects such us house cleaning and proper vaccinations. In addition, vaccinations were provided for the distributed chicks during the activity duration by ATARC

Type of data, methods of data collection and analytical tools

Both qualitative and quantitative types of data were collected. Technology application data (feeding, health and housing management aspects), production performance and costs involved, number of eggs laid, no of eggs sold, price of egg, number of bird sold, price of selling bird, feed purchased and used were major collected type of data in the area. In addition, farmers' attitude towards the performance of the technology and number of participants on training, field visits and focus group discussion (FGD) were included. The data were collected through farmers' day to day recordings, observation, focus group discussion (FGD) and quick survey checklist. Farmers were trained on data collection techniques prior to demonstration. Qualitative techniques were analyzed through descriptions/narrations of the events. Quantitative information/data were analyzed using descriptive statistics and presented in tabular and graphic ways. The data was entered, coded and analyzed with MS excel and SPSS Ver.20.

Results and Discussion

A total of 30 (thirty farmers) were organized in FRG. One third of the members were female farmers while the rest two third are male. Following the establishment of FRG; farmers were trained both theoretically and practically on the concept and principle of FRG approach, improved poultry production and management practices.

Table 1. Description of FRG members trained by gender

Number of FRG	Location (on-station/ district with PAs)	Number of participants				
		Farmers/pastoralists			Extension workers	Total
		M	F	Total		
4	Arsi Negele	20	10	30	4	34

Source: Our results, 2015

The training was also given for extension workers in all the trial location. Accordingly, four development agents were trained on similar topic. Following the theoretical training farmers and DAs were visited ATARC poultry farm to see what is theoretically given on the training. Finally, the trial hosting farmers were advised to construct poultry house according to the principle and from locally available construction materials for startup.

Production and utilization of egg

Table 2. Production and utilization of egg in the study area

Variable description	FRG one	FRG two	FRG three	FRG four	Remark
No days egg collected	102	367	399	77	
Total egg collected	1059	3095	3054	680	
Average egg per day	10.38	8.43	7.65	8.83	No of days/ no egg
Egg consumed	177	275	361	42	
Percent consumed	17	8	12	6	
Egg no sold	882(83)	2820	2693	638	

Source: Own results, 2015/16

The production and consumption result of egg during the study indicate that among the number of procured poultry the average number of egg is different over location. The maximum number of egg production was obtained at FRG two followed by FRG one and the lower were obtained at FRG four.

With regard to the amount of egg utilized FRG one has achieved higher level of consumption or utilization. The utilization of egg in the rural areas does have an immense role in enhancing household, food and nutrition security (Samson & Endalew, 2010). To this end, participant farmers in this study used from 6 to 18% is egg produced in their home for house hold consumption where most of the household egg consumption was for children and the youngest member of the household.

The following stacked graph illustrates distribution of production, sell and consumption pattern of each trial household.

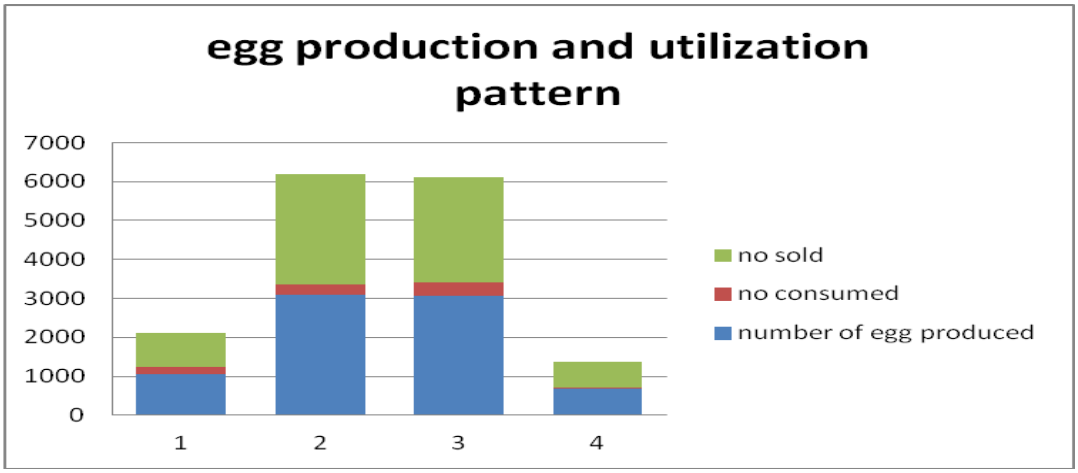

Figure 1. Egg production and utilization pattern over study site
Source: Own results, 2015/16

Economic Analysis

During the study time one year continues data result indicate that on average farmers were using 205, 106 and 155 grams of feed per day per chicken at site one, two and site four respectively. This result includes for the feed left over and the amount used is higher than that of feed intake of the same breed under Adami Tulu condition obtained by (Tesfa et al., 2013) which states that the average daily intake of layer fayoumi is 113.5 g/day. The higher amount under farmer condition doesn't control for the amount of left over from daily consumption. Therefore, the average 41g/day may be of leftover amount. The difference in the amount of use was significantly different between the locations. This might probably related with other factors of intake or management performance. The overall production cost is high at site two and one, respectively.

Table 3. Production cost analysis

Variable description	FRG one	FRG two	FRG three	FRG four	F	P-value
Feed cost	1930	5855	1502	6417.25	27.93	0.034
Vaccination and disinfection birr/bird	336	396	456	468		
Total	2266	6251	1958			

Source: Own computation, 2015/16

The partial budget analysis result in Table 4 indicates the economic efficiency of fayoumi chickens under farmers' intensive management condition.

Table 4. On farm level economic efficiency of fayoumi chickens production

Item	Cost involved			
	FRG one	FRG two	FRG three	FRG four
Total cost of feed consumed	1930	5855	6417.25	1502
Total cost of vaccination, disinfection, and medicine	168	198	234	228
Total variable cost	2098	6053	6651	1730
Sales of egg	3177	6963.75	7635	2040
Sales of birds	900	1150	1400	1450
Net return	1979	2060.75	2384	1760

Source: Own computation, 2015/16

The average net profit of 2045 ETB is the return on investment obtained of fayoumi chicken production under farmers management from the sales of eggs and sold birds. The revenue in the above table did not considered of the value of poultry litter either as a bio fertilizer or animal feed. Assuming the long run production function that does not calculate for the fixed cost; using the family labor with no cost the highest cost of production under farmers' condition is feed cost.

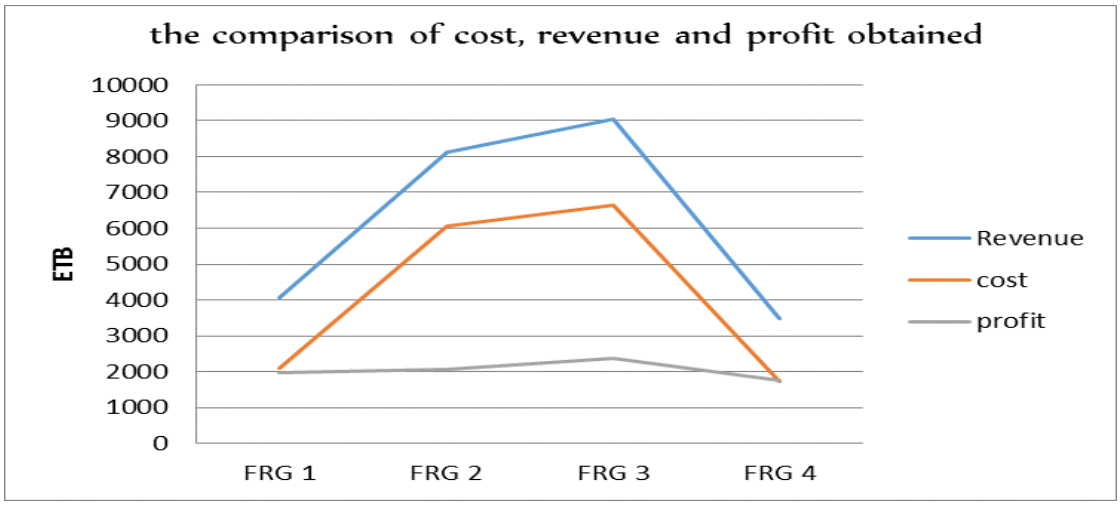

Figure 2. Graphic comparison of revenue, cost and profit of poultry production in study area
Source: Own results, 2015/16

Farmers' feedback to the technology

Farmers' preference of poultry to other livestock technology this is primarily from economic analysis. According to the appraisal result there are three major reasons why people prefer poultry to other. These are poultry requires minimum investment capital relative to other livestock technology although the benefit is less too. It requires low input and is short term that can generate income over a short period of time. Further, the production of poultry in a village enhanced the nutritional security. According to farmers' feedback, the major challenge to poultry production is disease. It was reported that sources of

improved poultry breeds are from research centre, non-governmental organization (IDE), and Woreda livestock agency. Those improved breed have been sensitive to disease than local (New castle disease). This can be associated with less adaptability of improved breed and weak and/or lack of sustainable health extension services. Farmers also perceived that attention to poultry is low relative to other large and small livestock in the area.

Problems observed

There is no operative improved poultry multiplication and input supply system in the district that can respond to farmers' needs/demand and facilitate the adoption of improved poultry technology. The sustainable health service is the very important package components but not yet learned and provided in the study area. The other factor of sustainable intensive improved poultry technology is related to the motivation of farmers. It is the issue of farmers lack of interest to invest in house and other improved poultry package for small flock size (5 -10) which is the maximum amount they will get by the extension organization although they had interest to receive more number of chickens. In addition, lack of capital and related input supply is the other factor in adopting improved poultry package.

Conclusion and Recommendations

Investing on small scale semi scavenging fayoumi chickens had an economic return. Besides, farmers prefer poultry to other large livestock for different reasons. The sustainable production of poultry under farmers' intensive management is hindered by lack of adequate supplementary feed, inadequate veterinary service, lack of improved breed and multiplying agent (source of stock and replacement foundation), disease outbreak, constructing house for small flock size (economies of scale). Therefore, it is necessary to establish input supply system, facilitate basic poultry veterinary service, supply or establish day old improved chicken multiplication (as a source of stock and replacement foundation). Further, since the local are more resistant than the introduced breeds; the breeding works of improving the performance of local poultry either through cross breeding both for productivity and resistance or improving through frequent selection should be focused on. It is also necessary to demonstrate how to enhance the productivity of local chickens through intensive management practice and formulate feed from the locally produced crop so that locally available crops and materials will be used in replacement.

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On Farm Evaluation and Demonstration of Substitution of Poultry Litter to Concentrate in Diet of Growing F1 Heifers in The Low Lands Areas of Mid Rift Valley of Ethiopia

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Abstract

In a place like central rift valley of Ethiopia where there is shortage of rain and grazing land the quality and quantity of available feeds is fibrous and low in crude protein. As the grazing fails, accepted practice is to redress the deficit with crop residues. Therefore, farmers have started to use optional feed types such as chicken litter as a substitute. Chicken litter is an economical and safe source of protein, minerals and energy for cattle. Previous on-station trail conducted at on-station at Adami Tulu Agricultural Research Center, Oromia, Ethiopia revealed that substituting concentrate feeds by poultry litter at 30% rate to growing heifers could result in the same result on growth when compared to heifer feed conventional concentrates alone. However, this study was not conducted at on-farm conditions. This study was therefore set out to evaluate the supplemental value of poultry litter at 30% rate on growing heifers at on farm conditions and find out its economic benefit as well according to farmers management. Similar to that of on-station result the results of the on-farm evaluations indicate that substituting poultry litter at 30% rate showed no statistically significant difference on the growth of the experimental heifers at $p<0.05$. i.e weather one supplements conventional concentrate or substitutes 30% of the concentrate with poultry litter there is no significance difference on the growth of the heifers. The financial analysis comparing the costs incurred and the revenue gained for the 105 days feeding period shows that one can save 842.15 birr /heifer by substituting poultry litter.

Key words: *Poultry litter, Substitution, On-farm, Concentrate feeds, Evaluations*

Introduction

When the rains cease the quantity and quality of grazing falls rapidly, so that dry grazing is fibrous and low in crude protein (CP.; around two per cent). As the grazing fails, accepted practice is to redress the deficit with crop residues. Efficient use of these resources demands supplementation and, or, modification of them. This is especially true where production targets (growth; reproduction; lactation; draught) have to be met. Under-supply of nutrients is often a combination of lack of feed coupled with an imbalanced diet (Bensalem & Smith, 2008).

Poor quality pastures and cereal crop residues, the main feed resources in East Africa, cannot sustain effective animal production or even maintenance when fed alone, particularly during the dry season. Thus, provision of appropriate supplementary feedstuffs would be an important step to enhance the productivity livestock under smallholder and pastoral production systems of East Africa (Adugna etal., 2000). Two possible inexpensive means of utilizing cereal crop residues to rear growing ruminants are ammonization and supplementation with available by products such as broiler litter (Anmute et al., 2002). The high content of protein, energy and minerals in poultry waste indicates its importance as a partial substitute for concentrates and high protein feeds like fish meal (Salama et al., 2002). Poultry litter can be successfully included in the diet of ruminants as a protein supplement and it is also rich in minerals. Optimum supplement levels for dairy cows are 1 to 2 kg daily. The ensiling of the poultry litter is a simple and appropriate method of conservation which effectively destroys harmful micro-organisms possibly present in poultry litter (LSU Ag Center, 2007).

The alternative feeds available chicken litter has also the greatest value for its cost. It is best if used in dry season feeding programs. It is an economical and safe source of protein, minerals and energy for beef cattle. Litter also makes an economical substitute for hay especially during the drought years when hay is in short supply (Carter & Poore, 1995). Furthermore, Layer chicken litter could be used as a supplement by farmers to avoid cases of Mg deficiency that can lead to decreased productivity and economic losses to the livestock industry (Hurley et al., 1990). However, farmers should vaccinate their animals for botulism before feeding layer chicken litter.

Use of by products can decrease production costs and increase total production. So far, there is very few works done on evaluation of poultry litter to the dairy cattle in Ethiopia. In a research conducted at on-station conditions at Adami Tulu Agricultural Research Center, Estefanos et al. (2016) found out that substituting poultry litter at 30% rate for growing F1 heifer did not show significant difference in growth rate when compared with conventional concentrate. However, the cost of using the substituted poultry litter was less than using conventional concentrate with a 0.91 marginal rate of return. Based on this on-station result an on farm evaluation and demonstration was conducted in 2016/17 with an objective to demonstrate the supplemental value of poultry litter as a substitution of concentrate in the diet of F1 growing heifer and find out the economic benefit of substituting poultry litter for concentrate at on farm conditions.

Materials and methods

Description of the study area

The experiment was conducted in Adami Tulu Jiddo Kombolcha district of Oromia regional state, Ethiopia. Two Peri urban sites namely Adami Tulu located and Bulbula areas were selected purposively taking into consideration the accessibility and availability of F1 cross breed heifers.

Animal management and treatment diets

Ten growing heifers were allocated to each treatment, and the animal's allocation to treatments was based on age and weight.

Table 3. Treatment diets

Feed ingredients proportion	Treatment1	Treatment2
Noug cake %age	36	25
Wheat bran %age	62	43
Poultry litter %age	0	30
Salt %age	2	2
Total	100	100

T1= Noug cake 40% and wheat bran 58% + 2% salt
T2= substitution poultry litter for concentrate at the rate of 30%
Source: Our design, 2015-2016

Data collected

Fortnight body weight, feed delivered, left over, price of feed, all cost incurred for each treatment and knowledge level and before and after trial of the participating farmers were collected

Financial Analysis

The financial analysis was calculated to determine the profitability of the supplemental feeds fed to growing F1 heifers calves under on farm management conditions. According to (Ehui et al., 1992) net income (NI) was calculated as the amount of money left when total variable cost (TVC) was subtracted from total returns (TR). In this experiment the variable costs included estimated purchase price of the hiefers before entering the feeding trial, purchase of supplemental feed cost, labour cost for preparation of the supplemental feed and cost for medicaments of treatments. While total return (TR) was estimated by the selling price of the F1 heifers. Therefore a formula of **NI= TR- TVC** was used for the calculation of profitability.

Feed sample Analysis

The chemical composition of the basal and supplemental diet for each treatment was collected and analyzed at Holeta Agricultural Research Center. Representative sample, 100g of the ingredients was collected each time when feed was mixed. For the individual feed components before mixing for the treatment sample from the upper, middle and bottom part of the container was used to make it representative. The feed samples 250gm from each ingredients and treatments were partially dried at 65°c for 48 hrs and grounded by 1mm sieve in the laboratory. Crude fiber, Dry matter, Nutrient free extract, Ether extract and Ash were determined using proximate procedures (Van Soest & Robertson, 1985). Nitrogen was determined according to Kjeldhal procedure and crude protein calculated as N x 6.25. In vitro dry matter digestibility was determined by two stage method developed by Tilly and Terry (1963). Rumen fluid was collected from three rumen fistulated steers before morning feeding. The steers were fed on natural pasture hay adlibitum and two kg concentrate per day.

Data analysis

In the feeding trial two treatments were replicated to 10 animals per treatment in Completely Randomized Design. The growth rate of the heifers was analyzed using GLM procedure of SAS version 9 (SAS 2004). Means were separated using Tukey test and were considered significant at $P<0.05$. Financial analysis was also used to analyses the cost and benefits difference among the treatments. Furthermore, a simple knowledge test was also used to compare participant farmers' knowledge level before and after the experimental period related with poultry litter.

Results and Discussion

Composition of experimental feed

The dry matter (DM), Ash, organic matter (OM), Neutral Detergent Fibre (NDF), Acid Detergent Fibre (ADF), Lignin, Crude Protein (CP) Digestible Organic Matter Digestibility (DOMD) of all the feed ingredients used in the feeding trial was presented in (Table 2). Broiler litter is high in CP, typically ranging between 15 and 35%, Levels of NDF are usually between 30 and 60%. (Saleh et al., 2003; Daniel & Oleson, 2005; Lanyasugna et.al., 2006).The present finding Table(2) has lower CP and ADF but higher NDF than the report of Abdul et al. (2008) which indicated 28.2%, 30.29 and 38.62 and slightly higher CP than the finding of Yosef and Mengistu (2013) which indicated 25%.

Table 4. Feed composition of the basal and supplemental feed used in the experiment

Feed Sample	DM%	Ash	OM	NDF	ADF	Lignin	CP
	% DM						
Poultry litter	90.18	15.45	84.55	58.09	20.83	6.15	27.47
Noug cake	91.98	12.51	87.49	39.64	31.56	9.16	29.16
Wheat bran	90.56	4.58	95.45	36.44	9.78	2.74	14.39
T1	91.28	6.94	93.06	44.26	22.06	5.25	19.71
T2	91.28	11.33	88.67	47	17.2	4.47	19.67

DM= dry matter, OM= organic matter, NDF = neutral detergent fibre, ADF= Acid detergent fibre, CP= crude protein.
Source: Own results, 2015-2016

Body weight change and supplemental feed Intake

Inclusion of poultry litter in the concentrate mix at the rate of 30% for noug cake does not affect the final body weight the growing F1 heifers ($p<0.05$) as compared to the concentrate without poultry litter mix (T3). Similarly the supplemental feed intake of poultry litter mix at 30% rate did no show significant difference at ($p<0.05$) as compared concentrate mix without poultry litter. Dry matter intake of the supplemental feed was not significantly affected by substitution with poultry litter (Table 3). Mixing the poultry litter with the concentrate did not have significant effect on the intake of poultry litter by the ruminants. The mixing action also delivered adequate amount of energy and protein for the microbes in the rumen to utilize the non-protein nitrogenous substance in the poultry litter. The present result is in agreement with the result of Hopkins and Poore (2001), which indicated similar feed intake observed with substitution of soya bean meal substitution with deep stacked poultry litter. The current weight gain result (Table 3) is slightly higher than the finding of Rossi et al. (1997) which indicated that 0.47-0.57 kg daily weight gain per cow per day with poultry litter substitution of concentrate diet for beef cow. And the results are greater than the result 0.37-0.44 kg daily weight gain per day per gestating beef heifer reported by Rossi and Leorech (1999) and the report of Mubi et al. (2008) which indicated average daily weight gain of 69.7 gram for growing heifer fed on alkali treated sorghum plus 0.5kg poultry litter/day/head in the north eastern Nigeria. More over the result is in agreement with the finding of Yosef and Mengistu (2013) supplementing dairy cows with concentrate mix at 22% poultry litter as a replacement of ground nut cake increased total dry matter intake and did not depress the body weight and reproductive performance of a cow as compared to cow fed supplementation only on ground nut cake in experiment conducted in Haramaya University.

Table 5. Body weight change of the F1 heifer during the 105 days of experimental period

Parameters	Treatments diets		N	SEM	P-value
	Treatment1	Treatment2			
Initial weight (kg± SEM)	197.2±12.62[a]	193.1±12.9[a]	10	12.78	0.82
Final weight (kg± SEM)	267.5±9.67[a]	262.8±13.25[a]	10	11.59	0.78
Body weight change (kg)	70.3	69.7	10	11.62	0.79
Average daily weight gain (kg/day)	0.6695	0.6638			
Feed intake (kg/day)	2.92 ± 0.047	2.81 ± 0.06	105	0.81	0.16

Parameters with in the column with different letter shows significant difference at $p< 0.05$ level of significance.
Source: Own results, 2015-2016.

Linear measurements

Both weather height and height at hip of the growing heifers showed an increasing trend for all the animals in the two treatments. Even though not significant the change in weather height for the heifers under concentrate without poultry litter as compared to the mix at 30% was 9.7 cm vs 8.4cm respectively (Figure 1).

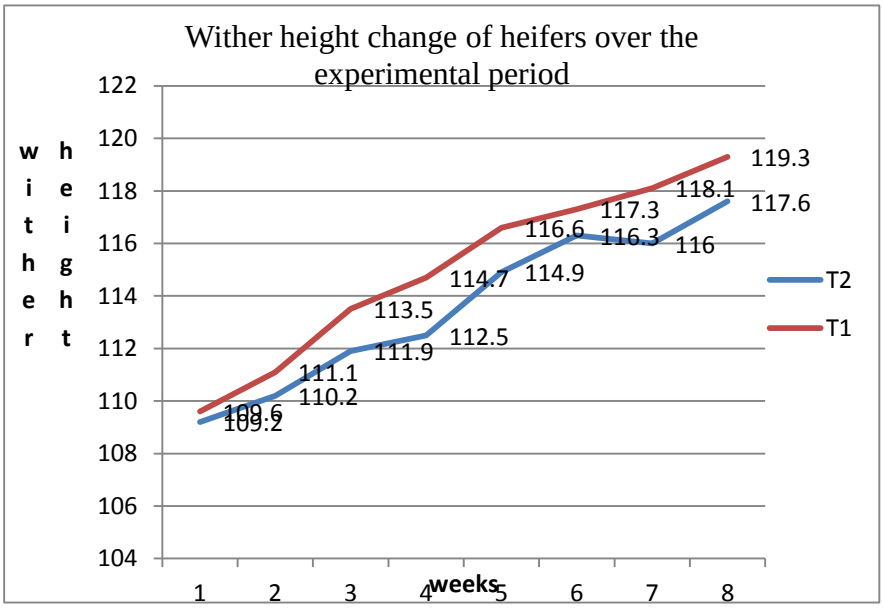

Figure 3. Wither height change of the heifers over the experimental period
Source: Own results, 2015-2016

But, the change in hip height was almost similar between the two treatments (Figure 2).

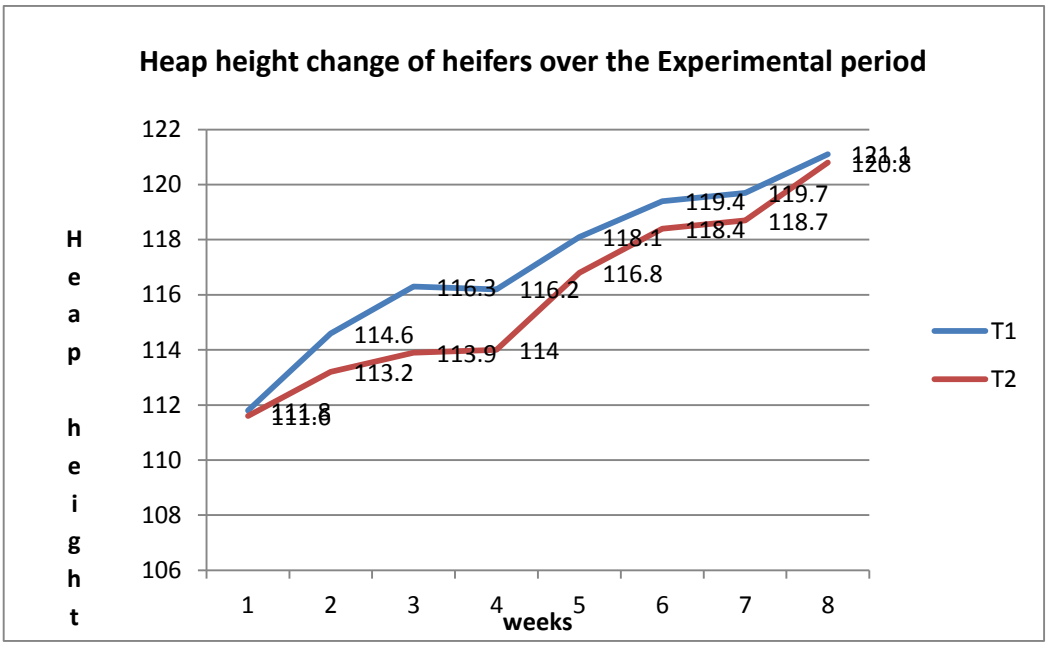

Figure 4. Heap height change of the F1 heifers over the experimental period
Source: Our results, 2015-2016

Financial Analysis

The financial analysis result shows that, the supplemental feed cost was highest for treatment diet 1 (without poultry litter inclusion) as compared to treatment 2 having 30% poultry litter substituted in the diet. The total net income was higher for the treatment having 30% poultry litter as compared to treatment without poultry litter. The following table describes the difference between costs encored and the profit gained during the 105 days feeding period per one heifer among the treatments.

Table 6. Financial analysis

Particulars	Treatment diets	
	Treatment1	Treatment2
Supplemental feed cost	1912.05	1069.875
Labour cost	1000	1000
Medicaments	100	100
Total Input cost	3012.05	2169.88
Average cost of the calves if purchased	4050	4050
Total variable cost	7062.05	6219.88
TR	10000	10000
NI	2937.95	3780.13

TR= total revenue, NI=net income

Source: Our results, 2015-2016

Farmers' feedback and knowledge level before and after the trial period

A simple yes or no question was designed and asked to rate the knowledge level of the participant farmers before and after the trial period involving a total of 30 farmers. The data was collected during training period before starting the trial and during seminar conducted after the trial to share the outputs of the experiment to the participating farmers. According to the findings, before intervention only 4.4 % of the farmers had information about what poultry litter is, it's nutritional and economic value and had interest in using poultry litter as their cattle feed. However after intervention all the participant farmers have responded as they have understood what poultry litter is and is interested in feeding their cattle with poultry litter (Table 7).

Table 7. Farmer's knowledge before and after trial

Statements	Before trial		After trial	
	Yes (%)	No (%)	Yes (%)	No (%)
Had information about poultry litter	1 (4.4)	29 (96.6)	30 (100)	0 (0)
Understand the nutritional and economic value of poultry litter	1 (4.4)	29 (96.6)	30 (100)	0 (0)
Interested in feeding poultry litter to my cattle	1 (4.4)	29 (96.6)	30 (100)	0 (0)
Know how to mix poultry litter with the conventional concentrates	0 (0)	30 (100)	30 (100)	0 (0)

Source: Our survey results, 205-2016

Conclusion and Recommendation

Inclusion of poultry litter at the rate of 30% (T2) for substitution of concentrate in the diet F1 growing heifers conducted on farm indicated that biologically similar and economically feasible. The result obtained as compared to conventional supplement used (T1.) So, further training and awareness creation has to be given for the farmers in the study area and they could practice the inclusion of 30% of the poultry litter in the diet of the growing F1 heifers.

Further studies required to identify the optimum level of inclusion poultry litter in the diet of growing F1 heifers for the locality since the feed cost is lower for poultry litter as compared to the conventional concentrate and the dairy farmers in the area will be more beneficiary.

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Pre- Scaling Up/Out of Improved Haricot Bean Technologies in Selected Ddistricts of Western Oromia, Ethiopia

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Abstract

This activity was conducted in Bako Tibe, Diga, Chewaka and Guto Gida districts of Western Oromia with the objective disseminating the already evaluated and selected varieties of haricot bean, Dimtu and Gabisa to the farming community in these districts. These districts were purposively selected based on potentiality for haricot bean production; and one potential peasant association from each was selected on the basis of accessibility and potentiality. After peasant associations were selected two varieties of haricot bean, Dimtu and Gabisa were planted on 0.25ha farmers' fields. A seed rate of 80-100kg/ha and 50kg DAP/ha was used with a line spacing of 40cm between rows. Accordingly; in the course of implementation, a total of 71 farmers were reached, 1775kg seed was distributed and an area of 17.25ha was covered with the activity. The grain yield performances of the two improved varieties were 22.5 and 21.4 quintal per hectare for Dimtu and Gabisa varieties respectively implying 125% yield advantage for Dimtu and 114% for Gabisa. The research intervention has contributed to improve food security and livelihood. At the completion of the activity an exit strategy that contributes to sustainability was designed where the district Bureau of Agriculture and Natural Resource 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 participating farmers.

Keywords*: Pre-scaling up; Haricot bean; Dimtu; Gabisa; Stakeholders linkage; Multidisciplinary*

Introduction

More than 85% of the Ethiopian population, which resides in the rural area, is engaged in agricultural production as a major means of livelihood (World Bank, 2006). The agricultural production system is mainly rain fed and traditional, which is characterized by low input of improved seeds, fertilizer, pesticides and other technologies (Legesse, 2004). Moreover, the ever increasing population pressure led to decline in land holding per household that eventually resulted in low level of production to meet even the consumption requirement of the households (Bezabih & Hadera, 2007).

Increasing agricultural production at the household level is vital to achieve food security (Degnet & Belay, 2001). On the other hand, any marketable surplus could be sold to the non-farming and even to the farming communities (Hailu, 2008).Therefore, increasing the production and productivity in a sustainable manner could address the problem of food shortage **(**Habtemariam, 2004). As one of the approaches to ensure households food security, the Ethiopian rural development policy and strategy document has given weight to follow diversification and specializations in production systems along with improved access

and use of agricultural technologies (Hailu, 2008).In general, raising agricultural output and productivity on a sustainable basis necessitates large scale adoption and diffusion of new technologies (Mehumud et al., 2009).

Although cereal crops are most important in Ethiopian agriculture in providing staple diet to the population, pulses are also important components of crop production (Ali et al., 2003). Accordingly, pulse crops provide an economic advantage to small farm holdings as an alternative source of protein, cash income, and food security (Ferris & Kaganzi, 2008). The two major haricot bean producing regions are Oromiya and Southern Nations, Nationalities and People's Region (SNNPR), which produce 70 and 60 thousand tones per year, respectively, and these two regions make up 85% of the total production (Central Statistical Agency [CSA], 2005). Average national production is approximately 150 thousand tons per annum. The level of production in 2005 was approximately 175 thousand tones with a domestic market value of United State Dollar (USD) 30 million (Ferris & Kaganzi, 2008).

Haricot bean stands out among the pulses and is also known as "the poor man's meat" due to its high protein content, which compensates for the deficiency that could have occurred in a population with low income. Different types of haricot beans are grown in Ethiopia. These include white pea beans, grown in the central Ethiopia (Shoa) as cash crop, colored beans grown in the southern part of Ethiopia for local consumption and climbing beans grown in the North West (Metekel) and western Ethiopia (Wollega). Climbers are planted along fences and on the borders of maize fields (Zelalem, 2002).

Although haricot bean is largely grown in Ethiopia, the national average yield of haricot beans is low ranging from 0.5 to 0.8 tone ha–1, which is far below the corresponding yield recorded at research sites (2.5 – 3 tones ha–1) using improved varieties (Ethiopian Pulses Profile Agency [EPPA], 2004). The low national mean yield observed for haricot bean could be attributed to various constraints related to low adoption of improved agricultural technologies, drought, and lack of improved varieties, poor cultural practices, disease, and environmental degradation (Legese et al., 2006).

Research center have made all-round effort to provide solution to these problems. As result more than 5 haricot bean varieties with their full package were formally released for production from regional and national research centers. Besides; the center has been making great effort in demonstrating haricot bean technology package on small plot and also evaluated by farmers' criteria and meet farmers' need in these selected districts of East Wollega, West Shewa and Buno Bedele zones of Western Oromia for the last five years.

Despite the fact that though the technologies were demonstrated and evaluated by the farmers in the selected districts, many farmers were not accessed, produced and benefited from these technologies package. Considering the above facts, pre-scaling approach of haricot bean technologies, aiming at mitigating the lack of technology and seeds through a multiple crop technology up scaling approach was undertaken. Therefore, this activity was conducted with the objectives of popularizing haricot bean technologies in selected zones of Oromia, strengthen linkage between farmers, extension, research and others key stakeholders and improve the knowledge and skills of farmers on haricot bean production and management thereby improving livelihood of small scale farmers in the area.

Methodology

Description of the Study Area

East Wollega zone is located at 331 km west of Finfinne (Addis Ababa) and it's at junction point of Jimma town (Jimma Zone) ,Ghimbi town (West Wollega Zone), Bure town (Gojjam), Shambu town (Horo Guduru Wollega Zone), and Ambo (West Shewa Zone) routes which makes the favorable the town for commercial, communication and other activities. It extends from $08^0 31'52''$ to $10^0 19'44''$N latitude and $36^0 07'51''$ to $37^0 11'52''$E longitude. According to the population census 2007 report, from 1,552,689 total populations of the zone 785,820 (50.61%) were males whereas about 766,869 (49.39 %) were females; this indicates that the sex ratio is almost one to one. During this year about 82.28 % of the total populations were rural populations, which are directly engaged their life with even the back bone of the country called agriculture.

The climate of the zone is traditionally divided into three categories. Namely high land 20.50%, midland 50.90% and lowland 28.60%. The annual temperature is between 14 ^{0}c to 25 ^{0}c and annual rain fall is also between 1000 mm to 2400 mm. This shows that the zone is favorable for the existence of human being, animal rearing, and different kinds of agricultural activities.There are different types of soils found in the zone. Namely; acrisols, cambisols, nitosols, vertisols, rendizenas, phaeozems and cambic aerosols.The climatic condition of the zone is suitable for different types of crops. Among the major crops cereal, pulses and oil seeds are produced largely throughout the zone. During the year 2008 E.C 485,733.48 hectares of land was cultivated from which 24,021,557.40 quintals of cereals, pulses and oil seeds was produced in the zone.

The activity was conducted in four districts namely, Gito Gidda, and Diga and of East Wollega and Chewaka of Buno Bedelle zones that makes it difficult to describe each location individually in a detailed way. This, thus, necessitated describing the locations based on the common characteristics they exhibit. All of the locations are 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. Rain fall in all of the sites is uni-modal in nature that mostly extends from May to October.

Despite the fact that all of the districts constitute high land, mid and low land agro ecologies, this activity was specifically carried out in mid land areas of the districts characterized by temperate type of climate that favors sorghum production. Maize, sorghum and finger millet are among the most common cereals where as Haricot, soybean and Sesame, are among the most common pulse and oil crops grown in these specific locations.

Approaches Used

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 $100m^2$ at the respective sites where the technology was planned to be 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.

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 multi disciplinary 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.

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 pre-scaling 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 agriculture and natural resources 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 Development Agents (DAs) who are closer to, and know more about each famer 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 fertilizer application, spacing and other important agronomic information was tagged to and was delivered with the seed.

Development Agents (DAs) of the respective Peasant Associations (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 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 famers 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.

Research Design

The activity was conducted on a plot size of 0.25ha per farmer for each variety. A farmer could use all or only one of the varieties on his/her farm given he/she could afford to allocate appropriate land, labor and purchase relevant inputs like agro-chemicals. Seed was planted at the rate of 80 kg per hectare and a spacing of 40cm between rows was used.

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) and 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. Area covered by the varieties, number of farmers used the technology, number of farmers participated on training and field day and number of locations addressed by the varieties were the major types of data that collected during scaling up process. Descriptive statistics such as summation, mean and percentage were used to analyze numeric collected data whereas qualitative data were analyzed through interpretation and narration. The yield advantage of improved haricot bean technology over local/standard check is calculated in the following formula.

$$\text{Yield advantage \%} = \frac{\text{Yield of new variety - Yield of standard check}}{\text{Yield of standard check}} \times 100 \quad (1)$$

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 Agricultural Development Partners Linkage Advisory Council (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.

Actors' Roles and Responsibilities

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

Table 8. Roles and responsibilities of the stakeholders in haricot bean scaling up activity

Actors	Role and responsibility
Farmers	Providing land free of rents; labor for all field activities (land preparation, planting, weeding, harvesting and threshing); follow up of the activities; and evaluate and select the best species.
Bako Agricultural Research center	Providing improved seeds and fertilizer; technical backup for the farmers Follow up all the field activities; organizing field days; making strong linkage with concerned stakeholders; farmers' selection and group (FRG) formation; and writing useful information produced from the technology demonstration
Zonal and District MOARD	Organizing farmers in group with cooperative office; organizing training for farmers; organizing field days and experience sharing forum among the FRGs and other farmers; coordinating all the field activities
Zonal and Woreda Administration	Coordinating the activities; and facilitate grouping of farmers into FRGs

Source: Own designed, 2011-2014

Results and Discussions

On-Farm Performance of the Varieties

Despite the variability in performance, 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 22.4Qt/ha for Gabisa, 22 Qt/ha for Nasir and 22.5Qt/ha for Dimtu, respectively was reported as compared to the local variety that yields only 10 Qt/ha or even less.

$$\text{Yield advantage \% for Nasir} = \frac{22 - 10}{10} \times 100\% = 120\ \%.$$

Yield advantage % for Gabisa= $\frac{21.4 - 10}{10}$ X 100 =114 %

Yield advantage % for Dimtu = $\frac{22.5 - 10}{10}$ X 100 =125 %

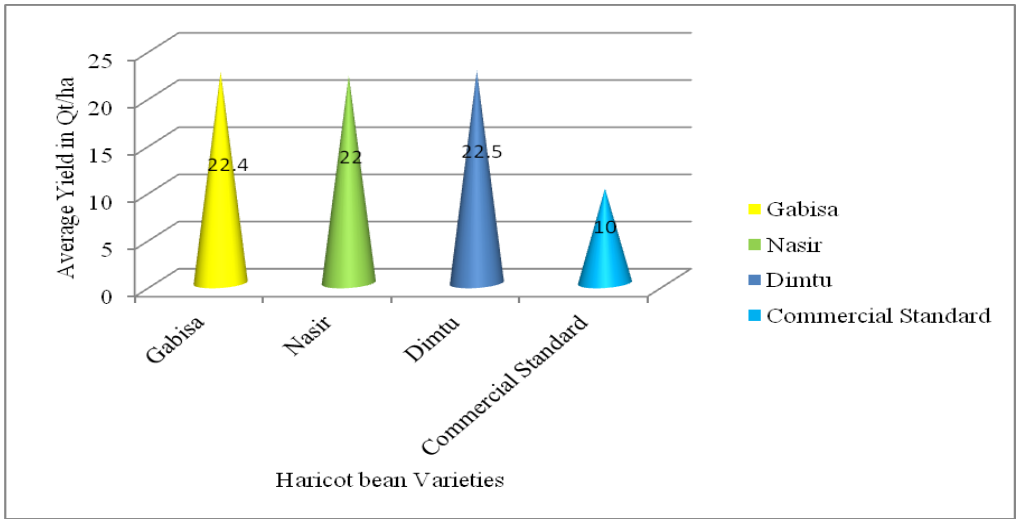

Figure 5. Average yield obtained from haricot bean varieties
Source: Own computation, 2011-2014

Seed Distributed and Area Covered

Between 2011 and 2013, a total of 60 farmers were reached in Bako Tibe, Chewaka, Gutin and Diga districts of western Oromia. In 2014 / 15, 11 more farmers were reached with the technology in the same districts. Total number of farmers reached so far, area covered and amount of seed distributed so far is 71farmers, 17.25ha and 1775kg, respectively.

Table 9. Number of benefited farmers and area covered in hectare by year

No	Year	Area covered (hectare)	Number. of beneficiary farmers per district				Total	Amount of seed distributed (kg)
			Bako	Chewaka	Gutin	Diga		
1	2011	5	5	5	5	5	20	5000
2	2012	5	5	5	5	5	20	5000
3	2013	5	5	5	5	5	20	5000
4	2014	2.75	3	4	0	4	11	275
Total		17.25	18	19	15	19	71	1775

Source: Own results, 2011-2014

Training on capacity building

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, 100 farmers, 10 district experts and 15 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.

Achievements

Through direct pre-scaling up, 71 farmers were reached with the technology. As a result food or nutritional status of the host farmers and those reached indirectly was believed to be improved. This could be achieved through either direct consumption or sale of the crops to purchase crop of their interest. Indirectly, the problem of mono- cropping was partly addressed, there at least be improvement in soil fertility status of the fields after use of the crop. 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 two of the varieties with the exception of Dimtu which exhibited undesirable test, were liked by farmers as they exhibit better preferable color, better yield performance, better stew quality and test and market price.

Lessons learned

During the course of the work, the team came to learn that concerted effort among different actors is instrumental for fruitful work. Thus, identification and 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.

Conclusions and Recommendations

The technology is very important in improving the nutritional and income of many farmers one way or the other. Despite this fact, however, the activity was completed this year, and the extension wing of the center does not disseminate the technologies beyond its limit. The technologies should then be handed over to the respective bureaus of Agriculture to sustain the technologies.

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Pre- Scaling Up/Out of Improved Sesame Technologies in Diga, Chewaka and Guto Gida Districts of Western Oromia, Ethiopia

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Abstract

This activity was conducted in Diga, Chewaka and Guto Gida districts of Western Oromia with the objective disseminating the already evaluated and selected varieties of sesame, Obsa and Dicho to the farming communities. These districts were purposively selected based on potentiality for sesame production; and one potential peasant association from each was selected on the basis of accessibility and potentiality. After peasant associations were selected two varieties of sesame, Obsa and Dicho were planted on 0.25ha of land on farmers' fields. A seed rate of 5kg/ha and 50kg DAP/ha was used with a line spacing of 40cm between rows. Accordingly; in the course of implementation, a total of 160 farmers were reached 200 kg seed was distributed and an area of 40ha was covered with the activity. The grain yield performances of the two improved varieties 12 and 10 quintal per ha for Obsa and Dicho varieties respectively implying 71.43 % yield advantage for Obsa and 42.86% for Dicho over the local check used during demonstration. The research intervention has contributed to improve food security and livelihood. At the completion of the activity an exit strategy that contributes to sustainability was designed where the district Bureau of agriculture and natural resource 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 participating farmers.

***Keywords**: Pre-scaling up; Sesame; Obsa; Dicho; Stakeholders linkage, Multidisciplinary*

Introduction

The world of sesame seed market is a billion dollar industry that supports the livelihoods of millions of farmers throughout the world (United State Agency for International Development [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 (Central Statistical Agency [CSA] 1996/1997–2007/2008 as cited in Negash et al., 2011). Tigray, Oromia, Amhara and Benshangul Gumuz are the major producers in Ethiopia. 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 1.0t 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 (Food and Agricultural Organizations [FAO] STAT, 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. 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). But, such technologies are not widely disseminated on farmers' field to address real problems mentioned. Therefore, this activity was conducted with the objectives of popularize improved sesame technologies, strengthen linkage between farmers, extension,

research and others key stakeholders, improve the knowledge and skills of farmers on sesame production and management practices thereby improving livelihoods of farmers in the area.

Methods and Materials

Description of the Study Area

East Wollega zone is located at 331 km west of Finfinne (Addis Ababa) and it's at junction point of Jimma town (Jimma Zone) ,Ghimbi town (West Wollega Zone), Bure town (Gojjam), Shambu town (HoroGuduru Wollega Zone), and Ambo (West Shewa Zone) routes which makes the favorable the town for commercial, communication and other activities. It extends from $08^0 31'52''$ to $10^0 19'44''$N latitude and $36^0 07'51''$ to $37^0 11'52''$E longitude. According to the population census 2007 report, from 1,552,689 total populations of the zone 785,820 (50.61%) were males whereas about 766,869 (49.39 %) were females; this indicates that the sex ratio is almost one to one. During this year about 82.28 % of the total populations were rural populations, which are directly engaged their life with even the back bone of the country called agriculture.

The climate of the zone is traditionally divided into three categories. Namely high land 20.50%, midland 50.90% and lowland 28.60%. The annual temperature is between 14 ^{0}c to 25 ^{0}c and annual rain fall is also between 1000 mm to 2400 mm. This shows that the zone is favorable for the existence of human being, animal rearing, and different kinds of agricultural activities.There are different types of soils found in the zone. Namely;acrisols, cambisols, nitosols, vertisols, rendizenas, phaeozems and cambicaerosols.The climatic condition of the zone is suitable for different types of crops. Among the major crops cereal, pulses and oil seeds are produced largely throughout the zone. During the year 2008 E.C, *485,733.48* hectares of land was cultivated from which *24,021,557.40* quintals of cereals, pulses and oil seeds was produced in the zone.

The activity was conducted in four districts namely, Guto Gidda, and Diga and of East Wollega and Chewaqa of Buno Bedelle zones that makes it difficult to describe each location individually in a detailed way. This, thus, necessitated describing the locations based on the common characteristics they exhibit. All of the locations are 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. Rain fall in all of the sites is uni-modal in nature that mostly extends from May to October.

Despite the fact that all of the districts constitute high land, mid and low land agro ecologies, this activity was specifically carried out in mid land areas of the districts characterized by temperate type of climate that favors sorghum production. Maize, sorghum and finger millet are among the most common cereals where as Haricot, soybean and Sesame, are among the most common pulse and oil crops grown in these specific locations.

Site and Farmer Selection

Purposive sampling was used to select both districts and Peasant Associations (PAs) where the activity was carried out. The locations were selected on the basis of potentiality for sesame production and accessibility for ease of supervision of the activities. Selection of the site was done with assistance of

district experts and Development Agents (DAs) who are information rich about the districts and specific PAs. Accordingly, Guto Gida, Diga and Chewaka districts were selected based on afore mentioned criteria. The host farmers in the district were selected based on experience in sesame production, accessibility, possession of suitable land, and additionally capability to acquire inputs like fertilizer as the scaling up process doesn't include supply of other inputs other than seed and technical backstopping.

Research Design

Two varieties of sesame, Obsa and Dicho were planted on 0.25ha of land on farmers' fields. A seed rate of 5kg/ha and 50kg DAP/ha was used with a line spacing of 40cm between rows. Accordingly; in the course of implementation, a total of 160 farmers were reached 200 kg seed was distributed and an area of 40ha was covered with the activity.

Types of Data and Data Collection Method and Analysis

Agronomic data (yield), total number of farmers participated in training, field visits and field days Change in level of knowledge and skill of farmers; Farmers' perception on the characteristics of technology Stakeholders participation, was collected. The collected data was analyzed using excel sheet and SPSS statistical package. Descriptive statistics tools such as mean, and percentages were used to analysis the data. The yield advantage of improved sesame technology over local/standard check is calculated in the following formula.

$$\text{Yield advantage (\%)} = \frac{\text{Yield of new variety - Yield of standard check}}{\text{Yield of standard check}} \times 100 \quad (1)$$

Stakeholder's Roles and Responsibilities

In enhancing sesame technologies generation, dissemination, improving sesame production and productivity, the research center was closely working and has made frequent consultation with its respective stakeholders. 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.

Table 10.Stakeholders roles and responsibilities in sesame technologies

Actors	Role and responsibility
Farmers	Providing land free of rents; labor for all field activities (land preparation, planting, weeding, harvesting and threshing); follow up of the activities; and
Bako Agricultural Research center	Providing improved seeds and fertilizer; technical backup for the farmers Follow up all the field activities; organizing field days; making strong linkage with concerned stakeholders; farmers' selection and group (FRG) formation; and writing useful information produced from the technology demonstration
Zonal and District MOARD	Organizing farmers in group with cooperative office; organizing training for farmers; organizing field days and experience sharing forum among the FRGs

	and other farmers; coordinating all the field activities
Zonal and Woreda Administration	Coordinating the activities; and facilitate grouping of farmers into FRGs

Source: Own design, 2012-2015

Results and Discussions

On-farm performance of the varieties

Yield performance of the varieties on the face of existing variability between locations and within locations, 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. Despite this fact a yield of 12Qt/ha for Obsa and, 10 Qt/ha for Dicho, respectively was reported as compared to the local variety that yields only 7Qt/ha or even less.

$$\text{Yield advantage of Obsa (\%)} = \frac{\text{Yield of Obsa - Yield of standard check}}{\text{Yield of standard check}} \times 100$$

$$\text{Yield advantage of Obsa (\%)} = \frac{\text{12Qt/ha - 7 Qt/ha}}{\text{7Qt/ha}} \times 100 = 71.4\%$$

$$\text{Yield advantage of Dicho (\%)} = \frac{\text{10Qt/ha - 7 Qt/ha}}{\text{7Qt/ha}} \times 100 = 42.86$$

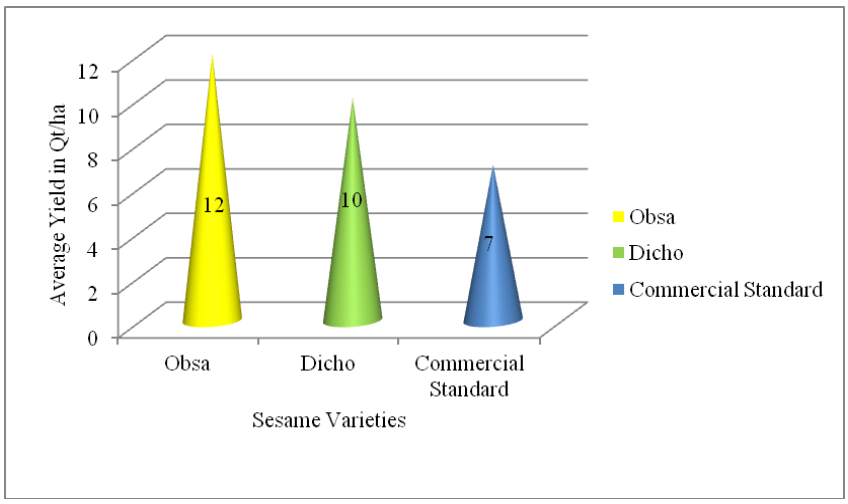

Figure 6. Average yield obtained from sesame varieties
Source: Own computation, 2012

Seed distributed and area covered

Between 2012 and 2015, a total of 200kg of sesame seed were distributed for 160 farmers to cover 40ha of land in Chewaka, Diga and Guto Gida districts of Western Oromia.

Table 11. Benefited farmers and area covered in hectare by year

No	Year	Area covered (hectare)	Number of beneficiary farmers per district			Total	Amount of seed distributed in (kg)
			Guto Gida	Chewaka	Diga		
1	2012	6.75	7	10	10	27	33.75
2	2013	9.25	12	15	10	37	46.25
3	2014	9	10	14	12	36	45
4	2015	15	18	22	20	60	75
Total		40	47	61	52	160	200

Source: Our results, 2015

The seed supply route

The pre-scaling up activity involves large number of farmers than that of technology demonstration. Thus, it is difficult to contact each farmer personally during pre-scaling up. As a result, it becomes important to deal with district experts and development agents of the respective localities. Accordingly, the varieties were handed over to the respective district bureau of agriculture with all the necessary information like seed rate, fertilizer rate, spacing, time of fertilizer application and the likes. Development Agents are the ones to dispatch the seeds to the farmers in their respective jurisdiction sticking to the aforementioned criteria. On top of delivering the seeds the Development Agents assist the farmers in planting and closely supervise the fields during the season of planting.

Training on capacity building

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, 50 farmers, 10 district experts and 10 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.

Achievements

Through direct pre-scaling up, 160 farmers were reached with the technology. As a result income of the host farmers and those reached indirectly was believed to be improved. This could be achieved through either direct sale of the crops. Indirectly, the problem of mono- cropping was partly addressed, there at least be improvement in soil fertility status of the fields after use of the crop. 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 two of the varieties were liked by farmers as they exhibit better/ preferable color, better yield performance, and market price.

Lessons learned

During the course of the work, the team came to learn that concerted effort among different actors is instrumental for fruitful work. Thus, identification and 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.

Conclusions and Recommendations

The technology is very important in improving income of many farmers one or the other ways. Despite this fact, the activity was completed this year, and the extension wing of the center does not disseminate the technologies beyond this limit. The technologies should then be handed over to the respective Bureaus of Agriculture and Natural Resource to sustain them and reach more number of farmers.

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Pre Scaling Up/Out of Improved Soybean Technologies in Selected Districts of Western Oromia, Ethiopia

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Abstract

This activity was conducted in Diga, Ilu-Harar and Guto Gida districts of Western Oromia with the objective disseminating the already evaluated and selected varieties of soy bean, Ethio-Yougzlavia, Boshe and Didessa to the farming community in these districts. These districts were purposively selected based on potentiality for sesame production; and one potential peasant association from each was selected on the basis of accessibility and potentiality. After peasant associations were selected the varieties were planted on 0.25hafarmers' fields. A seed rate of 80-100kg/ha and 50kgDAP/ha was used with a line spacing of 40cm between rows. Accordingly; in the course of implementation, a total of 161 farmers were reached, 3220 kg seed was distributed and an area of 40.25ha was covered with the activity. The grain yield performances of the three improved varieties were 22.7, 18.9 and 16.9 quintal per ha for Ethio-Yougslavia, Boshe and Dedessa varieties respectively implying 127% yield advantage for Ethio-Yougslavia, 89% for Boshe and 69 % for Didessa over the local check result used during demonstration and evaluation. The research intervention has contributed to improve food security and livelihood. At the completion of the activity an exit strategy that contributes to sustainability was designed where the district Bureau of Agriculture and Natural Resource 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 participating farmers

Keywords*: Pre-scaling up; Soybean; Ethio-Yougzlavia; Boshe; Didessa; Stakeholders linkage; Multidisciplinary*

Introduction

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

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

The total area of land under the production and total volume of production of soy bean has been growing over years. It is found that the major source of increase in the total production of soy bean has been mainly resulted from increase in area of land allocated for its production. The total hectare of land under soy bean production between 2001/02 and 2011/12 has increased by 10 folds; while the total volume of soy bean production during the same period has increased by more than 21 folds. The increased hectare of land for the production of soy bean as well as increased total production during the last ten years has been resulted from increasing demand for soy bean at local and international market (CSA, 2000-2011). Despite the tremendous increase in the amount of land allocated for soy bean production during the last ten years, the amount of land allocated for the production of soy bean is very low compared to land allocated for other oil crop commodities (FAO, 2010).Therefore, this study was conducted with objectives of popularizing improved soya bean technologies in selected zones of Oromia, strengthening linkage between farmers, extension, research and others key stakeholders and improving the knowledge and skills of farmers on soy bean production and management practices thereby improving livelihood of small scale farmers in the area.

Materials and Methods

Description of the Study Area

East Wollega zone is located at 331 km west of Finfinne (Addis Ababa) and it's at junction point of Jimma town (Jimma Zone) ,Ghimbi town (West Wollega Zone), Bure town (Gojjam), Shambu town (HoroGuduru Wollega Zone), and Ambo (West Shewa Zone) routes which makes the favorable the town for commercial, communication and other activities. It extends from $08^0 31'52''$ to $10^0 19'44''$N latitude and $36^0 07'51''$ to $37^0 11'52''$E longitude. According to the population census 2007 report, from 1,552,689 total

populations of the zone 785,820 (50.61%) were males whereas about 766,869 (49.39 %) were females; this indicates that the sex ratio is almost one to one. During this year about 82.28 % of the total populations were rural populations, which are directly engaged their life with even the back bone of the country called agriculture.

The climate of the zone is traditionally divided into three categories. Namely high land 20.50%, midland 50.90% and lowland 28.60%. The annual temperature is between 14 ^{0}c to 25 ^{0}c and annual rain fall is also between 1000 mm to 2400 mm. This shows that the zone is favorable for the existence of human being, animal rearing, and different kinds of agricultural activities. There are different types of soils found in the zone. Namely;acrisols, cambisols, nitosols, vertisols, rendizenas, phaeozems and cambicaerosols.The climatic condition of the zone is suitable for different types of crops. Among the major crops cereal, pulses and oil seeds are produced largely throughout the zone. During the year 2008 E.C 485,733.48 hectares of land was cultivated from which 24,021,557.40 quintals of cereals, pulses and oil seeds was produced in the zone.

The activity was conducted in four districts namely, Gobu Sayo, Diga of East Wollega, Bako Tibe of West Shewa and Chewaka of Buno Bedelle Zones of Western Oromia zone that makes it difficult to describe each location individually in a detailed way. This, thus, necessitated describing the locations based on the common characteristics they exhibit. All of the locations are 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. Rain fall in all of the sites is uni-modal in nature that mostly extends from May to October.

Despite the fact that all of the districts constitute high land, mid and low land agro ecologies, this activity was specifically carried out in mid land areas of the districts characterized by temperate type of climate that favors sorghum production. Maize, sorghum and finger millet are among the most common cereals where as Haricot, soybean and Sesame, are among the most common pulse and oil crops grown in these specific locations.

Approaches Used

Procedurally, pre-scaling up activities is preceded by demonstration and participatory variety selection with farmers and relevant stake holders. Accordingly, a year before the pre-scaling up process, the varieties were demonstrated on some farmers plots using plot size of 100m^2 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 pre scaling up phase was planned and executed.

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 multi-disciplinary teams 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.

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.

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.

Research Design

The activity was conducted on a plot size of 0.25ha per farmer for each variety. A farmer could use both of the varieties on his/her farm given he/she could afford to allocate appropriate land, labor and purchase relevant inputs like fertilizer and other necessary agro-chemicals. Seed was planted at the rate of 126kg per hectare. 100kg/ha DAP was applied at planting and 50kg/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. Area covered by the varieties, number of farmers used the technology, number of farmers participated on training and field day, stakeholders participation, change in level farmers knowledge and skills and number of locations addressed by the varieties were the major types of data that collected during scaling up process. Descriptive statistics such as summation, mean and percentage were used to analyze numeric collected data using MS excel whereas qualitative data were analyzed through interpretation and narration. The yield advantage of improved soy bean technology over local/standard check is calculated in the following formula.

$$\text{Yield advantage \%} = \frac{\text{Yield of new variety - Yield of standard check}}{\text{Yield of standard check}} \times 100 \quad (1)$$

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 Agricultural Development Partners Linkage Advisory Council (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.

Actors' Roles and Responsibilities

Stakeholder Analysis (SA)

In enhancing soy bean technologies generation, dissemination, improving soy bean 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.

Table 12. Roles and responsibilities of the stakeholders in soy bean scaling up activity

Actors	Role and responsibility
Farmers	Providing land free of rents; labor for all field activities (land preparation, planting, weeding, harvesting and threshing); follow up of the activities; and evaluate and select the best species.
Bako Agricultural Research Center	Providing improved seeds and fertilizer; technical backup for the farmers Follow up all the field activities; organizing field days; making strong linkage with concerned stakeholders; farmers' selection and group (FRG) formation; and writing useful information produced from the technology demonstration
Zonal and District MOANR	Organizing farmers in group with cooperative office; organizing training for farmers; organizing field days and experience sharing forum among the FRGs and other farmers; coordinating all the field activities
Zonal and Woreda Administration	Coordinating the activities; and facilitate grouping of farmers into FRGs

Source: Own result, 2012-2015

Results and Discussions

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 18.9Qt for Boshe, 16.9Qt/ha for Didessa and 22.7Qt/ha for Ethio-Yugoslavia, respectively was reported as compared to the local variety that yields only 10-15 Qt/ha or even less.

Yield advantage % for Boshe= $\frac{18.9 - 10}{10} \times 100 = 89\%$

Yield advantage % for Didessa= $\frac{16.9 - 10}{10} \times 100 = 69\ \%$

Yield advantage % for Ethio-Yugoslavia= $\frac{22.7 - 10}{10} \times 100 = 127\ \%$

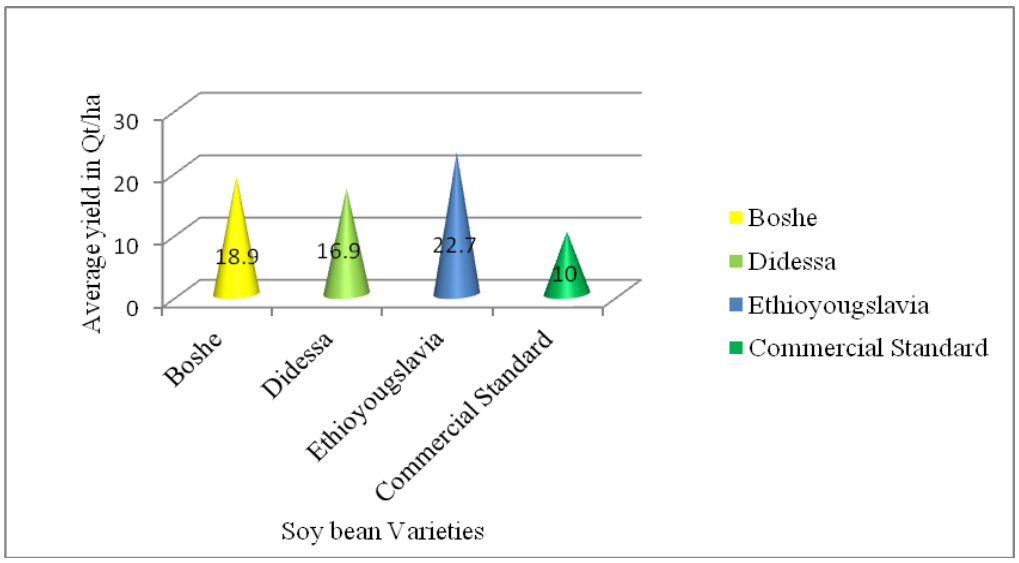

Figure 7. Average yield obtained from soya bean varieties
Source: Own computation, 2012-2015

Seed Distributed and Area Covered

In the first year of the activity (2012,) a total of 40 farmers were reached in Ilu-Harar, Bako Tibe, Diga, Angar Gute (Gutin) and Gobu Sayo 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 famers 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 Bako Tibe and 34 farmers from Ilu-Harar district were reached with the technology. A total of 3216kg of soybean seed were delivered to 100 farmers to cover 44.5ha of land

Table 13. Number of benefited farmers and area covered in hectare by year

No	Year	Area covered (hectare)	Number of beneficiary farmers per district					Total	Amount of seed distributed (kg)
			Bako Tibe	Chewaka	Gobu Seyo	Gutin	Diga		
1	2012	10	10	10	10	10	0	40	800
2	2013	12	10	15	10	0	13	48	960
3	2014	11	12	12	5	0	15	44	880
4	2015	7.25	8	12	-	0	9	29	580
Total		40.25	40	49	25	10	37	161	3,220

Source: Own result, 2012-2015

Seed delivery mechanism

As compared to technology demonstration, the pre-scaling 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 Agriculture and Natural Resources 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 famer than the district experts. Information related to variety, seed rate, fertilizer rate, and time of fertilizer application, spacing and other important agronomic practices 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.

Training on capacity building

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, 80 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.

Achievements

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 soy bean 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, 161 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 all of the varieties were liked by farmers as they exhibit better 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 came to learn that concerted effort among different actors is instrumental for fruitful work. Thus, identification and 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.

Conclusions and Recommendations

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 at Chewaka, however, was shocking and is a big blow to the farming community that bases its livelihood on soybean 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.

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Pre-scaling up of Improved Potato Technologies in Horro Guduru and East Wollega Zones, West Oromia, Ethiopia

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Abstract

Potato (Solanum tubersom L.) is an important crop for smallholder farmers in Ethiopia, serving as both a cash and food security crop. This activity was conducted during the 2013-2016 main cropping season year at Jimma Arjo, Jimma Rare and Horro districts East Wollega and Horro Guduru Wollega Zones with the objectives of increase potato productivity and income of target farmers. A total of 123 farmers were participated on the pre-scaling up activity. Belete and Gudane varieties with full package were pre-scaled up on 0.125hectare of land at each hosting farmers. In each kebele one farmer extension group members comprising of 15 farmers were established to popularize the technologies. A total of 694 participants at Jimma Arjo, 569 participants at Jimma Rare and 600 participants at Horro districts were participated on potato production and management's training. Field days were organized in collaboration with stakeholders at each district and total of 2420 participants were participated on the event. Agronomic data and farmer feedback were collected. The collected data were analyzed through descriptive statistics and graphs by SPSS software and qualitatively. The agronomic result shows that the average total marketable yield harvested from Belete and Gudane varieties were 35 ton/ha and 29 ton/ha, respectively. Besides, handover strategy of the technologies for further scale-out on wider area was also facilitated through establishing of seed producer cooperative. Therefore, Belete and Gudane varieties was recommended for further scale up/out for East and Horro Guduru Wollega zones and others area which is similar agro-ecology to the districts.

Keywords: *Pre-scaling up; Improved Potato Technology; Farmers Extension Group*

Introduction

Potato (*Solanum tuberosum* L.) is an important crop in eastern and central Africa and plays a major role in national food and nutrition security, poverty alleviation, and income generation. In its efforts to transform the economy of the country, the Ethiopian government has planned a five-year rapid agricultural growth programme (AGP) (Federal Democratic Republic Ethiopia [FDRE], 2011), which considers potato as a strategic crop. With increasing urbanization, the potato is not only being used as a fresh tuber but also in processed products such as French fries and crisps (Mulatu et al., 2005).

Although potato has a relatively short history of cultivation, today it is a widely grown crop in Ethiopia. It is planted in around 164,000 ha of land producing an estimated tuber yield of over 940,000 tons every year (Central Statistical Agency (CSA, 2015). This is mainly because of the favorable climatic and edaphic conditions in many parts of the country that favor potato production. In Ethiopia potato production can fill the gap in food supply during the hungry months of September to November just

before harvesting of the grain crops. Potato is a known cheap source of energy and supplies good quality food within a relatively short period. In many regions of the country, it is possible to grow potato throughout the year, which offers a way to ensure a continuous supply of potato and become a reliable source of income to small scale farmers.

There has been an increase in potato cultivation in the highland part of Western region of Ethiopia compared to the other regions owing to the presence of high demand from the local market, due to this fact in this region; the potato supports the welfare of smallholder farmers. However, the average potato tuber yield in Western Oromia is low, ranging between 8 to 10 t ha-1. This is far lower than the experimental yield in the country, which averages range from 30 to 40 t ha-1 (Mulatu et al., 2005). The major causes of low yields of the crop are low soil fertility shortage of disease resistant, adaptable and high yielding varieties, appropriate crop management practices and post-harvest management (Storck et al., 1997; Gebrekidan, 2003).

Research center have made all-round effort to provide solution to these problems. As result more than 27 potato varieties with their full package were formally released for production from regional and national research centers. Besides this, National Agricultural Research System (NARS) has made a great effort in demonstrating the potato technology package on the small plot and also evaluated by the farmers' criteria and meet farmers' needs in these selected districts of East and Horro Guduru zones. Even though the technologies were demonstrated and evaluated under farmers conditions in the selected areas, many farmers in the farming community were not accessed, produced and benefited from these technologies package.

On the basis of the above facts, this pre-scaling approach of potato technologies, aiming at mitigating the lack of technology and seeds through a multiple crop technology up scaling approach was undertaken for three consecutive years (2009-2016) with the objectives of addressing the un-addressed areas with potato technologies and creating wide demand for technologies, strengthen institutional and functional linkages with key players through joint actions and performances, increase productivity and income of target farmers and generate and share information, knowledge and experiences for different target groups in the studies area.

Materials and Methods

Description of the Study Area

The activity was conducted in three districts namely Horro, Jimma Rare and Arjo of East and Horro Guduru Wollega Zones of Oromia Region. Overall, description of the study area is presented in Table 1 as follow.

Table 1. Description of each study areas

Description	Selected districts for pre-scaling promotion		
	Arjo	Horro	Jimma Rare
Altitude	2000 meters above sea level.	2350 meters above sea	2324 meter above sea

Coordination location	$8^0$55N latitudes and $36^0$44'E Longitudes	$9^0$33N latitudes and $37^0$22'E Longitudes	$9^0$88 latitudes and $37^0$87' E Longitudes
Average RF	1400 and 2000mm.	1600-2400mm	900mm- 1700mm
Min &Max temp	15^0c and 20^0c	20c and 22c	$16c^0$ and $22c^0$
Major soil	Dystric , Nitosols and OrthicAcrisols	Distich Nit soil and Artic Aero soil	Dystric Nitosols and OrthicAcrisols
Agro-ecology	Humid and sub-humid types of climate.	Sub-humid types of climate.	Sub-humid types of climate.
Major crop grown in term of areas coverage	Wheat, Barely, Tef, Potato, Maize, Sorghum and Field pea	Wheat, Barely, Tef, Potato, Faba bean Sorghum and Field pea	Wheat, Barely, Tef, Potato, Maize and Field pea

Source: District BoFD, 2016

Approaches followed

Selections of technological package

Gudane and Belete improved potato varieties with full package were identified for this pre-scaling up technology dissemination activity by the key stakeholders, because the two varieties previously were evaluated and selected by FRG members criteria, Ethiopian government has planned a five-year rapid agricultural growth programme which considers potato as a strategic crop and the crops were also well adapted to the agro-ecologies where the demonstration were conducted previous year.

Multidisciplinary Team Formation and Joint Planning

This activity was implemented by the multidisciplinary team of Bako Agricultural Research Center consisting of crop breeder, pathologies, agronomist, agricultural economics and agricultural extension researchers with the collaboration of others key stakeholders. The team was led by BARC Agricultural extensionist. The others key stakeholders (partners) involved in the potato pre-scaling project implementation were included; Woreda Agriculture and Natural Resource Office, site Development Agents (DAs), Woreda and *kebele* administration and Zonal Agriculture and Natural Resource Office. Before implementation of the project, joint plan meeting were made at the project field site to share experience, setting a common vision and objectives, defining all the necessary functions to make the innovation system work, identifying the roles of each stakeholder based on the defined function and formulating task sharing with clear responsibilities among stakeholder.

Table 214. Stakeholder roles and responsibilities in implementing the activity

No	Stakeholders	Roles and responsibility
1.	Bako Agricultural research centers	Coordination and facilitation, Provision of Potato technologies Provision of training Technical backstopping Organize field days and Supervision and joint monitoring and evaluation with zone and district BoA
2.	Agriculture Development Office (at Zone, district and Kebele level)	Assist in site and participant farmers' selection Follow up day to day activities from zone to Kebele level Assist in providing training Facilitate seed distribution Jointly organize and participate on field days
3.	Farmers (potato growers)	Allocate land and perform required agronomic practices Actively participate in the training for capacity building Share skills and experiences to neighbor farmers Transfer produced seed to surrounding farmers and Finally, supply excess produced seed to cooperatives
4	Cooperatives	Agricultural input supply Facilitate Potato seed marketing

Source: Own data, 2013-2016

Site and Farmers Selection

Potato pre-scaling up activity was conducted in three major representative's potato growing strict found in Bako agricultural research center mandate areas. These districts are Horro, and Jimma Rare from Horro Guduru Wollega and Arjo from East Wollega Zone. The districts were selected based on potentiality for potato production and accessibility for supervision. Then, three potential and representative *kebele* from each district were selected .Final, participating farmers were selected based on their interest, gender composition and capacity and capability to properly execute pre-scaling up planed the projects activities. Accordingly, total of 123 hosting farmers were selected and involved in this study. In each *kebele* one FEG members comprising of 20 members farmers were established and managed. Gender and youth balance in each FEGs member was strictly considered.

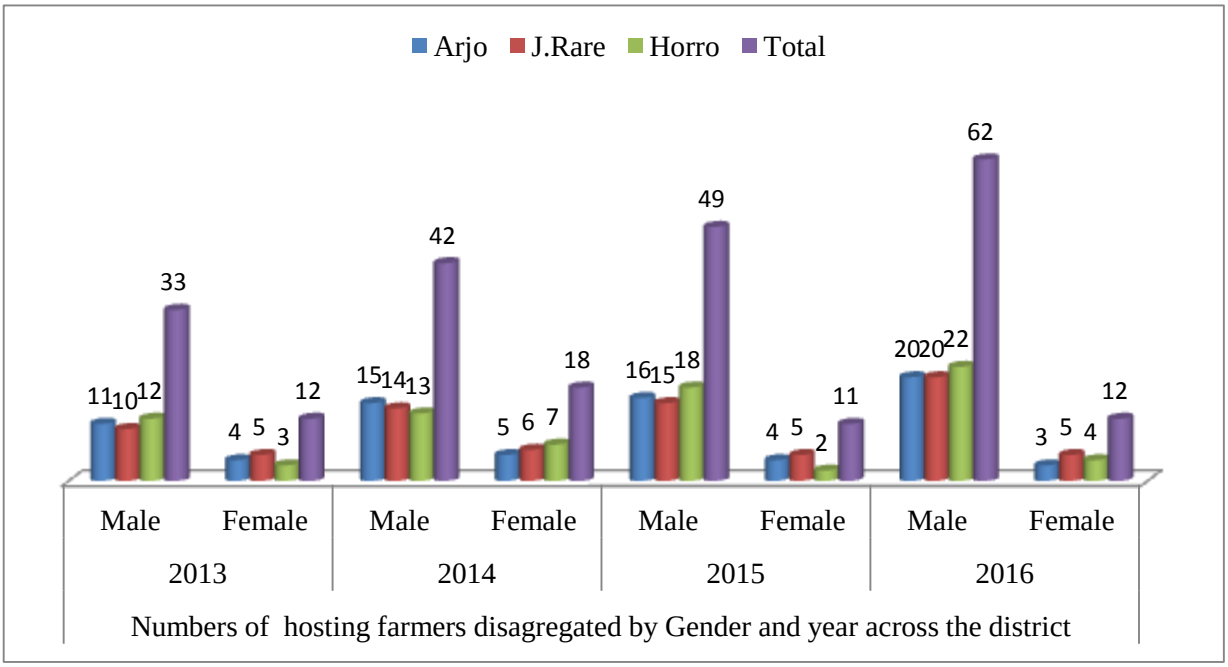

Figure 1. Participants' farmers in pre-scaling up activities by gender and project year
Source: Our computation, 2016

Stakeholder training

The technology package training approach was rigorously employed during every season for participant farmers and the competent technical groups were leading the implementation. Intensive monitoring, evaluation and system support was put in place and undertaken by the multidisciplinary team of the combined research and extension teams.

After the establishment of the FEGs, a theoretical training session was arranged to farmers, Development agent and district experts. At this juncture multi-disciplinary team of researchers consisting of breeder, agronomist, pathologies, extensionist and economist drawn from Bako Agricultural Research Center were given the training to stakeholders on issues like economic and nutritive importance of potato, suitable ecologies and weather condition for potato production, agronomic practices, post-harvest and storage strategies of potato

Pre-scaling up design

Gudane and Belete were the two potato varieties selected for the pre-scaling up activities based on the positive results obtained in the previous production season. Out of 123 hosting farmers involved in the pre-scaling of the two varieties, 80 farmers planted Gudane and the remaining 43 planted Belete on plot area of 0.125ha for each variety. The demonstrations plots were established and managed exclusively by the researcher/extension worker or together with farmers. The plot was labeled with a sign giving the name of the variety, its duration, yield, performance on station. Spacing of 70cm and 30cm between rows and plants respectively were used for the demonstration. Recommended rate of 200kg/ha of DAP and

100kg of UREA fertilizer were used to conduct experiment. All other recommended agronomic practices were maintained by all farmers. Finally, field day and training materials (leaflet) were prepared at farmer's field.

Data Collected and Analysis

Agronomic data (yield), total number of farmers participated in training, field visits and field days Change in level of knowledge and skill of farmers; Farmers' perception on the characteristics of technology, stakeholders participation, marketable tuber yield as well as unmarketable tuber yield (ton/ha) and disease and pest reaction was collected. The collected data was analyzed using MS. excel sheet and SPSS Ver. 20 statistical package. Descriptive statistics tools such as mean, frequencies, and percentages were used to analysis the data. Qualitative data was analyzed through narration and interpretation.

Monitoring and Evaluation

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

Communication Methods Used

Field day, study tour/field visit, training, meeting and mass media (television, radio and print media such as leaflets, pamphlets and production manuals) were used for creating awareness and for enhancing users' knowledge and skill in conservation agricultural practices.

Results and Discussion

Stakeholders' Awareness Creation

Training of farmers and other stakeholders

Participatory training was given by multi-disciplinary team of researchers consisting of breeder, agronomist, pathologies; extensionist and economist drawn from Bako Agricultural Research Center were given the training to stakeholders on issues like nutritive and economics importance of potato, suitable ecologies and weather condition for potato production, crop production management, post-harvest and storage strategies of potato crops. A total of 694 participants at Jimma Arjo, 569 participants at Jimma Rare and 600 participants at Horro district (mostly farmers, some researchers, Office head and extension expert of Woreda and Zonal Agriculture and administrators of Woreda and development agents) have attended the program as mentioned in table below.

Table 3. Stakeholders training participants across three demonstration districts

District	Numbers of farmers participants in including others stakeholders							
	2013		2014		2015		2016	
	Male	Female	Male	Female	Male	Female	Male	Female
Arjo	120	45	123	33	89	40	90	34
Jima Rare	140	65	89	57	140	34	145	24
Horro	135	45	100	34	123	51	140	52
Total	395	155	312	124	352	125	375	110

Source: Own data, 2013-2016

Field day

Field day was jointly organized in collaboration with other stakeholders (district level agriculture and natural resource offices and participant farmers) at Arjo, Horro and Jimma rare districts to create opportunities for stakeholders to see and learn from the demonstration promotions and evaluation the performance technologies and get farmers' feedback for better improvement. Over the four year project period between 2013 and 2016 years a total of 800 participants at Jimma rare, 838 participants at Jimma Rare and 782 participants at Horro district (mostly farmers, some researchers, seed agencies, Office head and extension expert of Woreda and Zonal Agricultural office and administrators of Woreda and development agents) have attended the program. Brief explanation on the objectives of potato pre-scaling up project was presented for participant a head of field visit at each site. On field work, questions and comments were entertained. Farmers, administrators, researchers and stakeholders were invited to give feedback. Farmers, administrators and all participants were very much attracted with the performance of improved potato variety grown with fertilizer at each site.

Table 4. Illustrates participants of field day organized at scaled up districts

District	Numbers of farmers participants							
	2013		2014		2015		2016	
	Male	Female	Male	Female	Male	Female	Male	Female
Arjo	200	50	180	60	120	30	120	40
Jimma rare	210	30	200	40	160	22	142	34
Horro	160	40	180	40	140	34	146	42

Source: Own data, 2013-2016

Amount of Basic Seed Distributed Over the Year

A total of 410 quintal seed (138 quintal seed for each district) of improved potato technologies (Belete and Gudane) was distributed to 123 trial farmers for pre-scaling up purpose.

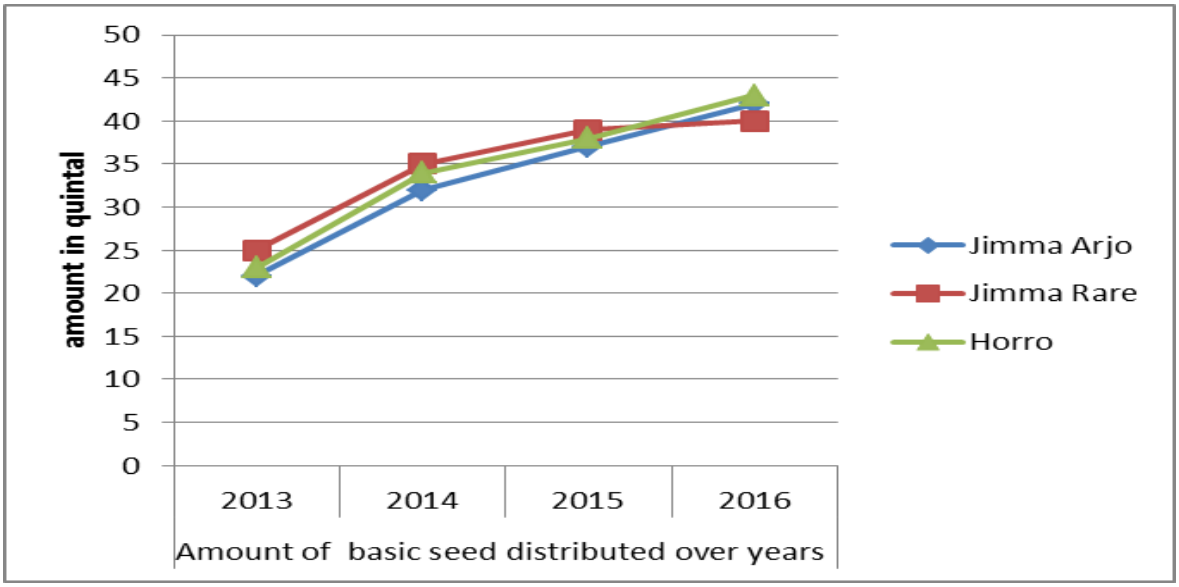

Figure 2. Amount of basic potato seed distributed to the farmers by years.
Source: Own data, 2013-2016

On- Farm Productivity of the Potato Technologies

At the evaluation stage of the activity, during a field day, representative farmers were requested to evaluate the varieties based on their own criteria. Accordingly, the farmers in their order of preference selected Belete and Gudane varieties. In general, both Belete and Gudane varieties were selected as the best varieties that fit their actual circumstance. Accordingly, data of the three varieties on yield parameters were taken from the demonstration plots site in the districts. The highest mean marketable tuber yield of 349.5Qt/ha was obtained from the Belete variety while the overall mean tuber yield obtained from Gudane variety was 293.1Qt/ha and the local variety recorded a mean tubers yield of 40Qt/ha in three districts. The hosting farmers across the all site obtained the yield gain (advantage) from the demonstrated improved potato technologies. They had obtained 86% yield advantage from Belete variety over the local while 84% yield advantage from Gudane variety over the local variety.

Table 5.Overall mean marketable tuber yield of the Belete and Gudane varieties at three districts

No	District	Overall mean marketable yield (qt/ha) of three years	
		Gudane	Belete
1	Jimma Arjo	290.5	347.5
2	Jimma Rare	289.5	351.2
3	Horro	299.3	350.0
	Total	293.1	349.5

Source: Our computation, 2016

Stakeholders' Feedback on Potato Technology

During these feedback sessions, farmers were asked about the advantages and disadvantages of the improved potato technologies as well as their perception towards technologies. This collected information will be used for future improvement of research technology development and dissemination process. Accordingly, Farmer Extension Group (FEG) farmers listed the advantage of new technologies over the local due to high yield, easily catering, relatively resistance to early and late blight and marketability. The participants' farmers also appreciated the FEGs research approaches than the conventional research system and the advantage over previous approach due to quickness in operations, team spirit, share knowledge, labor and experiences and encourage each other.

Conclusion and Recommendation

The pre-scaling up has been supplementary to the approaches that the research system has been following in its technology transfer through research-extension linkage. Along with the possibility of improved technology transfer to areas that had limited access, the approach has served to trigger the local formal and informal seed systems, as the activity was designed in a way that the produced seed will be further used to reach other farmers. This has directly improved access to the technologies used in the interventions. The linkage created among the different stakeholders has assured the use of the seed produced for the intended purpose, which is for reaching further farmers with relevant technologies.

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

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Demonstration of improved Teff varieties at selected midland districts of Guji Zone, Oromia, Ethiopia

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Abstract

The activity was conducted for two consecutive years, 2014 and 2015/16 at Adola Rede and Ana Sora districts, of Guji zone, Oromia, Ethiopia. Two improved teff varieties (Tseday and Boset) were demonstrated along with local varieties. The objectives were to evaluate the performance of improved teff varieties along with management practices under farmers' circumstances and to raise farmers' knowledge and skill on improved teff production and management practices. Sites were selected with respective district agricultural offices based on potential of the area for teff production. Training was given for farmers, Development Agents and experts on teff production and packages of seed and fertilizer rate were used for the experiment. The Participating farmers were also capacitated through training, follow up exchange visits and mini field days. According to the results, the two improved Teff varieties demonstration showed better yield performance when compared to the local variety. Thus, farmers in the area are recommended to use Tseday and Boset variety in order to increase their teff production and productivity.

Key words: *Demonstration, Teff, Evaluation, Guji zone*

Introduction

Teff (*Eragrostis teff*) is a self-pollinated and warm season cereal crop; believed to have originated in Ethiopia, and have been domesticated and used throughout the world due to its excellent nutritional value as grains for human consumption and as forage for livestock (Baye, 2014). Ecologically, teff is adapted to diverse agro-ecological regions of Ethiopia and grows well under stress environments better than wheat, barley and other cereals known world-wide (Refissa, 2012). It tolerates low moisture conditions and often considered as a rescue crop that survives and grows well in the season when early planted crops fail due to moisture stress. Because of this, it is said to be a "low-risk" crop for farmers. For better performance, it requires an altitude of 1800-2100 masl, annual rainfall of 750-850 mm and a temperature range of 10-27° C (Adera, 2016).

In Ethiopia, Teff is important cereal crops that 24.02% of all land under cultivation is covered by Teff (first among all cultivated crops in terms land coverage) and contribute 17.57% to grain production, second next to maize in terms contribution to total grain production (CSA, 2015). Teff has both cultural and economic value for Ethiopian farmers. In recent days it is among the cash crops and has been

attracting an export market due to its nutritional value and is believed to be gluten free. Teff straw, besides being the most appreciated feed for cattle, is also used to reinforce mud and plaster the walls of house and local grain storage facility called *gotera* (Adera, 2016, Minten *et al*., 2016).

Teff is the main crop produced in the midland area of Guji Zone. Usually the crop is sown after other crops (maize and haricot bean) are harvested. The crop is produced for both household consumption and cash crop. Teff could be produced in both seasons (*meher* and *belg)* hence the crop is used for double cropping purpose which increases farmers' production and income. The straw of teff is also used for construction of house and used as the main feed resource for cattle during drought. Despite the importance of teff the yield of the crop is low in the midland area of Guji zone due to lack of improved seeds, drought resistant and low application of the recommended packages of teff. To over-come these problems demonstration of teff was initiated with objectives of demonstrating and evaluating the performance of improved teff varieties along with their management practices under farmers' circumstances, increasing knowledge and skill on improved teff production and management practices and enhancing the network between research, farmers and agricultural offices.

Methodology

Description of the study areas

Adola Rede district located around Adola town which is situated at a distance of 470 km from Addis Ababa and 120 Km from the zonal capital city, Negele Borena. It is an area of where a mixed farming and Sami- nomadic economic activity takes place, which is the major livelihood of the local people. The total area of the district is 1254.56km$^{2.}$ Astronomically, Adola Rede district is located between 5°44'10" - 6°12'38" northing latitudes and 38°45'10" - 39°12'37" easting longitudes. The district is characterized by three agro- climatic zones, namely Dega 11%humid, Weina Dega 29% sub humid and Kola 60% dry arid respectively.

Most of the earth surface of the district is ups and down of the land surface with an elevation ranging from 1500 meters up to 2000 meter in the larger southern portion of North Western part. Plains, dissected hill plateau and mountain as well as valleys and gorges characterized the relief of the district. The major soil of the district are Nitosols (red basaltic soils) and Orthic Acrosols. They are red brown and black brown in colors and they are found on sloping terrain. Therefore, their agricultural utilization is good under natural vegetation. The percentage coverage of each soil is red soils 80%, brown soil 15% and black clack 5% respectively.

Ana Sora district was established in 2001 E.C budget year. The district is situated at a distance of 410km from Addis Ababa and 180 km from zonal capital city, Negelle Borana. The district has an area of about 798.740km^{2}; it is an area where mixed farming economic activities take place, which is the major livelihood of the people. The expansion of social service, secondary economic activities and modern means of transportation and communication are in their early stage of development.

Sampling procedures

The demonstration took place in two districts of Guji Zone namely Adola Rede and Ana Sora. Three Kebeles from Adola Rede and one Kebele from Ana Sora districts were then purposively selected based on their potential to teff production. The selection of Kebeles and participating farmers was carried in collaboration with district agricultural offices, DAs, and Kebele leaders. Group approach (Farmers Research Group (FRG)) was also used to select and group participating farmers.

Trial design and management

The trial was done on a land size of 100m2 (10m *10m) per variety. A seed rate of 30Kg/ha was used and 60Kg/ha DAP and 40Kg/ha UREA were applied.

Method of data collection

Technical data sheets (for agronomic data), Regular interaction with farmers, personal observations and key informant interviews were used to collect the data.

Data analysis Method

Simple descriptive Statistics and qualitative analysis of farmers' feedback were used to analysis data.

Results and Discussion

Training and Field day

Training was given for 120 farmers, 12DAs and Eight (8) experts on the demonstration of improved teff varieties. Technical support, Follow up and supervision were also done. Mini field day was arranged at Adola Rede district of Dole Kebele, so that, results and information about teff production was communicated among participating farmers. During the occasion farmers, DAs, agricultural office experts were satisfied by observing the demonstrated teff technologies and they demanded for these technologies for further pre-scaling up activities. Beside further promotion of teff technologies, the mini field day organized, has helped in enhancing the linkage between research and agricultural offices as agricultural problems were raised and discussed by participants.

Yield performance

The maximum yield performance (15.7qt/ha) was obtained from Tseday variety in Adama Diba Kebele during 2014/15 production year while the lowest yield performance was recorded from local variety in all production seasons. During the 2014/15 production year there was comfortable environment (good rain fall). But during 2015/16 production year there was frost and shortage of rain fall that reduced the yield performance of varieties. When compared the districts, good yield of tef was obtained from Adola Rede. This showed that Adola Rede is more potential area for tef production than Ana Sora district. The average yield performance of Tseday variety in midland district of Guji Zone was 12.95qt/ha while Boset was 11.18qt/ha. During the demonstration of tef the lowest yield (7.88qt/ha) was obtained from local variety. Generally, the improved varieties were not showed their maximum potential yield due to shortage of rain

fall when compared to the adaptation yield of 15.82qt/ha for Tseday and 15.61qt/ha for Boset in midland agro ecology of Guji Zone (Aliyi et al., 2016) and 14.27 qt/ha (CSA, 2015) in Guji Zone.

Table 1. Demonstrated yield of tef over two years

Variety	The yield of Adola Rede (in qt/ha)								The yield of Ana Sora (in qt/ha)		Average yield (qt/ha)
	2014/15				2015/16				2014/15	2015/16	
	Gobicha	Adama Diba	Dole	Ave.	Gobicha	Adama Diba	Dole	Ave.	Sololo Kobo	Sololo Kobo	
Tseday	14.5	15.7	15	15.1	14.6	13.1	10.3	12.7	13.5	10.5	12.95
Boset	11.6	14.4	11.7	12.6	14.4	14.8	9.1	12.8	11.3	8	11.18
Local	10	13.2	8	10.4	7.2	9.2	7.8	8.1	7	6	7.88

Farmers' preference

Farmers have their own preference to use certain technology. Yield per plot determines acceptability of teff by farmers. Higher yield than locally available teff variety increases farmer's motivation to grow recommended and improved teff varieties. Not only high yield but also characteristics like early maturity among teff varieties is also important characteristics in teff variety promotion works to withstand draught. More farmers were inclined to rank Tseday first and Boset second for further production. But some farmers yet prefer Boset variety for multiplication. Tseday and Boset showed better performance for most of the studied characters including grain yield (Aliyi *et al*., 2016). Generally variety preference depends on farmers and each variety had its own unique trait for further production. The following table describes farmers' preferences among the demonstrated teff varieties based on their characteristics.

Table 2. Farmers' preference of teff

Tseday	**Boset**	**Local**
High yielder	Relatively low yielder	Lower
Early mature	Relatively late mature	Late
Tolerant to disease (Leaf rust)	Tolerant to disease(Leaf rust)	not at all
Not lodge	Not lodge	At some place lodge
White in color	White	Mixed
Thin and few straw	Has strong and more straw	Few straw

In the midland area of Guji zone rain fall is not uniform and scarce. Thus, early mature varieties are preferred by farmers. As shown on the above table, Tseday variety is early mature than both Boset and Local varieties thus preferred by farmers to over-come drought. But Tseday variety can shatter unless harvested as soon as it matured.

As Teff is multipurpose crop beside its grain the straw is also used for house roof construction in rural areas. The straw is also used as feed for cattle. This is an important characteristics farmers also look in teff varieties. To this end, Boset variety was preferred as it has strong and more straw than Tseday which has thin straw that can easily be broken in to pieces. Besides the above characteristics, Teff seed color is also another important characteristics farmers see to increase the market demand of their teff products as white seed teff is preferred on the market. With regard to color, both Tseday and Boset varieties have white and attractive seed color than the local variety farmers produce.

Conclusion

The demonstration was conducted midland district of Guji zone, Adola Rede and Ana Sora districts. The two improved variety of tef demonstrated were Tseday and Boset. Farmers Research Groups evaluated Tseday and Boset during belg season of 2015 and 2016 on their farm. These varieties get acceptance over local varieties due to their better yield, early maturity and no-lodging status. Therefore, Tseday and Boset variety should be further disseminated in the midland of Guji zone to increase teff production in the area.

Recommendations

Farmers should use Tseday and Boset varieties in their teff farming. These varieties were promised for further extension since they have good yielder, early mature and have importance against local varieties. Thus farmers should multiply both varieties to improve their teff production and income from teff. Tseday variety should be harvested as soon as it matured to minimize the shattering problem.

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Pre-scaling up of Faba bean at highland districts of Guji Zone, Oromia, Ethiopia

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Abstract

Pre scaling up of two improved faba bean varieties (Gebelcho and Walki) was conducted in the highland districts of Guji Zone, Oromia, Ethiopia for two consecutive years from 2014/15-2015/16 to increase farmers' capacity in production and management practices of faba bean. Two kebeles from each two districts namely Bore and Ana Sora were selected purposively based on their potential for faba bean production. From each kebele nine farmers were selected for the demonstration making it a total of 72 farmers for the two years. Depending on the capacity of farmers 50kg-100kg of faba bean was given for the selected farmers. Around 24.5ha was covered by the crop during the production years. Training was also given for participating farmers and others on production packages of faba bean. Exchange visits and mini field days were arranged for further promotion. The yield gained from the varieties was 33.76qt/ha and 27qt/ha from Gebelcho and Walki respectively. Furthermore, both varieties were found to be acceptable during field days by farmers due to their disease tolerant capacity. Thus, highland farmers are recommended to use Gebelcho and Walki varieties to increase their faba bean production and generate more income for their livelihood. Further dissemination of faba bean is expected from seed multipliers in producing quality seed and addressing potential areas.

Key Words: *Faba bean, Pre-scaling up, Guji Zone*

Introduction

Faba bean (*vicia faba L.*) is one of the major pulse crops grown in the highlands (1800 – 3000 m.a.s.l.) of Ethiopia (Temesgen and Aemiro, 2012). Faba bean is a valuable protein-rich leguminous crop cultivated and consumed as human food in the specified areas. In addition, its straw is used as animal feed. With a cheap protein source, it partly compensates for the large deficiency in animal protein sources. Faba bean plays a significant role in improving the productivity of soil by fixing atmospheric nitrogen and is a suitable rotation crop for cereals. A major benefit of rotating pulse crops, such as faba bean with cereal crops is in compensation or response to low soil fertility as well as in the interruption of diseases and insect pest cycles (Barri and Shtaya, 2013).

Despite the immense economic and ecologic merits, however, the productivity of faba bean, in Ethiopia is far below the potential due to a number of biotic and abiotic constraints, socioeconomic constraints in smallholder farms and inadequate technological interventions. Among pulses grown in the country, faba bean accounted for 31.4% (0.84 million mt) (CSA, 2015). However, the productivity of the crops under smallholder farmers is not more than 1.89 t /ha^{-1} (CSA, 2015). Shiferaw *et al*. (2013) also mentioned the productivity of faba bean is far below expected potential due to low input usage, natural disasters like snow storm, depletion of macronutrient from cultivable land and unavailability of essential nutrients such as phosphorus.

The production of faba bean in the highlands of Guji Zone is well known. Faba bean serve as source household food in the form *kik wot, shumo* prepared during *Jigi*. Faba bean is also used as cash crop since the crop has high market price that brings high returns to farmers in the area. However, most highland farmers use local varieties which are not disease resistant that lead to low yield. Therefore to over-come lack of improved seed and disease resistant variety the pre scaling up of faba bean was initiated with objectives of scaling up improved faba bean varieties in the community and increase the production of faba bean in the highlands of Guji zone, Oromia, Ethiopia.

Methodology

Description of the study areas

The experiment was executed at Bore and Ana Sora districts during the main cropping season of 2014/15 and 2015/16 under rain-fed conditions. Bore district is situated in the Northern part of Guji Zone, Oromia regional state at a distance of 385km from Addis Ababa and 210km from the zone capital city, Negele. Astronomically, Bore is located between 5°57'23" - 6°26'52" latitudes and 38°25'51" - 38°56'21" longitudes. It has elevation ranging from 1450-2900meters above sea level. The annual rain fall is about 122.7mm (recorded data 1996) and the annual temperature of the district ranges from 10.1upto $20c^{0}$. The major soils of Bore district are Nitosols (red basaltic soils) and Orthic Acrosols. The two soils are found on the highland areas, and they are red brown and black brown in colors and on sloping topography and their utilization are good under natural vegetation respectively.

Ana Sora district is situated at a distance of 410km from Addis Ababa and 180 km from zonal capital city, Negelle. Astronomically, the district is located between 6°20'30" - 5°57'30" latitudes and 38°39'30" - 38°57'30" longitudes. The district is characterized by two types of climatic zone, namely temperate, Dega (locally known as Bada) and Woina dega (locally known as Bada-dare). It has humid and sub humid moisture conditions, with a relatively longer growing season. The annual rainfall nearly about 122.7mm and the annual temperature of the district is nearly about $10.1c^{o}$upto $20c^{0}$.

The major soils of the district are Nitosoils (red basaltic soils) and Orthic Acrosoils. These two soils are found on the highland areas of the district, and they are red brown and black brown in colors and on sloping topography and their agricultural utilization are good under natural vegetation cover respectively.

Sampling procedures

The pre -scaling up of improved Faba bean varieties were conducted at two (2) districts (Bore & Ana Sora). At each district two Kebeles were purposively selected based on their potential for faba bean production. From each Kebele nine (9) farmers were then selected having 0.25-1ha of land for each variety (Gebelcho and Walki). A total of 72 farmers have planted the two faba bean varieties.

Method of data collection

Technical data sheets (for agronomic data), Regular interaction with farmers, key informant and focus group discussion were used to collect the data.

Data analysis Method

Simple descriptive Statistics was used to analysis the data.

Results and Discussions

Training and Field days

Training was given for 144 farmers on the productivity of improved varieties of this crop with its all packages for both farmers who got seeds and who not got seeds in order to share information on the technologies. Mini field day was arranged at Bore district of Ano Kerensa Kebele and Ana Sora of Irba Buliyo Kebele to share experience among farmers and PAs participating on the activity. During the occasion farmers, DAs, experts were satisfied by observing the technologies delivered. On self-initiation, farmers, DAs and others encouraged to work together in similar activities. Around 140 farmers, 11 DAs,18 experts, two administrators (from two districts) and researchers attended and observed the yield advantage of the improved varieties over the local varieties and the field visit created a pressure of interest among farmers, DAs and other participants.

Yield performance faba bean varieties

From the pre scaling up of faba bean varieties in Guji zone the higher yield (33.76qt/ha) was obtained from Gebelcho variety while Walki variety only gave 27qt/ha. The current study states that faba bean production in Guji zone is at its maximum potential when compared to the production yield obtained by Kissi *et al.*, (2016) which was 28.65 qt/ha in the highlands of Bale.

Table 3. Yield of improved faba bean varieties scaled up

Variety	Yield from Bore district (qt/ha)					Yield from Ana Sora district (qt/ha)					Average yield (qt/ha)
	2014/15		2015/16		Average	2014/15		2015/16		Average	
	Ano Kerensa	Abay Kuture	Ano Kerensa	Ano Kuture		Irba Buliyo	Bube Korsa	Irba Buliyo	Bube Korsa		
Gebelcho	40	46	22	24	33	48	44	26	20	34.48	33.76
Walki	34	36	18	20	27	9.5	32	22	20	27	27

The above table revealed that during 2014/15 production season the production of faba bean was higher than that of 2015/16 in both districts. Bore district. When comparing the varieties, Gebelcho variety has better yield performance than Walki variety**.**

Conclusion

The pre scaling of faba bean in Guji Zone was conducted in the highlands of Ana Sora and Bore districts to increase the production of faba bean in the community. Faba bean is potential crop in the highlands of Bore and Ana Sora districts. The crop is used for household consumption as well as cash crop in generating income for farmers. Not only used for consumption and generate income for household faba bean but also used to keep the fertility of land and thus contribute to increase productivity of subsequent crops. Training, exchange visit and mini field days capacitated farmers on production of faba bean. Gebelcho and Walki varieties were acceptable by farmers due to their productivity per hectare. Gebelcho and Walki variety has got acceptance by participants during mini field days.

Recommendations

- Highland farmers should use Gebelcho and Walki variety of faba bean in order to increase their faba bean production and generate more income for their livelihood.
- Further dissemination faba bean is expected from seed multipliers in producing quality seed and addressing potential area
- New adapted and disease resistant variety of faba bean should be adapted by research center

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On farm demonstration of recently adapted Irish Potato (*Solanum tuberosum*) variety In the Highlands of Guji zone, Oromia, Ethiopia

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Abstract

The activity was conducted at Bore and Ana Sora districts of Guji zone, Oromia, Ethiopia from 2015-2017 production seasons to evaluate the productivity and profitability of improved potato variety (Belete) along with its standard check (Gudene) under farmers' conditions. Accordingly, six Kebele's, were selected for the study based on their potato production potential. From each Keble, one FRG having 15 members was established. The selections of participating farmers was carried out in collaboration with district agricultural offices. Training was also provided for farmers, development agents and experts. Exchange visit also performed to share experience of experimental farmers' and management practices conducted by FRG members. Data was collected and the collected data was then analyzed by descriptive statistics. Net farm income was also used to estimate the profitability of Irish potato. Accordingly, average yield of Belete and Gudane was 355 Qt/ha and 269 Qt/ha respectively. The result of sample t-test states indicated that there was a significant difference in yield between Belete and Gudane varieties. The production of Belete variety in highlands of Guji Zone was also found to be profitable with the net farm income of 28182.64 Birr/ha and 14158.34 Birr/ha in Bore and Ana Sora districts respectively. Pairwise ranking showed disease resistance, market demand and taste traits were considered to be the most important traits preferred by farmers. To this end, Gudane was moderately disease resistant and showed high market demand and good taste than Belete. Thus, Farmers should use the existing variety (Gudane) in their potato production.

Key Words*: Belete, net farm income, pairwise ranking, demonstration, on-farm*

Introduction

In Ethiopia, agriculture is the most important sector which accounts 46% of GDP, 80% of export value and about 73% of employment (Aklilu, 2015). In addition, agriculture of the country supports 98% of the total calorie supply and 70% of industrial raw material supplies (Assefa, 2014). The sector still remains largely dominated by rain-fed subsistence farming by smallholders (Aklilu, 2015).

Having all these importance, agriculture continues to face a number of constraints. Agricultural production in Ethiopia is characterized by subsistence orientation, low productivity, low level of technology and inputs, lack of infrastructures and market institutions and extremely vulnerable to rainfall variability (Urgessa, 2014). Weak institutions and lack of appropriate and effective agricultural policies and strategies also hampered the development of agricultural sector (Aklilu, 2015). Bezabih (2010) also mentioned that natural resources degradation and lack of business oriented agricultural production system are key challenges. Despite its important roles agriculture fails to meet the minimum food requirements of the population and to eradicate poverty in Ethiopia. But the government of

Ethiopia is supporting the interventions of improved technologies that can bring radical change on the farmers' livelihood.

Potato (*Solanum tuberosum* L.) is one of the most important tuber crops in Ethiopia having the potential of improving the livelihood of smallholder farmers. Potato has been considered as a strategic crop by the Ethiopian government aiming at enhancing food security and economic benefits to the country. As the population grows rapidly, increased productivity of potatoes can improve the livelihood of smallholder potato producers and is required to meet the growing demand (Gildemacher, 2012; Habtamu, 2015). It produces considerably more energy and protein than cereals (Haverkort *et al*., 2012). Potato is also the fastest growing staple food crop and source of cash income for smallholder farmers in Ethiopia (Beliyu and Tederose, 2014; Berhanu and Getachew, 2014). Potato has become an increasingly important crop and contributes for food security, employment, nutrition and development in the socio-economic status of producers. Ethiopia has very conducive climatic conditions for production of high quality seed potato. The major potato producing regions of Ethiopia are Oromia, Amhara, SNNPR and Tigray States in that order of production levels (Bezabih *et al*., 2015).

In Ethiopia, potato is mainly grown at high altitude of 1500-3000 masl by small scale farmers (Abebe *et al*., 2014). Nevertheless the national average productivity of potato is only 8.03 tons/ha which is far lower than the world average productivity of 16.02 tons/ha (Addisu *et al*., 2013). Out of the 216971.05 ha allocated to the root crops during the main season of 2014/2015 in Ethiopia, potatoes occupied 67361.87 ha (31.13%) (CSA, 2015). In the main production season, average potato productivity on research based and farmers level is 29-45 t/h and 22 t/ha respectively (Ali *et al*., 2014). This productivity gap between research based and smallholder farmers could be due to mismanagement practices done by the farmers, lack of improved seed and adverse climate conditions.

As many parts of the country, there are shortage of improved potato varieties in Guji zone and the existing varieties were deteriorating yield potential from year to year due to diseases and adverse environmental conditions. Despite the zone is potential for tuber crop potato the production of crop is characterized by lack of accessibility, shortage of improved technologies, and lack of improved varieties, lack of resistant variety and absence of awareness on the importance of the crop. Therefore, to overcome such problems on farm demonstration of recently adapted Irish Potato was proposed in Guji zone to develop and promote improved Irish Potato technology for sustainable production and productivity there by contributing to food security through increasing Irish Potato yield. The activity has also envisioned to evaluate yield and profitability of improved potato variety with standard check (Gudane) under farmers' condition, to increase farmers' participation in research activities and create linkage among essentially stakeholder and to build farmers' knowledge and skill on production and management of the improved potato varieties.

Methodology

Description of the Study Areas

Bore district is situated at a distance of 385km from Addis Ababa and 210km from the zone capital city , Negele. Bore district is situated at the northern part of Guji Zone, Oromia regional state. Astronomically,

Bore is located between $5^{o}57'23''$ - $6^{o}26'52''$ latitudes and $38^{o}25'51''$ - $38^{o}56'21''$ longitudes. It has elevation ranging from 1450-2900meters above sea level. The annual rain fall is about 122.7mm (recorded data 1996) and the annual temperature of the district ranges from 10.1up to 20^{0}c. The major soils of Bore district are Nitosols (red basaltic soils) and Orthic Acrosols. The two soils are found on the highland areas, and they are red brown and black brown in colors and on sloping topography and their utilization are good under natural vegetation respectively.

And Ana Sora district is situated at a distance of 410km from Addis Ababa and 180 km from zonal capital city, Negelle. Astronomically, the district is located between $6^{o}20'30''$ - $5^{o}57'30''$ latitudes and $38^{o}39'30''$ - $38^{o}57'30''$ longitudes. The district is characterized by two types of climatic zone, namely temperate, Dega (locally known as Bada) and Woina dega (locally known as Bada-dare). It has most humid and sub humid moisture conditions,which has relatively longer growing season. The annual rainfall nearly about 122.7mm and the annual temperature of the district is nearly about 10.1^{o}c up to 20^{0}c.

The major soils of the district are Nitosoils (red basaltic soils) and Orthic Acrosoils. These two soils are found on the highland areas of the district, and they are red brown and black brown in colors and on sloping topography.

Sampling Procedures

The experiment was conducted at two highland districts of Guji Zone, southern Oromia. Bore and Ana Sora districts were selected purposively. From all Irish Potato producing Peasant Associations (PAs), six PAs were selected purposively based on their Irish Potato production potential. From each PA, one FRG having 15 members was established deliberately taking into consideration their willingness, wealth status, and gender. The selections of participating farmers were carried out by close collaboration with agricultural district offices, DAs, SMSs, opinion leaders, and PA leaders. Among the FRG members, three trial famers were selected while others grouped under the trial famers.

Research Design

The activity was conducted at two high land districts of Guji zone, Bore and Ana Sora districts during 2015-2017. From all Irish Potato producing Kebele, six PAs were selected based on their Irish Potato production potential. From each kebele one FRG having three trial farmers was organized making it a total number of 18 trial farmers (using farmers as replication) in all Kebeles. One improved variety (Belete) of Irish Potato was evaluated on a plot size of 10m*10m along with its standard check (Gudane) in a single plot experimental design. For each treatment (variety) a spacing of 75cm and 30cm between row and tuber respectively was used. A seed rate of 18 quintal/ha and a fertilizer rate of 100Kg/ha of UREA using split application during planting and earthing up was used. 200Kg/ha DAP at planting time was also applied. Furthermore, training was given on the general information of improved Irish Potato varieties, recommended agronomic packages and the goal of the experiment for the selected farmers, DAs, and SMSs. Land preparation, planting, earthing up, weeding and harvesting were done according to the roles and responsibilities assigned between farmers, researchers and Development Agents (DAs) during the training.

Method of Data Collection

Data sheets, Regular interaction with farmers, key informant and Focus Group Discussions (FGDs) were used to collect the data.

Data Analysis Methods

Simple descriptive Statistics and qualitative analysis of farmers' feedback were used to analysis data. Yield data and profitability analysis and farmers' perception on demonstrated potato were used in this analysis. Pairwise ranking was used for trait and varieties selection by farmers.

Results and Discussion

Capacity building

Intensive orientation and training were given to update the farmers' knowledge and skills related to agronomic practice, protection, weed management and post-harvest management on potato during the two year span of the activity. A total of 6FRGs were established having a total of 180 FRG members (131 males and 49 females), 8 development agents (DAs), and 5 subject matter specialists (SMSs). Follow up was also done during the span of the activity. Exchange visit was arranged among experimental FRGs to evaluate the performance of the crop and the management practices done by the FRGs. In addition, this exchange visit helped to share experience of FRG members on potato production.

Yield performance

In production per plot, Belete variety was best performed than the standard check variety (Gudane). The average yield for the demonstrated Belete variety was 355 Qt/ha while it was 269 Qt/ha for the standard check Gudane variety. When the yield was compared based on locations, Belete had better performance at Bore district (Enshido Alayo kebele) than at Ana Sora district (Raya Boda kebele). According to the findings, the yield found for the standard check was lower than previous demonstration works done by Bore Agricultural Research Center (BOARC) which was reported to be 367 Qt/ha (the average yield of Gudane variety in highland of Guji zone and 413 Qt/ha of Gudane at Bore district (BOARC, 2013) in 2013. The following table describes the yield gained during the demonstration.

Table 4. The yield of demonstrated potato per FRG of kebeles and districts (in qt/ha)

Variety	Yield of potato at Bore district				Yield of potato at Ana Sora district				Average yield of two the districts in qt/ha (n=18)	Std. Dev.	CV (%)
	Kebeles			Ave.	Kebeles			Ave.			
	Enshido Alayo	Ano Kerensa	Kombolcha Wate		Irba Buliyo	Raya Boda	Bube Korsa				
Belete	450	413	316	393	333	250	367	317	355	93.82	3.78
Gudane	367	283	233	294	233	200	300	244	269	68.90	3.90

n= sample size

The yield difference across location may came from management practices performed by experimental farmers. Belete and Gudane did not showed their maximum yield potential due sudden break-out of bacterial wilt. Belete was more affected by bacterial wilt starting from vegetative stage to flowering stage. But Gudane was not much affected by wilt bacteria except lower yield may be due to the mother seed deterioration. In addition to wilt bacteria, frost also affected Belete during vegetative stage in study area. Based on the results of independent t-test (P<0 .05) it was concluded that there was significant difference in yield between Belete and Gudane variety.

Table 5. Independent t-test output

		t-test for Equality of Means			
		t	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Yield/ha	Equal variances not assumed	3.118	.004	85.56	27.44

Profitability Analysis

Production costs and returns of demonstration of potato was collected from experimental farmers. Production cost and return was taken from the area of demonstration (100m^2) but it was converted to hectare in order to calculate the profitability of potato. Production costs included were variable and fixed costs. Variables costs includes cost of land preparation, cost of seeds, cost of fertilizers, planting, weeding, harvesting, cost of transport and cost of sacks. Since potato (Belete) variety was perishable the cost of loss was included in analyzing profitability of Belete. This loss cost was calculated based on the loss in the ground and during post storage. Bore farmers estimated that the loss of Belete variety was 60qt/ha while in Ana Sora loss occurred was estimated 70qt/ha. To calculate the loss of Belete, amount of loss per hectare was multiplied by farm gate price. Fixed cost was cost of land. In the study area potato can be produced twice a year. After potato was harvested other secondary crops such as wheat, barley and faba bean can be produced. Therefore, cost of land was included for only one season of production (2388.89 Birr/ha for Bore district and 2444.44 Birr/ha for Ana Sora district). Average farm gate price was 150 Birr/Qt. The price of potato after harvest was low but gradually it increases specially during planting time. Thus, both potato varieties have the same price during harvesting time. The demonstration of potato in the highland Guji is profitable for farmers with return of Belete 28182.64 Birr/ha and 14158.34 Birr/ha in Bore and Ana Sora districts respectively. From the table below, Belete was more profitable than Gudane but experimental farmers were not interested on Belete since it was not tasty as Gudane and not used for *Datah* (local name of cooked potato sold near road for consumption).

Table. 6. Profitability analysis in Ethiopian Birr (ETB)

Location	Variety		Location	Variety	
Bore district			Ana Sora district		
	Belete	Gudane		Belete	Gudane
Yield qt/ha (Y)	393	294	Yield qt/ha (Y)	317	244
Price (P) per quintal	150	150	Price (P)	150	150
Total Revenue (TR)= TR= YxP	58950	44100	TR = YxP	47550	36600
Variable costs			Variable costs		
Cost of land preparation	2160	2160	Cost of land preparation	1890	1890
Seed cost	12110	12110	Seed cost	12400	12400
Fertilizer cost	3325.78	3325.78	Fertilizer cost	3557.22	3557.22
Planting	475.56	475.56	Planting	511.11	511.11
Weeding	382.35	382.35	Weeding	811.11	811.11
Harvesting	486.67	486.67	Harvesting	833.33	833.33
Cost of transport, sacks	438.11	438.11	Transport, sacks	500	500
Others (loss)	9000	0	Others (loss)	10500	0
Total variable costs (TVC)	28378.47	19378.47	TVC	31002.77	20502.77
Fixed costs			Fixed costs		
Cost of land	2388.89	2388.89	Cost of land	2444.44	2444.44
Total fixed costs (TFC)	2388.89	2388.89	TFC	2444.44	2444.44
Total Cost (TC) = TVC+TFC	30767.36	21767.67	TC = TVC+TFC	33447.21	22947.21
Gross Margin (GM) = TR-TVC	30571.53	24721.53	GM = TR-TVC	16547.23	16097.23
Profit= GM-TFC	28182.64	22332.64	Profit= GM-TFC	14158.34	13652.79

Farmers' Preference Criteria

Farmers have their own criteria to select certain new or improved technologies characteristics from their farm experiences. In this demonstration during varietal selection, the 6 FRG member farmers (18 members) and six non FRG members with a total of 24 household heads (male =18 and female =6) have participated to set their own selection criteria (Traits) for the planted varieties. These criteria's were

ranked using pair wise ranking. Scoring and ranking were done on consensus and differences were resolved by discussion as indicated by de Boef and Thijssen (2006). The evaluation was conducted after harvesting. Each trait was compared with other traits to know which traits are more important to the farmers. The trait to appear most times during the ranking is said to be the most important trait preferred by farmers. The number of time for a trait has been measured by counting the number of times trait number appeared in the matrix.

Thus, as described on the table below, number of tubers per plant, tuber size, market demand, disease resistance and early maturity were some of crop attributes identified and used to evaluate the potato varieties demonstrated. Yet a trait "disease resistance" appeared more times (six times) in the matrix than any other traits. Therefore, disease resistance trait was considered to be the most trait by the participating farmers.

Table 7. Pairwise ranking of farmers' selection traits for potato varieties (n= 24)

Selection criteria	**Early maturity**	**Yield/ Area**	**Number of tubers/plant**	**Tuber size**	**Market demand**	**Disease resistance**	**Sweetness**	**Total score**	**Rank**
Early maturity								0	7
Yield/ area	Yield/ area							3	4
Number of tubers/ plant	Number of tubers/plant	Yield/ area						2	5
Tuber size	Tuber size	Yield/ area	Number of tubers/plant					1	6
Market demand	Market demand	Market demand	Market demand	Market demand				5	2
Disease resistance	Disease resistance	Disease resistance	Disease resistance	Disease resistance	Disease resistance			6	1
Sweetness	Sweetness	Sweetness	Sweetness	Sweetness	Market demand	Disease resistance		4	3

n= number of farmers selecting potato traits

After the pair wise ranking of the traits the participating farmers were let to participate on the direct matrix ranking of the potato varieties demonstrated to rank the varieties based on the set criteria (traits) by during the pair wise ranking. Accordingly Gudane was found to be more preferred by the farmers than Belete despite its low yield. Gudane showed lower yield than Belete but farmers prefer to produce Gudane in the study area as it was not seriously affected by bacteria wilt, have better taste than Belete and has higher market demand. Farmers did not prefer to produce Belete due it's to low reaction to bacteria

wilt and being left in the land it was perceived as it can further initiates the spread of disease to the whole land. In addition, Belete variety was also easily affected during post-harvest (especially in storage).

Table 8. Direct matrix ranking of potato varieties by farmers

Selection criteria	Early maturity	Yield /area	Number of tubers/plant	Tuber size	Market demand	Disease resistance	Sweetness	Total score	Rank
Relative weight	2	3	2	2	3	3	3	-	-
Belete	**6**(3)	**12**(4)	**8**(4)	**8**(4)	**9**(3)	**6**(2)	**9**(3)	58	2
Gudane	**6**(3)	**9**(3)	**6**(3)	**6**(3)	**15**(5)	**9**(3)	**15**(5)	66	1

Source: Farmers' preference result

Note: Number of farmers in the evaluation= 24; numbers in parenthesis indicated the performance rating value of each variety given by farmers from 1-5 (5= excellent, 4=very good, 3= good, 2= poor and 1=very poor) and numbers written in the bold indicate total score of a variety as per each selection criteria, which was obtained by multiplying the relative weight of each selection criteria with that of the performance rating number in the parenthesis. The relative weight criteria (3= very important, 2 = important, 1= somewhat important).

Conclusions

Improved variety, Belete and standard check, Gudane did not show their maximum potential of productivity during the demonstration as a result of sudden break out of wilt bacteria in both years. The production of Belete variety in highlands of Guji Zone was found to be more profitable with the net farm income of 28182.64 Birr/ha and 14158.34 Birr/ha in Bore and Ana Sora districts respectively than Gudane. Though in both yield and profitability Belete variety had better performance than Gudane variety the participating farmers' preferred Gudane as it was found to be moderately resistance to the disease, demanded on the market and have a better taste. From the study it can also be concluded that disease resistance was the most important trait farmers look for on potato varieties in the study areas.

Recommendations

Based on the results the following recommendations are made.

Farmers in the study are can use the existing variety (Gudane) in their potato production along with effective chemicals to control bacterial wilt. Since potato is relatively early mature crop, chemicals and necessary management practices should also be quickly monitored and necessary inputs such as potato seed, chemicals and fertilizers should be provided on right time at fair price for local farmers.

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Participatory Evaluation and Demonstration of Improved Cassava Varieties at Fedis District, East Hararghe Zone, Oromia Region, Ethiopia

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Abstract

Fedis is one of the major food insecure districts found in East Hararghe Zone which influences by shortage and unevenly distribution of rainfall pattern area. Introducing drought tolerate crops are an option to reduce this food insecurity problems. The objective of this activity was to demonstrate and evaluate the productivity and profitability of adapted cassava varieties on farmers' field at moisture stress areas of East Hararghe Zone. A total of 30 farmers were involved for the consecutive two years (2015-2016). Two improved cassava (Kelo and Kule) varieties and standard check were used for this experiment. Since this technology was not well known by the community, target farmers, Development Agents (DAs) and expert of district are well trained before start to the experiment. Two years result indicated that the average total tuber yield ranges from 7.28 to 8.59 ton/ha. Under farmers condition, Kelo variety gave higher tuber yield (8.59 ton/ha) followed by Kule (7.39 ton/ha) and lower tuber yield by standard check variety (7.28 ton/ha). In study area, farmers were internalized with cassava processing and utilization for food purpose. For this purpose from cassava processed root flour with mix of wheat it was made Injera, Kukus, Porridge, Bread and Bobolino food types. Kelo variety was the first and Kule the second selected crop varieties by farmers based on their set criteria selection. Therefore, these selected varieties by farmers should be more popularized through facilitating the technologies and by participating the concerned body at right time and places.

Keywords: *Cassava; Demonstration; Improved technology; Food processing and utilization*

Introduction

Cassava (Manihot esculenta Crantz) is the fourth most important crop for farmers in tropics after rice, wheat and sugarcane, consumed by up to a billion people globally (Food and Agricultural Organization [FAO] STAT, 2010). Cassava is a perennial woody shrub with an edible root, which grows in tropical and sub-tropical areas of the world. Among the most important tropical crops in terms of source of calorie which are rice, sugarcane, maize and cassava; it is more cheaply cultivated (Mathews et al., 1993; Reamakers et al., 1993; Nweke, 2004). It is very important for the agro-economy of several tropical countries because of its broad adaptation to a variety of soil, climate, drought tolerance, and ability to grow on marginal soil (Mathews et al., 1993; Reamakers et al., 1993; Le et al., 2007).

In Sub-Saharan Africa (SSA), cassava is mainly a subsistence crop grown for food by small-scale farmers who sell the surplus. It grows well in poor soils with limited labor requirements. It provides food security during conflicts when the invader cannot easily destroy or remove the crop, since it conveniently grows underground. Cassava is usually intercropped with vegetables, plantation crops (such as coconut, oil palm, and coffee), yam, sweet potato, melon, maize, rice, groundnut, or other legumes (International Institute of Tropical Agriculture [IITA], 2009). In Ethiopia, cassava grows in vast areas mainly in Southern Region. According to Feleke (1997), cassava was introduced by some non-governmental organizations (NGOs) to drought prone areas of southern part of the country such as Amaro, Gamogoffa, Sidama, Wolayta, Gedeo primarily to fill the gap for subsistence farmers due to failure of other crops as a result of drought. Although its first introduction in to the country is not yet known, the crop had been growing in south, south west and western part of Ethiopia for several years (Teshome et al., 2004). Its use as a potential food crop in Ethiopia has been appreciated since 1984 famine (Amsalu, 2006).

Cassava contains the potentially toxic compounds cyanogenic glucosides. If present in sufficient quantities, these compounds can cause acute cyanide poisoning and death in humans and animals when consumed. At concentrations less than 50 ppm, cassava products are considered harmless. Consumption of such non-toxic cassava over long periods of time results however in chronic toxicity (Food Safety Network [FSN], 2005). There are over 5000 known phenotypically distinctive cassava cultivars. All contain varying concentrations of the cyanogenic glucosides linamarin and lotaustralin, which are hydrolyzed to hydrogen cyanide (HCN) by endogenous linamarase when the tissue is damaged (Haque and Bradbury, 2003; Wilson, 2003). The cyanogenic potential of known cassava cultivars ranges from less than 10 mg kg-1 as HCN fresh weight basis to more than 500 mg kg-1 as HCN fresh weight basis (O'Brien et al., 1994). Consumption of cassava and its products is thought to cause cyanide poisoning with symptoms of vomiting, nausea, dizziness, stomach pains, weakness, headache and diarrhea and occasionally death . Moreover, high dietary cyanogen exposure from poorly processed cassava roots may be associated with the occurrence of the neurological disorder konzo –an irreversible paralysis of the legs. It is therefore crucial to characterize cassava cultivars based on their cyanogenic potential and assess factors affecting level of HCN in cassava roots such as growing conditions and plant nutrients so that cultivars for household consumption and industrial use can easily be identified and better strategies to reduce HCN content in cassava can be devised.

In East Hararghe zone, cassava production and its utilization is not known by the local farmers even though there are some local varieties that were introduced by NGOs for food security purposes at different time and at different places of drought prone areas (CSA, 2010). There are farmers who don't know what cassava is and those who know and have the crop use it more for animal feed as 2011 survey indicated. This implies that there are knowledge and skill gaps about cassava production, management, utilization and benefits. Taking all the above reviewed cassava potentials, its nature of toxicity and existing gaps into consideration, Fedis Agricultural Research Center horticultural research case team has brought improved cassava varieties (kule and kelo) from Hawassa Agricultural Research Center to conduct adaptation trial at moisture stress areas of the center research stations of Fedis and Babile districts. Since the performance of these varieties were checked for their adaptability on station and recommended to reach out to the farmers. Therefore, this research was proposed with the objective/intended of demonstrating and evaluating of the cassava technology under the farmers

condition, build farmers' knowledge and skill of production and management of cassava production, create awareness among farmers, development agents, subject matter specialist and other stakeholders on cassava technology thereby enhancing linkage among the stakeholders in East Hararghe Zone.

Materials and Methods

Description of the study area

The study was carried out in the rural areas of Fedis district, Eastern Ethiopia situated in the northeastern part of the East Hararghe zone of Oromia regional state. The district has latitude between 8°22' and 9°14' north and longitude between 42°02' and 42°19' east, in middle and lowland areas: altitude range is from 1200-1600m.a.s.l. with a prevalence of lowlands. The area receives average annual rain fall of 400-804mm. The minimum and maximum temperature of the area is 20–25°C and 30–35°C, respectively. The population's livelihood mainly consists of agriculture, husbandry and small-scale trade. The farm units are small family holdings with an average agricultural land area of less than one hectare.

Approach followed

Site and farmers selection

For this activity, Fedis district and two Peasant Associations (PAs) (Agdora and Tuta Kenisa) were selected purposively by researchers in collaboration with experts and development agents (DAs) of the Fedis office of Agriculture and Natural Resource. The site was selected based on the potentiality areas of cassava production, appropriateness of the land for the technology and easily access to the road for experiment monitoring. Two FRGs (Farmer Research Groups) were established in the district i.e. one FRG per PA was formed which consists of 15 members and a total of 30 farmers were involved in the activity. Three trial farmers and one FTCs from each FRG members were selected based on their interest on technology, willingness to cost sharing like land provision and experience sharing for members as well as non-members and activeness/innovativeness.

Research design

The trial was undertaken on farmers and Farmer Training Centers (FTCs) land in each PA. For this trial, two improved (Kelo and Kule) and one standard check varieties were used and planted side by side with equal plot size of land. The plot size was 10mx10m with 25 cutting per plot and farmers replicated. The plant was applied as usual farmers practice that occupied farmers land with different crops like *khat*, sorghum and maize that intercropped with this technology.

Training and field day organized

Training is an important core component of this activity. Training was delivered to the target groups, 30 target farmers (18 males and 12 females), 6 DAs and 2 experts. During training different professionals researchers were participated and share their knowledge and skills through PowerPoint presentation and distribution of extension materials such leaflet and manual.. In addition, mini-field day conducted which consisting a total of 40 farmers which are 10 females and 30 are males were participated. As planed to

this activity, the result should be communicated to the final target group as well as to non-members of the target group farmers. Accordingly, the result was communicated to the whole community through like in training and field day and moreover with the help of extension materials such as leaflet, manual and PowerPoint. This all events were undertaken during different times in organized way.

Data collection and analysis method

Both quantitative and qualitative data were collected during implementation. The quantitative data was collected through measuring basic data and using checklist format while qualitative data was collected using through personal observation, interview of farmers and their feedback and focus group discussion. Yield data, farmers' preferences and crop with cassava ratio of data were the major type of data collected during demonstration process. As a result, quantitative data collected from the field was analyzed using simple descriptive statistics by SPSS while qualitative data that collected using focus group discussion and field observation were analyzed using narrative explanation and argument. Finally, data from different sources were triangulated to get reliable information.

Results and Discussion

Training

At demonstration stage, training is the most important thing in the extension approach. As a result training is an impart knowledge and develop skill of farmers to adapt new practices. Therefore, in order to utilize the technology successfully, farmers, DAs and experts need training. Intensive knowledge and skill based training from launching the activity up to food utilization were given for target groups. A total of 38 target groups were participated during processing of training. Among them, 30 farmers, 6 DAs and 2 experts were involved. Out of trained participants, 14 females were involved to keep the gender balance in activity. Due to women are the active labor force in agriculture in general and cassava food processing in particular. The training has been given by multidisciplinary team on cassava production and management (input utilization and application method, weeds, disease, insect and their controlling mechanism) as well as its information exchange. Thirty eight manuals prepared and delivered for the participants.

Table 15. Number and participants of target group on the training given in the areas

No.	Participants	Fedis				
		Agdora		Tuta kenisa		
		Male	Female	Male	Female	Total
1	Farmers	9	6	9	6	30
2	DAs	2	1	2	1	6
3	Experts	2	0	0	0	2
	Total	13	7	11	7	38

Source: Own computation, 2016.

Yield performance

The performances of the cassava varieties during their growing season together with their total yields were collected and analyzed. Two years result indicated that the average yield (ton/ha) of improved cassava varieties (Kelo and Kule) were 8.59 and 7.39 and that of standard check variety was found to be 7.28 with standard deviation of 0.21, 0.55 and 0.24, respectively. The average yield of Kelo was higher than that of Kule and standard check variety in which that using improved cassava variety increase the yield of production of farmers in the areas. And also, the average yield of Kule variety higher than that of standard check. Kelo and Kule varieties were showed 18% and 1.5% yield advantage over local check variety, respectively. The result indicated that the average yield of Kelo variety was higher than that of Kule and standard check in which that using this cassava variety increase the yield of production of farmers in the areas.

Cassava utilization, food taste and farmers preference variety

Cassava has the potential to increase farm incomes, reduce rural and urban poverty and help close the food gap. Without question, cassava holds great promise for feeding Ethiopia's growing population. In the southern Ethiopia, cassava is almost used as a staple food. For instance, in Wolayta and Sidama Zone, cassava roots are widely consumed after washing and boiling or in the form of bread or "*injera*"(Ethiopia staple food) after mixing its flour with that of some cereal crops such as maize (*Zeamays*), wheat *(Triticum aestivum* L.), sorghum (*Sorghumbicolor*), or *tef* (*Eragrostis tef*) (Taye, 1994). Processing methods, storage experience and modes of consumption are not yet documented in Ethiopia, unlike most of cassava producing and consuming African countries. But, it is one of the underutilized root crops in the country. The bitter variety of cassava must be processed to improve palatability, eliminate or prevent acute toxicity in humans or reduce the level of cassava cyanide contents (Cardoso et al., 2005).

In study area, for this purpose from cassava processed root flour with mix of wheat it was made Injera, Kukus, Porridge, Bread Bobolino food types. Therefore, the mixing ratios of cassava versus wheat 75% and 25%, 50% and 50% and 100% cassava only were used for food utilization. In the case of cassava and wheat mixing with 75% and 25%, Kelo mixing wheat was the most preferred taste and first rank in food utilization and followed by Kulo mixing wheat. Similarly, cassava and wheat mixing with 50% and 50%, Kelo mixing wheat was the most preferred taste and first rank in food utilization and followed by Kulo mixing wheat and the same result was found with no mixing of cassava and wheat varieties. Moreover, in the case of *kukusi* and *bonbolino*; kelo, kule and standard check mixing ratio of (50%, 50%) with wheat flour were the most preferred by participant's farmers ranking respectively. In the case of *Injera* and Bread/*Kita*; kule, kelo and standard check mixing ratio of (50%, 50%) with wheat flour were the most preferred by participant's farmers ranking respectively. Similarly in case of Porridge; kule, kelo and standard check mixing ratio of (50%, 50%) with wheat flour were the most preferred by participant's farmers ranking respectively

Among the mixing percent, 50% cassava and 50% wheat flour were the most preferred and selected by farmer's interest. While in case of color preference kule, kelo and standard check varieties were selected and accepted by farmers, respectively. They have an eager to enter in the production of cassava in the

future for their consumption, marketing and promised to allocate their land for cassava planting in percent correlate to other crops they have been producing for long time.

Table 16.The cassava and wheat mixing ratio and food utilization

S.no.	Mixed crops' flour	Mixing ratio	Taste and farmers preference rank	Overall farmers preference ranking
1	Kelo + wheat	75, 25	1	
2	Kule + wheat	75, 25	2	2
3	S. check + wheat	75, 25	3	
1	Kelo + wheat	50, 50	1	
2	Kule + wheat	50, 50	2	1
3	S. check + wheat	50, 50	3	
1	Kelo + wheat	100, 00	1	
2	Kule + wheat	100, 00	2	3
3	S. check + wheat	100, 00	3	

Source: Own computation, 2015/16

Farmers' reaction and feedback

At processing of the activity, field day was organized at different years. During field day, different stakeholders were participated and react in what they observed the fruit of the technology in the areas. The participant stakeholders were hosting farmers, non-hosting farmers, Development Agents (DAs), district Experts and concerned researchers. Field days were organized at maturity and food processing stage when there is a difference observation between improved and standard check were reflected. Extension materials such as manuals, guidelines and leaflets prepared by researchers in Afan Oromo and English language and distributed to the all participants during field days. The materials help to enhance the level of awareness among the target groups on cassava technologies. According to the recommendation of the technologies, all necessary data and feedback were collected and analyzed in comparison with standard check variety and farmer's management practices. As a result, growing Kelo and Kulo varieties are more preferable than the standard check in food taste, color and gain higher yield of Kelo variety over other varieties.

Conclusion and Recommendation

Food security in the study area is mainly dependent on crop production. Crops are cultivated for many years. Different agricultural extension systems and packages were disseminated for the last many decades. But, farmers in the study areas are still food insecure. To alleviate this problem, adaptation study initiated by the center and recommended better performed varieties for further evaluation and demonstration in similar agro-ecologies. Among this, root crop or cassava crop demonstration and evaluation was conducted both on-farm and Farmer Training Centers (FTCs) in the area. . Therefore, farmers have less experience in cassava technology development and utilization. Hence, this study was conducted to see overall performance of the improved varieties under farmer's and FTCs condition.

Two improved (Kelo and Kule) and one standard check cassava varieties were used during activity processing. Kelo variety was shows better than Kule and standard check in terms of yield performance and well accepted by farmers in food utilization. As cassava has bitter taste by nature it was used wheat flour for mixing purpose to make better taste and multipurpose processing output. Therefore, for this case 25%, 50% and 100% cassava and wheat flour mixing ratio was used. Among the mixing percent, 50% cassava and 50% wheat flour was the most preferred and selected by target groups. Moreover, to consume adequately there should be high production is expected from a unit area. To get this high cassava producer farmer, they should have follow package its agronomic practice. In addition to this, promotion and dissemination of improved cassava varieties through on-farm experiment has created an opportunity for the farmers to have additional crop that can minimize the risk of food deficit resulted from crop failure. As a result, Kelo and Kule cassava varieties were recommended for more promotion in the area and other similar agro-ecological situation to reduce the problem of food insecurity in the areas.

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Seed Producer Cooperative Based Potato Seed Production and Marketing in Kombolcha district of East Hararghe Zone, Oromia Region, Ethiopia

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Abstract

The activity was implemented in Kombolcha district of Eastern Hararghe Zone during 2012 to 2015 cropping seasons with objectives of improving availability and sustainable supply of quality potato seed at farmers level through cooperative based seed production, and to encourage cooperatives to get involved in seed business through Scaling-up of Local Seed Business (LSB) in partners with ISSD (Integrated Seed Sector Development) project. Two seed producer cooperatives namely Madda Janata and Ifa egu seed producer cooperatives (SPCs) were selected from Billisuma and Egu Kebeles, from Kombolcha district for implementation of the activity. A total of 283 farmers of Madda Janata and Ifa Egu seed producer cooperatives (SPCs) involved in the potato seed production and marketing, and high yielding and late blight resistant seed of improved potato varieties (Gudane and Bubu varieties) were multiplied and disseminated through SPCs farmers in the area. Farmers' and experts' awareness on potato seed production, post-harvest handling, and market linkage was created. A total of 2340 quintals of potato seed produced and distributed by SPCs farmer in the area. And also a total of 1190 farmers benefited from SPCs based potato seed business and technology transfer. In addition, three Diffused Light potato seed storage technologies with holding capacity about 500 quintals of seed potato were constructed and promoted in the area in collaboration with Haramaya University-Integrated Seed Sector

Development, CASCAPE project and Fedis Agricultural Research Center. Therefore, strengthening of SPCs based potato seed production is need attention to improve access to quality potato seed sustainably in the area.

Keywords: *Cooperatives; Potato; Seed Production; Marketing*

Introduction

Potato (*Solanumtuberosum* L.) is a major vegetable crop which is widely grown by smallholder farmers in the highland and mid-altitude areas of Ethiopia. It is one of the major staple crops with the potential to improve food security and economic benefits of smallholder producers. Increasing demand for potato foods, and domestic and export markets are the major drivers for enhanced productivity of the crop in the country. In Ethiopia, currently, it is grown annually on 74,934.6 hectares with a total production of 863347.8 tones which makes the country to be considered as the potential producer of the crop (Central Statistical Agency [CSA], 2013).

East Hararghe zone is among the potential zones in Oromia region for potato production. Potato appears to have many opportunities in the areas in terms of addressing food security problems and improving income of smallholder farmers. In Hararghe, it is the most commonly marketed crop accounting for about 60% of the total vegetable crops produced (Bezabih & Hadera, 2007). In East Hararghe, potato is produced in both the rainy and dry seasons. Apart from its use as a food crop, it is one of the most important cash crops grown by smallholder farmers in east Hararghe. In some areas like Kersa, Kombolcha and Haramaya districts where irrigation water is available, it is often produced two to three times per year and hence serves as one of the major cash income for the farm households and as a means of livelihood for a large number of market actors. The productivity of the crop in the area; however, production is highly constrained by lack of improved seed varieties, knowledge gap on seed production, and seed maintenance techniques.

Availability quality seed of improved potato varieties is considered fundamental to improve crop productivity in general and potato in particular. However, in Eastern Oromia in general and East Hararghe Zone in particular, like in other parts of Ethiopia, the majority of farmers mainly obtain potato seed from informal channels which include farm saved seeds, seed exchange among farmers and the local market.

In addition, lack of formal seed production system is also constrained to access farmers improved seed potato in the area. Thus, to date the majority potato producers obtain their seed for planting informally from own saved seed or local market/exchange. According to Gildemacher et al. (2009), the informal system supplies 98.7% of the seed tubers required in Ethiopia. The potato seed supplied by informal system have poor sanitary, physiological, physical and genetic qualities (Adane et al., 2010). Potato producers highly depend on local seed tubers which have low genetic potential for yield, low quality attributes, and susceptible to diseases such as late blight in the area. It is, therefore, important to improve access to and use of quality seed required by farmers in order to maximize their productivity and profitability in the area.

To address these problems and enhance productivity and profitability of potato farmers, Fedis Agricultural Research Centre in collaboration with Haramaya University of Integrated Seed Sector Development (HU-ISSD) programme of has been promoting cooperative based production and market through Scaling-up of Local Seed Business (LSB) project. In Eastern Oromia, the programme was coordinated by Haramaya University, and implemented in collaboration with different stakeholders such as agricultural research centers, Zonal office of agriculture, Zonal cooperative promotion office, district office of agriculture, district cooperative promotion office, and Unions. Fedis Agricultural Research Centre (FARC) was one of the partners agreed to implement the programme in Kombolcha district of Eastern Hararghe Zone in collaboration with other stakeholders. Accordingly, FARC and ISSD Programme, SPCs based Potato Seed Production and Marketing was launched in the area with the objective to build the capacity of SPCs to produce and distribute quality seeds of farmers' preferred potato varieties sustainably in the area. As a result two SPCs were established and involved in potato seed production and marketing activity in the area.

Methodology

Description of the study area

The activity was implemented in *Kombolcha district of Eastern Hararghe Zone with objectives of* improving availability and sustainable supply of quality potato seeds through Scaling-up Local Seed Business (LSB) project in partners with ISSD programme and other stakeholders. The district is known for its potential in vegetable production, particularly in potato production, however, the production of the area is highly constrained by availability and use of improved potato seeds. The area is agro-ecologically characterized as sub-humid highland with mean annual rainfall of 790mm. The district has an altitude of 2161 m.a.s.l. with the geographical locations of 09°27'00.1"N and 42°06'16.9"E. The farming system of the district is dominated by crop production mixed with livestock husbandry. The major crops produced include potato, cabbage, beetroot, sorghum and maize. The district strategically located adjacent to main cities, Harar and Dire Dewa. In addition, due to its proximity to Djibouti and Somalia, the district access to potential vegetable markets in the area.

Local seed business sites and seed producer cooperatives farmers' selection

Prior to implementation of the activity, discussions were held with experts from office of agriculture and natural resources, and cooperative promotion office of Kombolcha district to identify and select sites and seed producer cooperatives (SPCs) in the district. The selection of LSB sites and SPCs farmers' was conducted in collaboration with experts from Zone and districts offices of Agriculture and Natural Resource, and Cooperative Promotion Offices. Prior to implementation of the activity, discussions were held with experts from Zone and districts to identify and select LSB sites and SPCs. Then after, two LSB sites such as Billisuma and Egu from Kombolcha district were selected based on potential in potato production, accessibility, availability of irrigation water, and irrigable land. Similarly, Two Seed Producer Cooperatives(SPCs) namely Madda Jalela, and Ifa Egu SPCs were selected based on well-organized farmers cooperatives having legal entity, having cluster land used for seed production with reasonable

size (half hectare and above), and interest to engage in potato seed business in the area.The description of the selected SPCs was presented in the following table.

Table 1. LSB sites and SPCs selected in Kombolcha district

Zone	District	Kebeles	SPCs	Member/s			Year of established
				Male	Female	Total	
East Hararghe	Kombolcha	Egu	Ifa Egu MPC	90	28	118	1999
		Bilisuma	Madda Jaalalaa MPCs	115	31	146	1999

Source: Seed Producer Cooperatives, 2015

Implementation approach

Sites, SPCs farmers and other stakeholders were identified and selected; **consultation meeting and discussions** held for the purpose of having common understanding about the SPCs based production and distribution, and setting action plan. Memorandum of understanding (MoU) was signed between FARC and HU-ISSD Programme which has stated the role and responsibility of each partner in the implementation of SPCs based seed production and distribution in the area. The activity was implemented by involving SPCs farmers, experts from Zone and districts offices of agriculture and Natural Resource, Cooperative promotion offices, Union, Haramaya University, ISSD programme, and Researchers for coordinating, monitoring and technical support for SPCs in the area.

Capacity building

Training of seed producer cooperatives farmers and others stakeholders

Training was given to SPCs farmers, Development agents, experts and other stakeholders on quality potato seed production techniques, field clustering, diseases and insect management, post-harvest handling, marketing and cooperative organizational management.

Knowledge sharing

Field visits, radio program and field exchange visit were used to promote SPCs based potato seed production and marketing activities, transfer knowledge and skill on potato seed production and marketing to enhance learning and experience sharing among stakeholders in the area. Moreover, experts, Development Agents (DAs), researchers and ISSD innovators have been actively involved in follow up and inspection to assure the desire quality seed production in the area.

Input and facility support

Inputs mainly potato seed was provided to the SPCs farmers prior to the planting time. In addition, facilities supports such as office facilities, motor pump for irrigation and Diffused Light Potato Seed Storage were provided for SPCs in the area.

Seed marketing and distribution

Seed collection, storing, certification, and marketing were facilitated by FARC in collaboration with ISSD programme, Zone and district office of Agriculture and Natural Resources, and Cooperative promotion offices. The produced seeds were sold to the neighbor farmers, unions, government organizations (GOs) and non-governmental organizations (NGOs) operating in the area. The produced seeds were sold locally for the SPCs member farmers and non-SPCs farmers in the area.

Data collection and analysis

Data such as number of farmers participated in seed production, number farmers, experts and DAs trained, number farmers, experts and DAs participated on field visits, quantity of inputs used, area allocated, quantity of seed produced and sold, and farmers perception were collected using checklists through interview and discussions. The collected data were analyzed using descriptive statistics and narrative.

Results and Discussion

Training of farmers and other stakeholders

Technical training was given to the SPCs farmers, DAs and experts on basic principles for quality seed production, postharvest handling, and marketing approach. The participants were also trained in cooperative management including basic cooperative principles, governance, financial management and record keeping. Accordingly, a total of 153 farmers (115 male and 38 female), 6 DAs, and 27 experts from Zonal and district offices of agriculture, and cooperative promotion offices, and NGOs have been trained.

Field visits and experience sharing

Field visits were organized in Kombolcha district with the objectives to create awareness and sharing experiences on SPCs based potato seed business activity. The farmers, stakeholders and partners from East Hararghe Zone, Kombolcha, Haramaya, Fedis and Babile districts were participated and they visited efforts made by *Madda Jaalalaa* and Ifa Egu SPCs on potato seed business activities in Kombolcha district.

Among the participants, SPCs and non-SPC farmers, experts from agricultural offices and Cooperative Promotion Offices, Unions, experts from Integrated Seed Sector Development (ISSD), Universities such as Haramaya, and Oda Bultum Universities, Technical and Vocational Education and Trainings (TVETs)

, experts from NGOs, and researchers from Fedis Agricultural Research Center. Accordingly, a total of 214 male farmers, 67 female farmers, 20 DAs, 18 Subject Matter Specialists (SMS), and 24 researchers and experts from other stakeholders and partners organizations were participated. In addition, exchange visits and tour were organized to SPCs farmers, DAs, experts and researchers at Haramaya district (*Rare Horaa SPC*), Kersa district (*Haqan Guddinaa SPC*) and Haramaya University for experience sharing on potato seed business (quality seed production, post-harvest handling, market linkage and cooperative governance and financial management). Accordingly, a total of 10 SPCs farmers (8 male and 2 female), 4DAs, 2 experts and 4 researchers were visited and shared the experience from the above mentioned SPCs. As a result, the SPCs farmers, DAs and experts have increased their awareness and knowledge on quality potato seed production techniques and marketing.

Seed production and dissemination

Seeds of four improved potato varieties (Badasa, Gudane, and Bubu) and one locally demanded variety (Dadafa) have been introduced to the potato producer farmers in the target area. In 2012/13 cropping season, FARC and HU-ISSD, supplied a total of 20 quintals of potato seed (Bedasa, Gudana variety) to *Madda Jaalalaa* SPC at Bilisuma *kebele* of Kombolcha district. Similarly, in 2013/14 cropping season, a total 126 quintals of seeds of Gudane and Dedefa varieties supplied to the *Madda Jaalalaa* and *Ifa Egu* SPCs. In a similar manner during 2014/15 cropping season, a total 110 quintals of potato seed of Bubu variety supplied to the *Madda Jaalalaa* and *Ifa Egu* SPCs jointly with Haramaya University.

A total of 256 quintals of potato seed was supplied to the SPCs farmers, comprising of 283 SPCs farmers (227 male and 25 female farmers) involved in the potato seed business in the area (Table 2). Moreover, high yielding and late blight resistant seeds of improved potato varieties (Gudane and Bubu varieties) were promoted through cooperatives farmers, and access to improved potato seeds enhanced in the area. The SPCs based potato seed production has resulted about 29 hectare area of land covered by improved potato varieties which has produced quality potato seed and disseminated to the farmers during 2012 to 2015 cropping seasons in Kombolcha district (Table 2).

Table 2. Number of SPCs farmers, area covered and seed produced during 2012 to 2015

Description	Year and number of SPCs farmers									
	2012		2013		2014		2015		Total	
Number of SPCs farmers participated	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
	36	2	50	5	55	7	84	7	227	25
Quantity of seed supplied (quintal)	*20*		*126*		110		0		256	
Area in hectare	*4*		*6*		7.5		12		29	
Varieties in number	*4*		*3*		3		2		-	

The SPCs produced a total of 2340 quintals of seed potato produced and disseminated to the farmers during during 2012 to 2015 cropping seasons in the area (Figure 1).

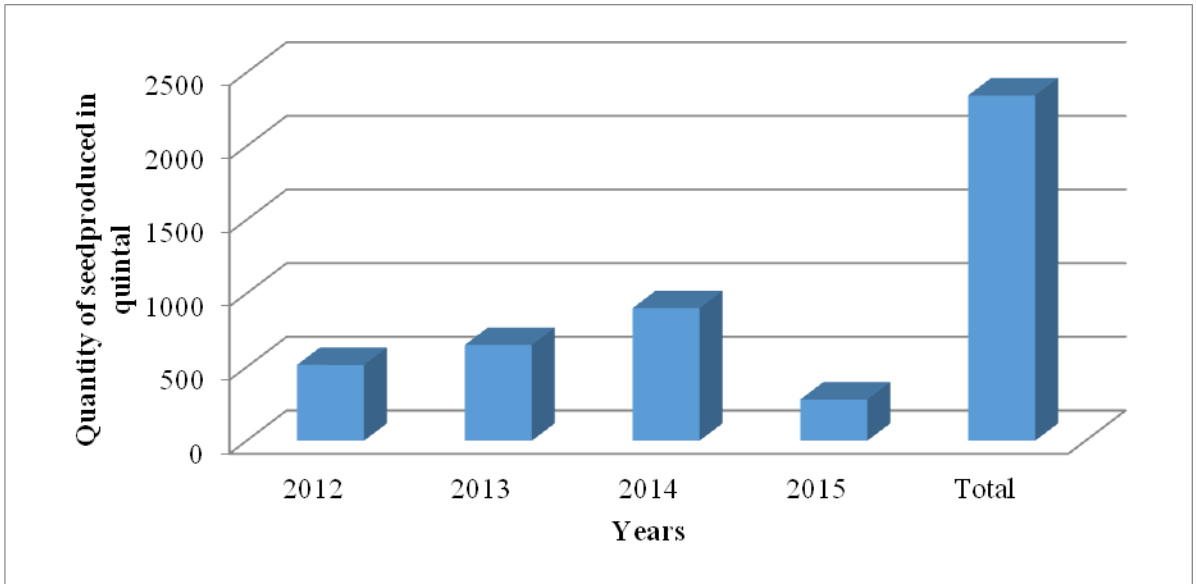

Figure 8. Quantity seed produced (quintal) by SPCs during 2012 to 2015.
Source: Own computation, 2015

The produced seed improved potato varieties have been disseminated to 907 potato producer farmers' throughsold and exchanged locally for the SPCs members and neighbors' farmers in the area. Thus, the SPCs based potato seed business has a great potential to benefit farmers by improving their access to quality seed of potato, thereby enhancing farmers' skills and knowledge on seed business and market linkage. It was also found that SPCs based seeds business is profitable with an average income of birr 63,466.00 per year from the potato seed business activities. This shows that the potato seed business is rewarding business in the area, and it should be encouraged. Therefore, SPCs based potato seed is should strengthen to access potato seed sustainably in the area. It is also found to be a lucrative income generating activity for farmers engaged in local seed production and marketing in the area.

Role of farmers and other stakeholders

The SPCs farmers play a significant role in input allocation (land, labour, fertilizer), land preparation, planting, applying recommended agronomic practices, follow up, harvesting, and storing with required quality. FARC and HU-ISSD were performed capacity building support through training, and experience sharing for SPCs and stakeholders, facilitating field supervision and coaching. In addition, FARC and HU ISSD programme provides potato seed for SPCs farmers in order to produce and distribute certified seed of improved potato varieties to the potato farmers and assists them in seed marketing in the area. The SPCs farmer, DAs, and experts from office of agriculture and researchers have been actively involved in field clustering, follow up and field inspection to assure the desire quality of seed production in the area. Facilitating seed certification and looking for buyer for produced seeds were also performed by FARC, HU-ISSD, Zonal and district office of agriculture, and district cooperative promotion office.

Farmers' reaction/feedback

The farmers' feedback indicates that the Bubu, Gudane, and Dedefa potato varieties were highly preferred by the farmers in the area due to their high yielding, resistance disease (late blight), tolerant to moisture stress and high market demand as a result, the farmers were interested for the varieties and because of this high demand created for these varieties in the area. Regarding potato seed production and marketing, the SPCs farmers perceived that potato produced for seed is a profitable venture as compared to potato produced for edible/warehouse in the area. This is due to potato produced for edible/warehouse sold at low price at harvesting time.

Conclusion and recommendation

A total of 283 farmers of Madda Janata and Ifa Egu SPCs involved in the potato seed production and marketing activities, high yielding and late blight resistant potato varieties were promoted through cooperatives farmers in the area, and access to improved potato seeds by cooperative farmers improved. The farmers' and experts' awareness on potato seed production and marketing was created. A total of 2340 quintals of potato seed produced and distributed by cooperative farmers during 2012 to 2015 cropping seasons. And also a total of 1190 farmers benefited from cooperative based potato seed business and technology transfer. Therefore, cooperative based potato seed business is need further strengthening the SPCs in the area. To ensure and maintain cooperative based seed production and marketing, it is suggested to work more on capacity building (technical and facility support), post-harvest handling and value addition, and linking them with markets and distribution system needs attention to maintain for sustainability of SPCs in seed production and marketing in the area.

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Pre-Scaling up of Improved Early Maturing Sorghum Technology at Babile and Fedis Districts, East Hararghe Zone, Oromia Region, Ethiopia

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Abstract

The activity was conducted in Babile and Fedis districts of East Hararghe Zone with the objectives to pre-scaling up improved lowland sorghum technologies and to create wider awareness by improving farmer's knowledge and skills and livelihoods of farmers in the area. Three improved sorghum varieties such as Misikir, Meko and Birhan were used for pre-scaling approach. Site and farmers were selected in collaboration with the respective districts Office of Agriculture and Natural Resource. Farmers were selected with the criteria of representativeness or willingness to manage the activity, innovative, enough land provision for experiment and able to transfer information/technology to others. A total of 117 farmers, 6 DAs and 4 Experts of the districts were involved for two cropping season in pre-scaling of lowland sorghum technology. Training was given by multidisciplinary researchers on agronomic or sorghum production, market information and experience sharing and technology transfer approaches. Field day was organized and different stakeholders were participated. A total of 18.72ha were covered with each farmer allocating 0.16ha and 234kg seeds were delivered. Independently at Babile district the yield performance of improved varieties were ranges from 11.98 to 30.60 whereas 13 to 27.80 quintal per hectare at Fedis district. The yield performance of Misikir variety was better while Birhan was poor performance than others at both districts in all cropping season. Therefore, high demand for the technology among farmers were created by agents and researchers then develop exit strategy for more promotion of the technology through government or non-government extension organization up to new technology developed.

Keywords*: Sorghum; Drought Tolerant; Striga Resistance; Improved Variety; Fedis and Babile districts*

Introduction

Sorghum is one of the most important cereal crops grown in arid and semi-arid areas of the world, receiving 400 to 800 mm of rainfall annually. Such areas are characterized by moisture deficit stress that affects the cultivation of the crop (Tadesse et al., 2008; Ouma & Akuja, 2013). It is an indigenous crop to Ethiopia. The origins of its domestication is Ethiopia and the surrounding countries, beginning around 4000-3000 B.C. Numerous varieties of sorghum were created through the practice of disruptive selection, where selection for more than one level of a particular character within a population occurs (Dillion et al., 2007). Sorghum (sorghum bicolor) is the fifth most important cereal globally and feeds around 500 million people. It is especially important for rural people in arid regions. It provides food for household consumption and produces larger amounts of fodder to support their livestock than other grains (Wortmann, 2006).

In Ethiopia, sorghum is a staple food crop widely cultivated in different agro-ecological zones, predominantly in dry areas where other crops can survive least and food insecurity is widespread. These areas cover nearly 66% of the country (Geremew et al., 2004; Adugna, 2007). In 2011/12, Ethiopian main

rainy season (Meher), 39,512,942.36 quintals of sorghum grain is produced on 1923717.49 ha of land (Central Statistical Agency (CSA, 2012). This shows that the productivity of the crop is still low, estimated to be 2054 kg/ha (Ibid, 2012), which is considerably lower than experimental yield that reaches up to 3500 kg/ha on farmers' fields in major sorghum growing regions of the country (Geremew et al., 2004).The current sorghum production in Ethiopia is estimated to be 3,604,262 tons on an area of 1,711,485 ha of land giving the national average grain yield of 2.11 tons per hectare (CSA, 2013). The contribution of improved varieties of sorghum is almost negligible mainly due to poor participation of farmers in the selection process, poor intervention of improved agricultural technologies (absence of improved varieties), birds damage to early maturing varieties, diseases (grain mold, head smut, anthracnose) and insect pests (shoot fly and stalk borer) (Asosa Agricultural Research Center [AsARC], 2011).

Moreover, sorghum is very important cereal in the semi-arid areas of the tropics and sub-tropics in Africa. Generally, the area under sorghum cultivation in Sub-Saharan Africa has steadily increased over the years but the average yield trends are downwards. Paramount among the yield reducing factors are predominant cultivation of inherently low yielding varieties, poor soil fertility, drought, striga, pests and diseases. Exploitation of host-plant resistance through genetic enhancement has always been the first approach or forms the basis of an integrated control package in addressing these constraints. This situation is more reflected in Ethiopia, particularly East Hararghe zone, in which is local variety well highly utilized and easily affected by striga and drought. This implies that local sorghum varieties are unable to adapt the climatic change of the current situation and this problem are more aggravated in the area due to moisture stress dominant.

To solve the problems, Fedis Agricultural Research Center (FARC) has conducted adaptation trials and evaluated a number of early maturing and striga resistance variety in the area. Therefore, to address the problems stated in the above, the extension research team was demonstrating and evaluate under the farmers condition through different mechanism. But, these technologies do not reach the end users as much as it is required by target agents. Thus, this activity aimed on promote and popularized improved lowland sorghum varieties, create wider awareness by improving farmers knowledge levels through giving training and participating in technology processing and improve farmers' livelihood levels and enhance stakeholders participation and linkage with farmers-extension-research lines. These in turn increase household income and contribute more to food security so as to alleviate food shortage.

Materials and Methods

Description of the study area

The activity was conducted in moisture stress East Hararghe Zone, at Fedis and Babile districts. Fedis is also located in lowland area of East Hararghe zone. The altitude of the area ranges from 1200-1600m.a.s.l. and it receives average annual rain-fall of 400-804mm. The minimum and maximum temperature range of the area is 20-25°C and 30-35°C, respectively. The population's livelihood mainly consists of agriculture, husbandry and small-scale trade. The farm units are small family holdings with an average agricultural land area of less than one hectare. Agriculture is mainly rain-fed. The cropping system is classified as intensive with cereal mono-cropping mainly sorghum and maize. Babile is also

located in lowland area of East Hararghe zone. The altitude of this district ranges from 950 to 2000 meters above sea level and it receives average annual rain-fall of 400-600mm. A survey of the land in this district shows that 21.1% is arable or cultivable (17.5% was under annual crops), 3.9% pasture, 3.7% forest, and the remaining 71.3% is considered built-up, degraded or otherwise unusable. Oil seeds and groundnuts are important cash crops in the area. The 2007 national census reported a total population for this district of 93,708, of whom 47,178 were men and 46,530 were women; 17,712 or 18.9% of its population were urban dwellers. The 1994 national census reported a total population for this district of 50,204, of whom 25,419 were men and 24,785 women; 9,195 or 18.32% of its population were urban dwellers at the time.

Approach used

Site and farmers selection

Site and farmers were selected in collaboration with key informant farmers, DAs and SMS from the respective Offices of Agriculture and Natural Resource. The target site was selected based on the potential sorghum production and access to the road. Babile (Erer *kebele*) and Fadis (Balina Arba *kebele*) districts were selected. Farmers were also selected based on their interest on technology, willingness to provide their land for the technology and willingness to provide cost for fertilizers and other related cost. A total of 117 farmers were directly participated with close supervision of researchers and development agents of the respective districts.

Trial design

Misikir, Meko and Birhan varieties were delivered for the target farmers in both districts. The input source was Fedis Agricultural Research Center (FARC). The varieties were planted on farmers selected plot of 40mx40m land in late of June rain-fed season. The variety was planted with early maturing sorghum production recommendation or agronomic recommendation practices. Therefore, based on farmers' variety need, those selected varieties were procured to hosting farmers and planted by drilling at seed rate of 10kg/ha. Space used between row and plant is 75cm and 25cm, respectively. Fertilizers were applied at the rate of 100kg/ha DAP and 50kg/ha Urea.

Training, field visit and field day organized

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

Data collection and analysis method

Both quantitative and qualitative data were collected. Number of farmers participates in training, number of farmers participates in scaling up, number of participants on field day, number of locations addressed, farmers' feedback and amount of inputs delivered to the farmers were major type of data collected during scaling up process. Collected quantitative data were subjected to analysis using SPSS software version 20 (frequency, mean and range) while qualitative data collected using field observation and group discussion were analyzed using narrative explanation and argument. Finally, data from different sources were triangulated to get reliable information.

Result and Discussion

Training of target group

Training was given by multidisciplinary researchers for the farmers, DAs (Development Agents) and SMS (Subject Specialist Matters). The training was given on improved sorghum production, market information and knowledge, skill and experience sharing and technology transfer approaches.

Accordingly, a total of 57 farmers (46 male and 11 female), 6 DAs and 4 experts were participated during the training organized in the target areas. As indicated in Table 1, 85.07% of target groups are farmers whereas 14.93% of participates were DAs and experts in the training provided.

Table 1. Number and participants of target group on the training given in the areas.

		Babile		Fedis		
No.	Participants	Male	Female	Male	Female	Total
1	Farmers	29	7	17	4	57
2	DAs	3	0	2	1	6
3	Experts	2	0	2	0	4
	Total	34	7	21	5	67

Source: Own computation, 2015

Seed delivery

Misikir, Meko and Birhan varieties were used for this activity. A total of 117 farmers were involved in seed distribution. Fedis and Babile districts are the selected sites for activity processing. In the first year, a total of 56 farmers were addressed in both Fedis and Babile districts while in the second year, 61 farmers were addressed. Generally, area covered and seed delivered in both districts were 116.96ha and 14.62Qt, respectively. The number of farmer participant and seed delivering was very high in Babile as compared to Fedis district. This was due to that there was high demand for improved sorghum technology and land size accessed in the area.

Table 17. Seed distributed through pre-scaling up in selected districts

Cropping season	Location	Hosting farmers	Total seed distributed (Qt)	Total area covered (ha)
2014/15	Babile	32	4	32
	Fedis	24	3	24
2016/17	Babile	39	4.87	39
	Fedis	22	2.75	22
Total		117	14.62	116.96

Source: Own computation, 2015/16

Yield performance across districts

The yield performances for different varieties were different in both districts. For the cropping season, grain yield performances of the improved varieties (Misikir, Meko and Birhan) were ranges from 11.98 to 30.60 quintal per hectare in both districts. Independently at Babile district the yield performance of improved varieties were ranges from 11.98 to 30.60 whereas 13 to 27.80 quintal per hectare at Fedis district.

The average grain yield performance of Meko, Misikir and Birhan varieties were 21.83, 22.96 and 19.9 quintal per hectare in the production season at Babile district, respectively. But at Fedis district, the average grain yield performance of Meko, Misikir and Birhan varieties were 21.3, 24 and 20.20 quintal per hectare in the production cropping season, respectively. The yield performance of Misikir variety was higher than Meko and Birhan in both districts in the cropping season. However, the grain yield performance of Meko, Misikir and Birhan varieties were 37, 37 and 32 quintal per hectare on station at Fedis Agricultural Research Center which is higher than at farmer's conditionThe yield difference might be due to farmers land striga infestation, poor land and low crop managements. However, improved sorghum varieties were more advantages than the local one especially in case of severe drought in which farmers remains with some stalks. And also it was observed that there was better grain yield in the second cropping season than the first. The yield difference between the two seasons might be due to the rainfall fluctuation and improvement of farmers practice on the technology from year to year in the districts. Farmers involved in this activity were increased their production and maximize their income by selling the seed for different stakeholders.

Field day and farmers' feedback

Field day and field visit were organized at green mature stage of the crop when a clear difference between varieties was observed.. A total of 166 participants were participated with different backgrounds at both districts. Out of the total participants, 121 farmers, 6 Development Agents, 11 Farmer seed producers cooperative, 5 district Expert, 2 zonal Expert, 5 Haramaya University Integrated Seed Sector Development (HU-ISSD Program), 14 researchers and 2 journalists were observe the sorghum varieties on farmers field..The extension materials (90 leaflets and 26 small manuals) were prepared and

distributed for the participants. The extension materials are organized in Afan Oromo and English languages.

Most of the farmers showed high interest towards improved lowland sorghum technology production because of better grain yield and earned income by selling seeds for different stakeholders (neighbors' farmers, GOs and NGOs) as compare to the local seeds. Farmers were identified that local seed varieties have poor performance as compared improved varieties. These improved varieties are more advantageous than the local variety in that of; drought tolerant, early mature, striga resistant/tolerant, disease tolerant and low labor requirements and managements.

According farmer's views, Meko and Misikir varieties were most preferred by them because of better feed stalk and palatability, grain yield, food cooking, color, drought tolerant and market demand whereas Birhan was low feed stalk and drought tolerant but the most preferred variety by its quality of food cooking/home usage/nutritional value and local market demand for seed and food purpose. Therefore, overall preference, farmers ranking crops as their preference Meko, Birhan and Misikir in order of from first to third respectively at Babile district and similar condition was observed at Fedis district.

Drawbacks of lowland sorghum technology mentioned by farmers were; easily attacked by insects and land worms due to the stalk close to land/short stalk, eaten by birds as it was early mature and need labor intensive in bird protections, seed shortage in case if farmers need to extensively use their land for this technology. Generally, all farmers were very interested to have the technology for their future production. Therefore, all concerned bodies were shared their responsibility for the future intervention and wider reach out of the technology.

Table 3. Type of profession and number of participants during field days

		Babile		Fedis		
No.	Participants	Male	Female	Male	Female	Total
1	Farmers	52	13	40	16	121
2	DAs	3	0	2	1	6
3	FCS Producer	8	3	0	0	11
4	District expert	3	0	2	0	5
5	Zone expert	1	0	1	0	2
6.	HU ISSD-program	4	1	0	0	5
7	Researchers	8	0	6	0	14
8	Journalists	2	0	0	0	2
	Total	81	17	51	17	166

Source: Own results, 2016

Conclusion and Recommendation

In the study area, striga and rainfall shortage were the most problems that influencing sorghum production. To address this problem, Fedis Agricultural Research Center (FARC) has undertaken adaptation trials on improved early maturing and striga resistant sorghum varieties and identified the well adapted varieties to the areas. These varieties are performed well in grain yield, drought tolerant and

resistant to the spread of severe striga infestation which has devastative effect on yield and yield components. Those sorghum varieties were conducted to solve the identified problems and succeed observed in yield and yield components as compare to the local varieties except for stalk and food utilizing for some varieties. Using those technologies have great advantages for the producers to minimize risks associated with it and maximize their benefits. But currently, improving the productivity of our farmers remains a challenge that has to be faced with a multiple problems.

Therefore, the center has disseminated and popularized those demonstrated and selected varieties to the target farmers for the last two years. The varieties are well appreciated and recommended to more reach out of the whole farmers in the areas. Moreover, farmers said "using these varieties is alleviating the existed problems on production and productivity in the areas." But they only criticize on sorghum stalk (have short plant height and low biomass) as compared to the local varieties. This implies that farmers are planting sorghum not only for grain yield but also they used the stalk for animal feed, fire wood/fuel and construction materials. Overall the varieties are well accepted and suggested to widely promote and make farmers beneficials through the Office of Agriculture and Natural Resource of the East Hararghe Zone. This can achieved through appliying appropriate extension approach like giving training to DAs and farmers, experience sharing, field day organizing and collaborative work with stalkeholders, private producers, and NGOs that with close supervision of reseach center.

Exit strategy

The mandate of Fedis Agricultural Research Center (FARC) is starting from technology generation or adaptation to demonstration and up to per-scaling up stage in which the target participants limited in scope. So that, it is important to see an alternate option in which a mass of farmers can involve in the technology promotion through strategic mechanism. For this case, the main collaborator of FARC was Office of Agriculture and Natural Resource of the districts in the study area. Therefore, the wider scope or dissemination of the technology should have remained to be implemented by Office of Agriculture and Natural Resource of the respective districts of the study districts. This is to keep that the extension system linkage among those organizations and to relay the continuity of technology for wider coverage until the better new technology option developed. To realized this action, FARC and the respective districts of Offices of Agriculture and Natural Resource have discussed on how to keep the continuity of the technology and wider scaling up to the larger peoples and then agreed to own the technology by Offices of Agriculture and Natural Resource of the respective districts and with the facilitation of FARC in technical and close supervision.

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Seed Producer Cooperative Based Maize and Sorghum Seed Production and Marketing in Fedis and Babile Districts of East Hararghe Zone, Oromia Region, Ethiopia

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Abstract

Seed producer cooperatives (SPCs) farmers based maize and sorghum seed production and marketing was implemented in Babile and Fedis districts of Eastern Hararghe Zone during 2012 to 2015 production years with objectives to improve availability and sustainable supply of locally demanded seeds of improved varieties through Local Seed Business (LSB) in partners with Haramaya University ISSD Programme in the area. Accordingly, a total of five SPCs farmers involved in Local Seed Business (LSB) project with a total of 390 SPCs farmers who produce maize and sorghum seeds and distribute to the farmers and other stakeholders in the area. Training and field visits were organized for SPCs farmers, experts and development agents. Supports such as basic seeds, office facilities and farm machineries were provided for SPCs by Fedis Agricultural Research Center and Haramaya University Integrated Seed Sector Development Programme. A total of 879 quintals of sorghum and maize seeds produced and disseminated by the SPCs farmers during 2012 to 2015 cropping seasons. As a result the SPCs farmers

benefited from seed production and marketing access to quality seeds, and earning cash by selling the seeds to the farmers in the area. Currently, the SPCs were involved in seed business activities such as producing, buying and selling of improved seeds demanded by farmers in the area. To ensure and maintain cooperative based seed production and marketing, it is suggested to work more on enhancing SPCs on post-harvest handling and value addition, access to finance, and link them with potential seed market and distribution system in the area.

Keywords: *Farmer's cooperatives; Seed production; Sorghum; Maize; Marketing*

Introduction

Sorghum and maize are among the most important cereal crops dominantly grown in the eastern part of Ethiopia in general and East Hararghe zone in particular. These crops are served as a major source of food for farmers in the area. In addition, their leaf and stalk are used for animal feed, and construction fence and as fuel wood. In East Hararghe Zone, the total area under sorghum and maize amounts to 134,708.26 hectares and 49,979.80 hectares and the corresponding production was 2,652,781.44quintals and1, 332,857.81quintals, respectively in the area (Central Statistical Agency [CSA], 2016).

Despite the importance of sorghum and maize in the East Hararghe Zone, the productivity of these crops remained low in the area, mainly because of different factors such as recurrent drought, weed infestation; soil fertility degradation and farmers have too little access to affordable, and locally preferred high yielding varieties with multiple uses. The average yields of these crops are low 19.69 and 26.67 quintals per hectare for sorghum and maize respectively in the area (CSA, 2016). The major causes of low crop yields is limited awareness, and access of farmers to quality seeds of improved varieties are among the prominent causes for low productivity the crops in the area.

As it is well known, availability of quality seed of improved crops varieties is one of the most precious inputs in crop production which responsible for the productivity of a particular crop. For enhancing crop production farmers should access seeds of farmers preferred crop varieties with the desired qualities, quantities, at the right time and at affordable price (Gregg & Van Gastel, 1997). Despite the release of improved crop varieties, there has been limited use of improved seeds by the majority of farmers (CSA, 2011). Among others, unavailability of quality seeds at the right place and time coupled with poor promotion system, is one of key factors accounting for limited use of improved seeds, which further contributing for low agricultural productivity.Hence, improving availability of seeds of farmers preferred crop varieties with the desired quality will enhance the productivity and livelihood of the farmers of lowland areas of eastern Ethiopia in general and East Hararghe Zone in particular.

In line with, and to address the problem of limited access of farmers to seeds of improved sorghum and maize varieties, Integrated Seed Sector Development (ISSD) programme of Haramaya University embarked Seed Producer Cooperatives (SPCs) based seed production and marketing through scaling up of Local Seed Business (LSB) project in Eastern Oromia. The LSB project supports seed producer farmer groups/cooperatives; it aims at improving their autonomy, their business and marketing skills, and their capacity to produce and distribute quality seed of locally demanded improved varieties.

In line with this, Fedis Agricultural Research Center was collaborated with ISSD programme to support SPCs through LSB project for improving access to quality seeds of improved varieties that can increase the productivity of the crops. Accordingly, FARC and ISSD Programme, SPCs based Maize and Sorghum Seed Production and Marketing was launched in the area with the objective to build the capacity of SPCs to produce and distribute quality seeds of farmers' preferred varieties sustainably in the area.

Methodology

Description of the study area

The SPCs based seed production and marketing activity was implemented in ***Fedis and Babile districts of Eastern Hararghe Zone*** of Oromiya Region during 2012 to 2015 cropping seasons. Agro-climatically, Fedis district has midland and lowland which account for 39% and 61% of the total area, respectively. The climate of the district is characterized by warm and dry weather with low precipitation. The altitude of this district ranges from 500 to 2100 m.a.s.l. Similarly, agro-climatically, the Babile district has lowland which account for 100% of the total area. The climate of the area is characterized by warm and dry weather with low precipitation. The altitude of the district ranges from 950 to 2000 m.a.s.l. Agriculture is the major source of livelihood in both districts. Both districts are potential in sorghum and maize production, however, the production of these crops are constrained by limited availability and use of seeds of improved varieties, moisture stress and weed infestation in the area.

Local seed business sites and seed producer cooperatives farmers' selection

The selection of LSB sites and SPCs farmers' was conducted in collaboration with experts from Zone and districts offices of Agriculture and Natural Resource, and Cooperative Promotion Offices. Prior to implementation of the activity, discussions were held with experts from Zone and districts to identify and select LSB sites and SPCs. Then after, four LSB sites such as Bisidimo from Babile district, and Risqii, Iftu and Iddo Basso from Fedis district were selected based on accessibility, availability of land and water. Similarly, a total of five SPCs were selected based on well organized farmers' cooperatives having legal entity, having adjust/cluster land used for seed production, and interest to engage in seed production in the target area. The description of the selected farmers cooperatives were presented in the following table.

Table 1. The description of the farmers' cooperatives selected from Fedis and Babile districts

Zone	District	Name of site	Name of the Cooperative	Members of MPCs			Year of established
				Male	Female	Total	
East Hararghe Zone	Babile	Bisidimo	*Lelisa Ifadin MPC*	0	78	78	1998
		Risqii	*Madda Risqii MPC*	170	98	268	1999
	Fedis	Iftu	*Jaalala Guddina MPC*	154	30	184	1999
		Iddo-Basso	*Lega Hamaresa MPC*	498	77	575	2000
			Janale Irrigation MPC	67	13	80	2005
	Total			904	299	1203	

Note: MPC indicate Multipurpose Cooperative

Source: Multipurpose cooperative, 2015

Implementation approach

The LSB sites, SPCs farmers and other stakeholders were identified and selected; **consultation meeting and discussions** held for the purpose of having common understanding about the SPCs based production and distribution, the approach and setting action plan. Memorandum of understanding (MoU) was signed between FARC and HU-ISSD Programme which has stated the role and responsibility of each partner in the implementation of SPCs based seed production and distribution in the area. The activity was implemented by involving SPCs farmers, experts from Zone and districts offices of Agriculture and Natural Resource, Cooperative promotion offices, Union, Haramaya University, ISSD programme, and Researchers for coordinating, monitoring and technical support for SPCs in the area.

Capacity building

Training of SPCs farmers and others stakeholders

Training was provided to SPCs farmers, Development agents, experts and other stakeholders to build their technical capacity and helps in enhancing the seed production and distribution techniques in the area. The training was given on quality seed production techniques, diseases and insect management, field clustering, post-harvest handling and marketing, and organizational management.

Knowledge sharing

Field visits, radio program, and field exchange visit were used to promote SPCs based seed production and marketing activities, transfer knowledge and skill on seed production and marketing to enhance learning and experience sharing among farmers, experts, Development Agents and other stakeholders. Moreover, experts, Development Agents, researchers, ISSD innovators and seed inspection committee (from field to laboratory) have been actively involved in follow up and inspection of each SPCs' seed production fields to assure the desire quality seed production in the area.

Input and facility support

Inputs mainly basic seeds of sorghum and maize varieties were provided to the SPCs farmers prior to the planting time. In addition, facilities such as office facilities and farm machineries such as maize sheller, sorghum and wheat threshers, and sealing machine were provided for SPCs in the area.

Seed marketing and distribution

Seed collection, storing, certification, and marketing were facilitated by FARC in collaboration with ISSD programme, Zone and district office of Agriculture and Natural Resources, and Cooperative promotion offices. The produced seeds were sold to the neighbor farmers, Unions, GOs and NGOs operating in the area.

Method of data collection and analysis

Data such as number of farmers participated in seed production, number farmers, experts and DAs participated on training and field visits, quantity of inputs used, area allocated, quantity of seed produced and sold, and farmers perception were collected using checklists through interview and discussions. The collected data were enter into Excel and analyzed using descriptive statistics and narrative.

Results and Discussion

Seed producer cooperatives farmers

A total of five SPCs were involved in seed production and distribution of seeds of locally preferred sorghum and maize varieties during 2012 to 2015 year in the area. The SPCs' name and members involved in seed production and distribution was presented in the (Table 2). The Table 2 shows that a total of 390 farmers (256 male and 134 female) were involved in seed production and distribution activities during 2012 to 2015 in the area. These SPCs are functional in producing and distributing certified seeds of locally preferred varieties of maize, and sorghum in the area.

Table 2. The SPCs farmers involved in seed production and marketing during 2012 to 2015

Name of SPCs	SPCs farmers participated in LSB		
	Male	Female	Total
Lelissa Ifadin MPC	0	78	78
Jaalalaa Guddina MPC	82	6	88
Madda Risqi MPC	43	5	48
Laga Hammaressa MPC	30	2	32
Jenale Irrigation MPC	33	8	41
Total	256	134	390

Source: Our results, 2015

Capacity building and knowledge sharing

The SPCs have to follow the desired technical requirements for quality seed production of farmers preferred crop varieties. In line with this, the SPCs farmers, agricultural experts, cooperative experts, Development agents and other stakeholders were trained on quality seed production techniques, field clustering and management, basic agronomic principles in quality seed production, Post-harvest seed handling, linkage and marketing promotion and cooperative organizational management (principles, financial management and record keeping). Accordingly, a total of 120 SPCs farmers (95 male and 25 female), 13 DAs, and 26 experts/SMS from Zonal and district offices of agriculture, and cooperative promotion offices, and 37 experts received training on the above mentioned topics.

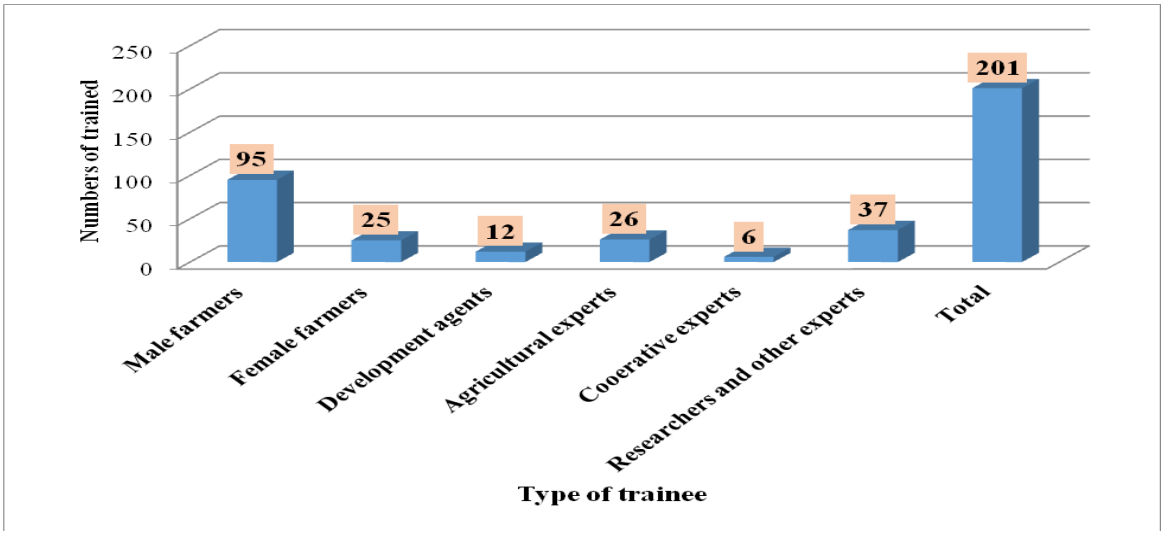


Figure 1. Number of farmers and other stakeholders trained on seed production and marketing
Source: Our results, 2015

In addition, field visits and experience sharing eventswere organized in Babile and Fedis districts with objectives to promote SPCs based seed production and sharing experiences and knowledge among the participants. Various stakeholders and partners from East Hararghe Zone, Fedis and Babile districts were participated and they visited SPCs based seed production activities implemented in the area. Accordingly, a total of 200 male farmers, 67 female farmers, 20 DAs, 18 experts from Zonal and district level offices and 24 researchers and experts from other stakeholders and partners were participated and visited the SPCs based seed production activities. In addition, exchange visits were also organized for sharing experiencing on seed production, and marketing, and a total of 25 SPC farmers and 8 experts were visited seed produce farmers at Kersa and Haramaya districts.

Moreover, a radio program also used to promote and transfer the experience of SPCs based seed business activities in the area. Accordingly, in collaboration with HU-ISSD programme, a radio programme "Producing Improved Seeds for Quality life" was organized to promote SPCs based seed business activities implemented in the area. The researchers and experts also provided extension and advisory services for SPCs farmers during coordination and field monitoring, and by communications in phone.As a result, the SPCs farmers, DAs and experts have increased their awareness and knowledge on quality potato seed production techniques and marketing.

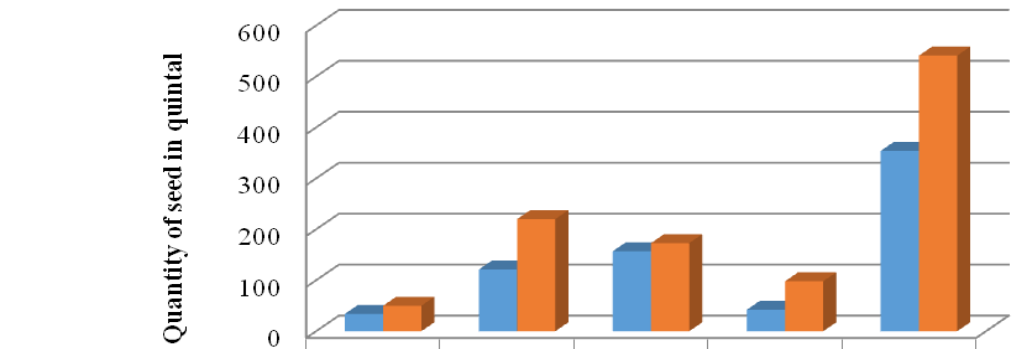
Role of farmers and other stakeholders

The SPCs farmers play a significant role starting from input allocation (land, labor and fertilizer), planting, managing the fields, harvesting to marketing of the produced certified seeds of sorghum and maize. Providing capacity building through training and experience sharing for SPCs and stakeholders, access to basic seeds and post-harvest technologies such as threshing and shelling machines, facilitating field supervision and coaching were performed by FARC and HU-ISSD. The SPCs farmer, DAs, and experts from office of agriculture, and researchers have been involved in field clustering, follow up and

field inspection to assure the desire quality of seed production in the area. Facilitating seed certification and looking for buyer for produced seeds were also performed by FARC, HU-ISSD, Zonal and district office of agriculture and district cooperative promotion office.

Seed production and dissemination

Basic seeds of improved maize (Melkasa-2, Melkasa-4 and Melkasa-6 varieties), and sorghum (Gubiye, Hormat, Teshale, and Abshir varieties) were provided by Fedis Agricultural Research Center to the SPCs farmers in the areas. Accordingly, a total of 8.5 quintals of basic seeds of sorghum varieties and 10 quintals of maize varieties were supplied to the SPCs farmers and produced on 46.5 and 37 ha of land, respectively through participating 390 farmers (256 male and 134 female) in Fedis and Babile districts during 2012 to 2015 production years. The SPCs have resulted in production of about 541 and 354 quintals of maize and sorghum seeds produced and distributed by SPCs during 2012 to 2015 cropping seasons (Figure 2).



	2012	2013	2014	2015	Total
Maize seed produced	34	121	157	42	354
Sorghumseed produced	50	220	173	98	541

Figure 2. Amount of seed produced and distributed (in quintal) by SPCS from 2012 to 2015
Source: Our computation, 2015

Seed marketing and promotion

Each maize seed producing SPCs was allocated, on average 9.25ha of land and produced and marketed about 213.6 quintal of quality maize seed. Similarly, each sorghum seed producing SPCs was allocated, on average, 11.6ha of land and produced and marketed about 109.5 quintal of quality sorghum seed for income diversification (Table 3). In the area, all the seed produced by SPCs was sold locally, and the average price for maize and sorghum Birr 1200 and 1300 per quintal, respectively. These prices are higher than the grain price (for maize and sorghum Birr 700 and 800 per quintal, respectively) at planting time in the area.

Table 3. Area cultivated, seed production and revenues by SPCs during 2012 to 2015

Descriptions	Maize	Sorghum
Number of active SPCs	3	3
Total area allocated(ha)	37	46.5
Average area (ha/SPCs)	9.25	11.6
Total production (quintal)	541	354
Average production (quintal/SPCs)	213.6	146
Average production (quintal/year)	160.25	109.5
Average productivity (quintal/ha)	26	20
Average price (Birr/quintal)	1200	1300
Average gross revenue (Birr/ha)	25200	26000
Average gross revenue (Birr/SPCS)	256,320	189,800

Source: Our computation results, 2015

In addition to producing and distributing of seeds, the SPCs were involved in buying and selling activities of locally demanded improved crop varieties requested by farmers, GOs and NGOs in the area. Example, the SPCs purchased a total of 900 quintals seed of improved sorghum, maize and potato varieties from locally seed producer farmers groups, and other Cooperatives and sold to farmers, GOs and NGOs in the area. From buying and selling activities, the SPCs earned about 240,000Birr/year and they said that seed business is profitable compared to grain production in the area.Thus, seed business has a positive impact on income of the farmers and thereby promoting improved technologies in the area.

Benefits from SPCs based seed production and marketing

The benefit of the SPCs based seed production and marketing ranges from dissemination of improved crops and varieties, knowledge and skills enhancement to improved incomes of the farmers. More specifically, the SPCs have advantages, such as access to quality basic seeds, earning cash by selling the seeds to GOs, NGOs and other farmers in the areas can have better access to quality seeds of improved varieties of sorghum and maize. The SPCs also play significant roles in dissemination of seeds of improved sorghum and maize varieties to the nearby farmer in the area. Because, the SPCs the produced seeds of sorghum and maize varieties were supplied locally to the farmers in the area. In addition, a total of 390 SPCs farmers were directly involved and benefited from the seed business. And also seeds produced by SPCs were disseminated to a total of 2060 farmers during 2012 to 2015 cropping seasons in the area. This has helped mainly the small holder farmers to easily access seeds of farmers' preferred improved varieties. As a result of tolerance to moisture stresses, early maturing and high yielding varieties of maize and sorghum were promoted through SPCs and access to improved seeds of these crops improved in the area. In addition, the SPC farmers expressed their satisfaction with seed production and marketing is profitable with average revenue of Birr 256,320 and 189,800 per year for maize and sorghum, respectively. So, they are willing to continue to producing and marketing of improved seeds in the area.

Furthermore, the farmers', DAs and experts' awareness on quality seed production, post-harvest handling, marketing and market linkage improved in the area. The knowledge and skill of the SPCs farmers on quality seed production and marketing were improved through training, field visits and experience sharing. As a result the SPCs producing, buying and selling of locally demanded improved seeds requested by farmers in the areas.

Conclusions and Recommendations

Cooperative farmers based seed production and marketing was implemented in ***Fedis and Babile districts of Eastern Hararghe Zone*** of the Oromiya region during 2012 to 2015 cropping seasons ***with objectives of*** improving availability and sustainable supply of quality seeds of improved varieties of sorghum and maize crops at farmers level through Scaling-up Local Seed Business (LSB) project. The LSB basically involves in supporting SPCs for production and supply good quality seed locally demanded crop varieties. Accordingly, a total of five SPCs farmers involved in local seed business with 390 members who produce seeds and supply seeds of maize and sorghum varieties in the area. A total of 879 quintals of sorghum and maize seeds produced and disseminated by the SPCs farmers during 2013 to 2015 cropping seasons. Therefore, to ensure SPCs based seed production and distribution, it is suggested to enhance the SPCs farmers' on seed post-harvest handling and value addition, access to finance, and link them with seed distribution system existed in the area for sustainable supply of seeds of farmers' preferred varieties in the area.

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Pre scaling up of Improved Maize (BH661) Variety: The Case of West and kellam Wollega Zones of Oromia National Regional State, Ethiopia

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Abstract

Maize is an important cereal crop in west and kellam Wollega zones. It plays greater role in ensuring food security and holds huge percentage of cultivable cereal crop. Therefore, the study was designed to promote and disseminate improved variety of maize BH661 in the study area. The operational sites of the study were Guliso and Nedjo districts from west Wollega zone whereas Hawa Gelan, Dale Sedi, and Seyo, districts from kellem Wollega zone. Selection of farmers was made purposively based on their representativeness of the majority of farmers, their interest in carrying out the recommended management practices, land ownership and other important socio economic variables. After farmer's selection, each farmer was given BH661 variety of maize seed which can grow on 0.25ha of land. To enhance farmer's knowledge on maize production training was given for target community on agronomic practice of maize. During training a total of 158 farmers out of whom 9 were female and a total of 157 experts out of whom 12 were female have attended training. The study addressed a total of 139 farmers out of whom 35 were female from the study area. An average productivity of 57.2 qt/ha was collected. A total of 7950.8 quintal of maize production was harvested during project life span. Finally, farmers' feedback concerning maize was collected and incorporated. Accordingly maize BH661 has its 'own merit and demerit. Woreda Agriculture and natural resource office in collaboration with other stakeholders should hold the turn for the full scale up of the maize BH661variety.

Key words- *Farmers Feedback, FREG, Grain yield, Maize*

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 is also used as feed for animal at different growth stage in the form of the silage at young stage and its residue is used as an important source of feed for animals. 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 consume 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 (Van den & 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 exposed to evaluate technologies under their existing system of production. As a result dissemination and adoption rates of many technologies popularized so far was not impressive. Furthermore, technologies from research station failed to fulfill farmers' technology selection criteria; hence adoption rate become low (Abera, 2004). In line with this, Haro Sabu 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. More over that, 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 technology was done by the center.

Objectives

1. To disseminate the already proved and verified productive maize Variety
2. To provide farmers with alternative improved high yielding maize Variety
3. To strength linkage among farmers and agricultural experts

Materials and Methods

Description of the study areas

West Wollega is one of the Zones in Oromia region and bordered on the west by Kellam wollega, on the north by the Benishangul-Gumuz region on the east for a short space by East Wollega, and on the southeast by Illubabor

Nedjo

Location and Area

Nedjo district is located in the North eastern part of west wollega Zone at a distance of 75 Km away from Zonal Capital (Gimbi).Astronomically the district is located between $9^0 37^{-1} 9^0 44^1$north latitude and $35^0 14^{1-} 35^0 40^1$ east longitude. It is bounded by Beneshangul Gumuz regional state in the East, Mena Sibu district in the North West, Jarso district in the west and Boji district in the south and south east .Generally the district has a total area of 958 $Km.^2$ Average annual temperature of the district is about 23 C^0 while average annual rain fall of the district is 13,000-17000mm.The district is characterized by slightly ups and downs topographic land feature having relative's plains, few hills and lots of rivers.

Guliso

Guliso is one of 19 districts of West Wollega Zone, with the capital located at 490 km West of Addis Ababa. It has an estimated area of 631.90square km; it is bounded by Boji Chokorsa in the northeast, Gawo Dale in the west, Aira in the south and Lalo Asabi in the east. Total human population of the

district is estimated at 91,471 of whom 45,525 were male and 45,946 were female. Of the total households 89.5 % is rural agricultural households (GWAO, 2016). The district has a total of 28 kebeles, of which 26 are rural based peasant associations and 2 are urban dwellers Associations Kebeles. From total rural passant associations 18 of them categorized to mid highland agro-ecology and 8 kebeles allocated to lowlands agro-ecology. The altitude of the Woreda varies from 1650 meters to 1700 meters above sea level.

It receives average annual rainfall of 720 mm and has an annual temperature range of 9^0c-18^0c. In terms of agro-ecology, the district is categorized as weina dega (69%) and lowland (kola) (31%) (Fanos, 2012). The soils types in the district are predominantly red (58%), black (32%) and mixed (10%).

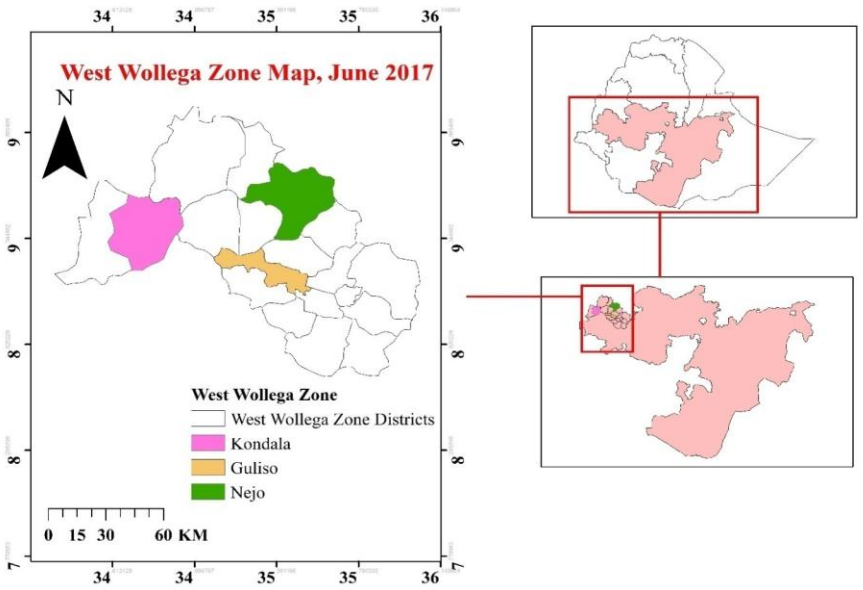

Fig 1: Map of West Wollega Zone

Kellam Wollega Zone

Kellam Wollega is one of the zones of the Oromia Regional State This zone is named after the former province of Wollega, whose western part lay in the area Kelam Wollega now occupies.

Dale sadi district

Dale sadi is situated at about 550 km West of Addis Ababa. It is bordered by: Illubabor to the South, Dale wabera to the West, Aira to the North and Lalo kile to the East. The area lies between 08°N 25 56 to 08°N 58 05 and 034°E 33 41 to 035°E 28 48 and has average altitude of 1150 meters above sea level. The area has temperature range of 33-35°C with more agricultural crops and people in rural of the country. The climatic condition alternates seasons from March to April. The winter dry seasons (November to February) with mean annual rain fall of 1200mm

Sayo

Seyo is one of the woredas in the Oromia Region of Ethiopia. This Woreda received its name from the name of the Oromo tribe (Sayyoo') that settled it first; Dembidolo which is city administration now is part of the Kellem Wollega Zone. Sayo is bordered on the south by the Gambela Region, on the west by Anfilo, on the north by Yemalogi Welel. On the northwest by Hawa Gelan, and on the east by the Birbir River which separates it from the Zone. Coffee is an important cash crop of this Woreda. Over 50 square kilometers are planted with this crop.

Hawa Gelan

Hawa Gelan is one of the woredas in the Oromia region of Ethiopia. It is bordered on the south and southwest by Sayo, on the north by Yemalog wolal, on the northeast by Dale wabera, and on the south and southeast by the Ilubabor zone. The administrative center of this woreda is Gaba Robi.

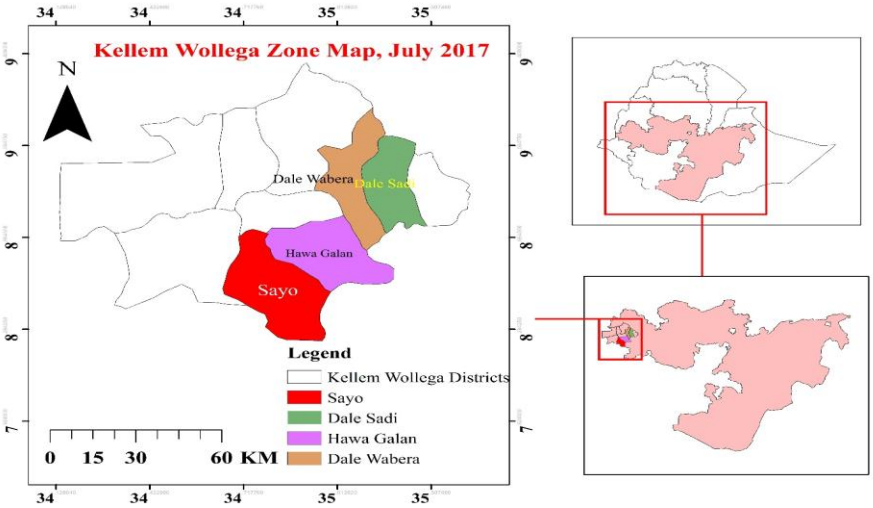

Fig 2: Map of Kellem Wollega Zone

Site and farmer selection

Five districts were selected purposively based on their maize production potential. From each districts potential kebeles were again selected purposively based on their potential for maize production. Before starting field work, formation of FREG (farmers research extension group) were made purposively based on their representativeness of the majority of smallholder farmers, their interest and motivation in carrying out the recommended management practices (timely weeding, roughing, harvesting on time) land ownership and their commitment to deliver the technology to other farmers by considering the gender balance and other important socio economic variables.

Seed distribution

After farmers selection had made by the researchers and DAs in respective kebeles, each farmers were given seed which can cover 0.25 ha of land for consecutive two cropping calendar of production (i.e. 2015-2016). The study addressed a total of 139 farmers in the two years of the project span.

Result and Discussion

Training on maize Production and Management Practices

Training was one of the most important FRG approach used. It is meant to introduce a new way of doing things and/or to fill observed gap in performance or undertaking some agricultural activity. Training was given for farmers and agricultural experts. Training on maize production, management practices and post harvest handling were given in 2008 and 2009. This includes both theoretical and practical types of training. The table below illustrates the number of farmers and experts participated on the training during project life span.

Table 1: Training of participants by category

Year	Participants						
	Experts (DA + SMS)			Farmers			Subtotal
	Male	Female	Total	Male	Female	Total	
2008	42	4	46	106	9	115	161
2009	107	8	115	43	5	48	163
Grand total	149	12	161	149	14	163	**324**

As it is indicated in above table to enhance farmer's knowledge on maize production training was given in 2008 and 2009 which covered a total of 324 target community and experts at woreda level. Among them 26 were female and the remaining 298 were male.

Seed distributed

Table 2: Amount of seed distributed to the beneficiaries

No	District	Kebele	FREG Members	Amount of seed distributed	Total
1	Seyo	Tabor	20	6.25/Farmer	1.25qt
2	H/Galan	Hawa mo'i	20	6.25/	1.25qt

3	D/Sadi	A/Birbir and Immo	39	6.25/Farmer	2.4qt
4	Guliso	Guji worabu	20	6.25/Farmer	1.25qt
5	Nedjo	Gida kumbi and W/Gida	40	6.25/Farmer	2.5qt
Grand total					8.65qt

During project life span a total of 8.65qt of improved maize BH661 variety was distributed for farmers of selected kebeles based on the size of FREG members.

Yield performance of BH661 maize over locations.

Yield of BH661 Maize variety was collected from FREG members in both years from both zones. Based on the result of data collected average yield of maize (BH661) is presented as fallow using graph over locations.

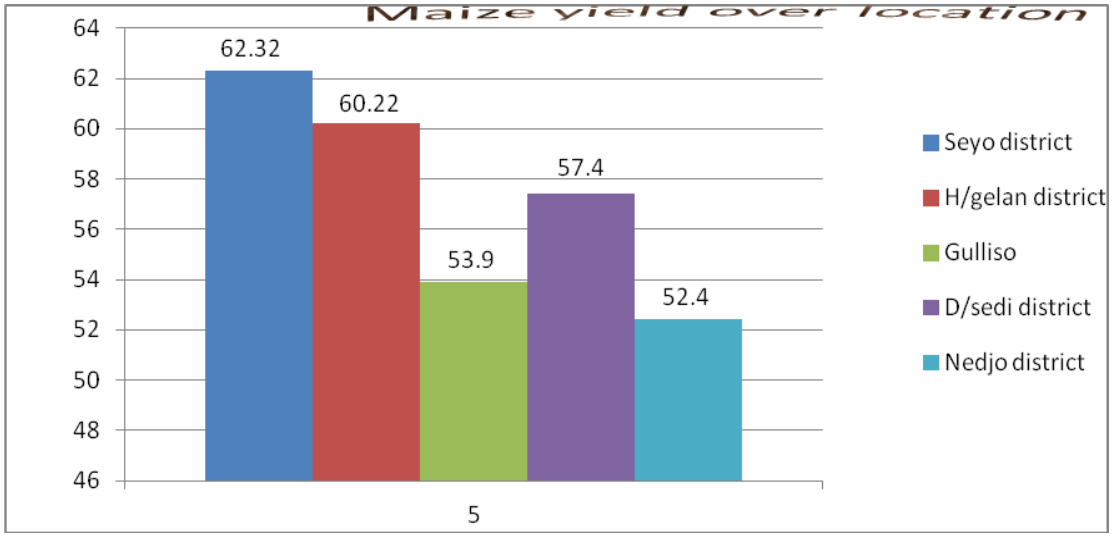

Fig 2:- yield of maize over location (BH661).
Source: own data computation

The above figure shows that the average yield of maize (BH661) varies across locations. The average yield of maize at Seyo district is relatively high with magnitude of 62.32qt/ha fallowed by H/gelan, D/sadi, Gulliso and Nedjo districts with magnitude of 60.22,57.4, 53.9 and 52.4 qt/ha, respectively. The overall average yield of maize was 57.2 qt/ha.

Farmers' feedback about maize BH661

Farmer's feedback assessment was collected in collaboration with DAs and researchers concerning this maize variety. Accordingly Farmers provided different feedback for this maize. The following feedback assessment matrix indicates the recorded farmers' opinion toward the provided maize variety (BH661).

Table 3: Farmers' feedback

Variety	Feedback Forwarded	
BH 661	Merit	Demerit
	High yielder	Growing of non productive false ear on Mother cob
	Resistant to major diseases	
	Demanded	Need fertile soil relative to other varieties
	Have good test and eye quality	Lodging
	Suitable to mix with other crop for consumption	Mostly one ear per plant
	Adopted to agro ecology of both zone	

Economic return to farmers

West and kellem wollega farmers were benefited from this project in two dimensions. The first dimension was during input purchasing they bought the seed with big discount of 75% of other sectors providing the same varieties. Second Farmers who were members of FREG were given seed of 8.65 qt (within two years) from which they produced an average yield of 7950.8 quintals during this project life span. This would contribute huge in ensuring food security and improving the livelihood of farmers in target area. As result the demand of farmers were increased to use this maize variety during the project life span.

Conclusion

The yield of maize (BH661) over these locations varies. Accordingly the average yield of maize BH661Variety at Seyo district is relatively high with magnitude of 62.32qt/ha fallowed by H/gelan, D/sadi,Gulliso and Nedjo districts with magnitude of 60.22,57.4, 53.9 and 52.4 qt/ha respectively. The overall average yield of maize was 57.2 qt/ha and the average total yield of 79550.8 quintals were obtained from the project. In order to enhance farmer's knowledge on maize production training was given for different stake holders; accordingly training was given in 2008 and 2009 which covered a total of 324 target communities. Among them 26 were female and the remaining 298 were male. An important part of this maize dissemination was farmer's feedback concerning this variety which was collected from different stake holders, accordingly maize BH661 do have its merit and demerit, some of its merit views of farmers were high yielder, resistance to major disease, highly demanded, have good test and eye quality, adopted to agro ecology of both zone and the demerit views of farmers were growing of non productive false ear on mother cob, Need fertile soil relative to other varieties, lodging, and mostly one ear per plant.

Recommendation

The project was carried out with full participation of FREG farmers and it was conducted on 139 farmers' field, generally since the maize provided got more positive feedback from farmers we recommend agricultural and natural resource office at woreda and zonal levels in collaboration with other stakeholders should work on the wider scaling up of this technology.

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Pre scaling up of Balo Cultivar of Sweet Potato: In Case of West and kellam Wollega zones of Oromia National Regional state.

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Abstract

Sweet potatoes are an important traditional food crop in Ethiopia, valued by farmers for their versatility, high caloric content, and taste. Sweet potatoes are also a resilient food security crop that can withstand drought, low soil fertility, and high levels of rainfall. Therefore, the study was designed to promote and disseminate improved variety of Balo cultivar of sweat potato in the study area. The operational sites of the study were Guliso from west Wollega zone whereas, D/ Sedi and D/Wabera, districts from kellem Wollega zone. Selection of farmers was made purposively based on their representativeness of the majority of farmers, their interest in carrying out the recommended management practices, land ownership and other important socio economic variables. After farmer's selection, each farmer was given Balo cultivar of sweat potato cutting which can grow on 0.25ha of land. To enhance farmer's knowledge on sweet potato training was given for target community on agronomic practice of sweat potato. During training a total of 90 farmers out of whom 20 were female and a total of 24 experts out of whom 5 were

female have attended training. The study addressed a total of 60 farmers out of whom 16 were female from the study area. An average production of 291.2qt/ha and a total of 873.56qt quintal of sweat potato yield was harvested during project life span. Finally, farmers feedback concerning technology was collected and incorporated, accordingly the farmers feel as the Balo cultivar have not god taste, but they were trained on how to improve its taste by removing leaf of plant early fifteen days before harvesting. Woreda Agriculture and Natural resource office in collaboration with other stakeholders should hold the turn for the full scale up of the technology.

Key words: *Balo, FREG, Farmers Feedback, Sweat potato, Pre scaling up*

Introduction

Sweet potato is one of the twelve principal plant species utilized as a human feed throughout the world. It can be cultivated in many different climatic conditions; and as a result large areas of sweet potato are cultivated in Asia, Africa, Europe, America and Oceania (Paneque Ramirez, 1991). It is also one of the most widely grown root crops in SSA, it is particularly important in countries surrounding the Great Lakes in Eastern (Vital Hagenimana, 1999) and Central Africa, in Angola, Madagascar, Malawi and Mozambique in Southern Africa, Nigeria in West Africa and China being the largest producer worldwide. In Africa, it is grown predominantly in small plots by poorer farmers and hence known as the poor man's food (Ermias et al, 2013). According to Ermias et al (2013) the sweet potato, Ipomoea batatas (Lam.) is a dicotyledonous plant that belongs to the family Convolvulaceae, and a tuberous root crop important for food security. Globally it is among the important food crops in the world, after wheat, rice, maize, Irish potato, and barley and it ranks second following Irish potato in the world's root and tuber crops production and third after Irish potato and cassava in consumption in several parts of tropical Africa (Teshome et al., 2012).

Ethiopia ranks fifteenth in the world in terms of sweet potato production (Dan et al, 2013). Sweet potatoes are an important traditional food crop in Ethiopia, valued by farmers for their versatility, high caloric content, and taste. Sweet potatoes are also a resilient food security crop than can withstand drought, low soil fertility, and high levels of rainfall. Sweet potatoes are grown both in the short rainy season (February through April) and the long rainy season (July through September). Sweet potatoes are grown mainly in the southern, southwestern, and eastern parts of Ethiopia, where the climate is warm and humid. One of the constraints facing crop production and productivity is unavailability of improved seeds. In relation to this majority of Sub-Saharan African countries are unable to utilize the result of crop improvement works at different agricultural centers (Girma Abera, et al., 2004). Improved and high yielding varieties of sweet potato have been developed by different research centers to improve farmers' production and income by enabling them adopt high yielding, adaptable and disease resistant varieties. For this reason, Haro Sabu Agricultural Research Center has evaluated and recommended top performed varieties for demonstration After that demonstration was done on farmers field and FTC 's to further verify the technology and recommended Balo cultivar of sweet potato to be popularized and disseminated on large scale.

Objectives

1. To disseminate the already proved and verified productive sweet potato Cultivar
2. To provide farmers with alternative improved high yielding sweet potato Cultivar
3. To strength linkage among farmers and agricultural experts

Methodology

Description of the study areas

The trial was carried out during 2015 and 2016 cropping seasons in Dale Wabera, Dale Sedi and Guliso districts in collaboration with District Agricultural and natural resource offices. D /sadi and D/wabera district are among districts found in kellam wollega zone, where as Gulliso district is one of districts found in west wollega zone.

Guliso district

Guliso is one of 19 districts of West Wollega Zone, with the capital located at 490 km West of Addis Ababa. It has an estimated area of 631.90square km; it is bounded by Boji Chokorsa in the northeast, Gawo Dale in the west, Aira in the south and Lalo Asabi in the east. Total human population of the district is estimated at 91,471 of whom 45,525are male and 45,946 were female. Of the total households 89.5 % is rural agricultural households (GWAO, 2016). The district has a total of 28 kebeles, of which 26 are rural kebeles and 2 are urban dwellers Kebeles. From total rural kebeles 18 of them were categorized to mid highland agro-ecology and 8 kebeles were allocated to lowlands agro-ecology. The altitude of the Woreda varies from 1650 meters to 1700 meters above sea level. It receives average annual rainfall of 720 mm and has an annual temperature range of 9^0c-18^0c.

Dale sadi district

Dale sadi is situated at about 550 km West of Addis Ababa. It is bordered by: Illubabor to the South, Dale wabera to the West, Aira to the North and Lalo kile to the East. The area lies between 08°N 25 56 to 08°N 58 05 and 034°E 33 41 to 035°E 28 48 and has average altitude of 1150 meters above sea level. The area has temperature range of 33-35°C with more agricultural crops and people in rural of the country. The climatic condition alternates seasons from March to April. The winter dry seasons (November to February) with mean annual rain fall of 1200mm

Dale wabera district

Dale Wabera district is situated at about 570km west of Addis Ababa, Western Ethiopia, and The altitude of the area ranges from 1100 to 1800 m.a.s.l. The mean minimum and maximum temperature of district are 11.0–15.5°C and 26.1–34°C, respectively. The Agro ecology of woreda varies between long summer rain fall (June to September) and winter dry season (December to March) with annual rainfall ranging from 1300 to 1600 mm. The livelihood of the society largely depends on mixed livestock and crop production. The total land cover of the district is about 1132.02 km

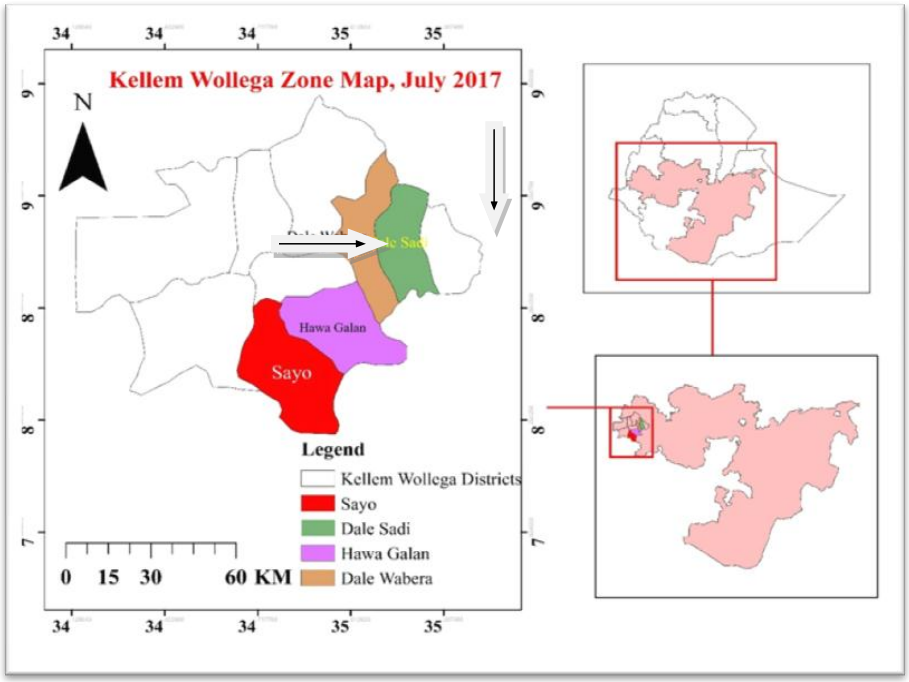

Figure 1: Map of Kellem Wollega Zone

Site and farmer selection

It was scaled out on 25 representative farmers' field in the first year in three woredas; Guliso woreda from west wollega and the other two woredas namely Dale sedi and Dale Wabera were from kellem wollega. In 2015 crop production year it was distributed for 35 households in these three woredas. Necessary management and monitoring was also performed properly. To achieve the above mentioned objective sites were selected based on sweet potato production with woreda agricultural expert and development agents. Before starting field work, formation of FREG (Farmers Research Extension Group) were made purposively based on their representativeness of the majority of smallholder farmers, their interest and motivation in carrying out the recommended management practices (timely weeding, roughing, harvesting on time) land ownership and their commitment to deliver the technology to other farmers by considering the gender balance and other important socio economic variables.

Result and Discussion

Training of farmers and development agents

Training was given for the target community on sweet potato production and management. Manuals were prepared and distributed for farmers and Development Agents. The training given covered a total of 24 experts and 90 farmers among them 25 people were females.

Table 1: Training on sweet potato Production and Management Practices

Locations	**Farmers**			**Experts**		
	Male	Female	Total	Male	Female	Total
Guliso	26	4	30	6	2	8
Dale Sedi	22	9	31	6	1	7
Dale Wabera	22	7	29	7	2	9
Total	70	20	90	19	5	24
Grand total						114

Seed distribution

After farmer's selection was made by the researchers and DAs in respective peasant associations, each farmer was given cutting of Balo which can cover 0.25 ha of land for consecutive two years of production. The study addressed a total of 60 farmers in the two years of the project span.

Yield performance of Balo over location

In 2007 and 2008 cropping season a total of 873.56 quintal of Balo sweet potato was produced by the FREG farmers from the total land covered. The average productivity of *Balo* variety in these three woredas was **291.2** quintal per hectare.

Table 2:-Average yield of Balo over locations.

Districts where sweet potato were scaled up	Sex of the household			Age group of the household			Average Yield obtained from hectare in quintal
	Male	Female	Total	Adult	Youth	Total	
Guliso	19	7	26	20	5	25	299.56
Dale sedi	15	5	20	18	4	22	289
Dale Wabera	10	4	14	10	3	13	285
Total	44	16	60	48	12	60	873.56qt

The above figure shows that the yield of Balo in Guliso district is higher with average magnitude of 299.56qt/ha fallowed by D/sadi and D/wabera with magnitude of 289 and 285 qt/ha, respectively.

Farmer's feedback concerning Balo cultivar of sweat potato

Farmer's feedback about Balo cultivar of sweat potato was collected and conceptually generalized. Accordingly, the cultivar was productive and highly adoptable to the agro ecology of the areas. However, the farmers criticized the technology by it taste, majority of farmers disliked the taste of Balo cultivar of sweat potato. But Training was given to farmers on how to improve its tastes by removing the leaf of plant 15 day before harvesting. After that many farmers liked the cultivar and want to produce it.

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Conclusion

Prescaling up of Balo cultivar of sweet potato was conducted in Guliso, D/sadi, and D/wabera woredas of Kellam and west wolega zones.The Project covered a total of 15 ha of lands from which a total of 873.56 qt/ha and average productivity of 291.2qt/ha was harvested. During project life span a total of 60 households where adressed and Training was given for target community on sweet potato production and managent especialy on how to improve the taste of Balo cultivar of sweet potato. Generally since it is difficult to address all farmers through the effort of center only, we recommend agricultural and natural resource offices of respective woredas and other stakeholders should take the responsibility for wider scaling up.

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Pre-extension Demonstration and Participatory Evaluation of Improved Haricot Bean Varieties in West and Kellam Wollega Zones

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Abstract

The trial was carried out during 2008 and 2009 cropping seasons in Dale Sedi and Dale Wabera woredas from kellem Wollega and Gulisoworeda from west wollega zones by selecting potential kebeles from each woreda based their haricot bean production potentials. Three varieties (Icap 0056, GLP 2 and Nasir) with local check were evaluated with the objective of selecting adaptable and best performing Haricot variety/ies with full participation of FRG member farmers under their management condition. The spacing between plants and rows were 10cm and 40cm, respectively. Each experimental plot had 10m x10m with a gross area of 100 m^2. Plant height, number of pod per plant, number of seed per plant and grain yield was recorded to evaluate the performance of varieties under experiment. Analysis of variance was done to see the variation among varieties across Woredas and the combined analysis of the Woredas was undergone. Accordingly the mean grain yields of Icap 0056, GLP-2, Nasir and local check varieties were 19.9,16.72,14.30,and 12.30 qt/ha, respectively. The combined analysis of variance over these woredas revealed that varieties were significantly varied for yields and not significantly varied in other agronomic trait considered in the trial. Farmers evaluated and gave rank for these varieties by setting their awn criteria; accordingly they selected Icap 0056 as a first rank by all criteria (Grain yield, grain quality, very good for consumption and demanded at local market) Nasir as second rankby criteria's (Long shelf life without deterioration, marketability, and variety brilliance) and GLP-2 ranked third by criteria's (Grain yield, Low variety brilliance, and susceptible to disease). Training was given for farmers and other agricultural stakeholders.. Hence based on objectively measured agronomic trait and farmer's preference varieties Icap 0056 and Nasir were selected to be popularized on large scale on farmer's fields.

***Key words**: Evaluation, Farmers, Feedback, Haricot bean, Grain Yield.*

Introduction

Haricot bean (Phaseolus vulgaris L) is widely grown in Ethiopia in areas between 1400-2000 m altitudes (Ali et al, 2006). It is produced primarily in tropical low-income countries, which accounts for over three quarters of the annual world production. Economic significance of common bean in Ethiopia is quite considerable since it represents one of the major food and cash in many parts of the country where it is consumed in different types of traditional dishes (Habtu, 1994). The importance of the common bean cannot be overemphasized. Apart from providing the subsistence need such as food to many people in the world (CIAT, 2004), beans are also sold in local markets and urban areas to provide cash to farmers and traders. They are the leading grain legume crop taking up 30% of the total pulse production and grown on more than 14 million hectares worldwide (Singh, 2001). Of the five domesticated species of Phaseolus,

the common bean (P. vulgaris) is the most widely grown, occupying more than 85% of production area sown to all Phaseolus species in the world (Singh, 2001). The estimated production area and yield of common bean in Ethiopia in 2016 cropping season were 211292.30 hectares and 3579424.69 quintals, with change in production of 8.66 compared with the previous year (CSA, 2016). In Ethiopia, population is growing in more rate than the agricultural production does. To feed this increasing population the agricultural production should grow accordingly with the same pace or even more. Pulses crops are the most important crops in the national strategy of food self-reliance and foreign exchange earnings.

Therefore, to increase the productivity of the farmers, it is crucial to increase the awareness of farmers towards the usage of different improved technologies that increase their production and accelerate food security through proper implementation. Access to new and improved agricultural technologies is limited in Kellem and West Wollega zones of Oromia due to remoteness from the center and inaccessibility of improved agricultural technologies in the areas. The potential of pulse crops is not exploited in this part of the region due to lack of improved varieties, poor management practices, biotic factors (weeds, diseases and insect pests),and a biotic factors (soil acidity**,** high intensity and long duration of rainfall).

By recognizing these problems Haro sabu agricultural research center conducted adaptation trial on different haricot bean varieties and recommended the top performed varieties to be evaluated under farmers management conditions. Therefore, to overcome the above stated problems and to acquaint smallholder farmers with new technologies of widely grown haricot bean production, the well-performed and high yielding haricot bean varieties were tested and identified under farmer's management condition by Haro Sabu Agricultural Research extension team beside farmers.

Objectives

1. To demonstrate and evaluate the best performing haricot bean varieties under farmer management condition
2. To create awareness on importance of haricot bean production
3. To create linkage among agricultural stakeholders

Methodology

Description of the study areas

The trial was carried out during 2015 and 2016 cropping seasons in Dale Wabera, Dale Sedi and Guliso Woredas based on their haricot bean production potentials in collaboration with Woreda Agriculture and Natural resource offices. Dale sadi and Dale wabera woredas are among woredas found in kellam wollega zone, where as Gulliso woreda is one of woredas found in west wollega zone.

Guliso district

Guliso is one of 19 woredas of West Wollega Zone, with the capital located at 490 km West of Addis Ababa. It has an estimated area of 631.90square km; it is bounded by Boji Chokorsa in the northeast, Gawo Dale in the west, Aira in the south and Lalo Asabi in the east. Total human population of the Woreda is estimated at 91,471 of whom 45,525are male and 45,946 were female. Of the total households

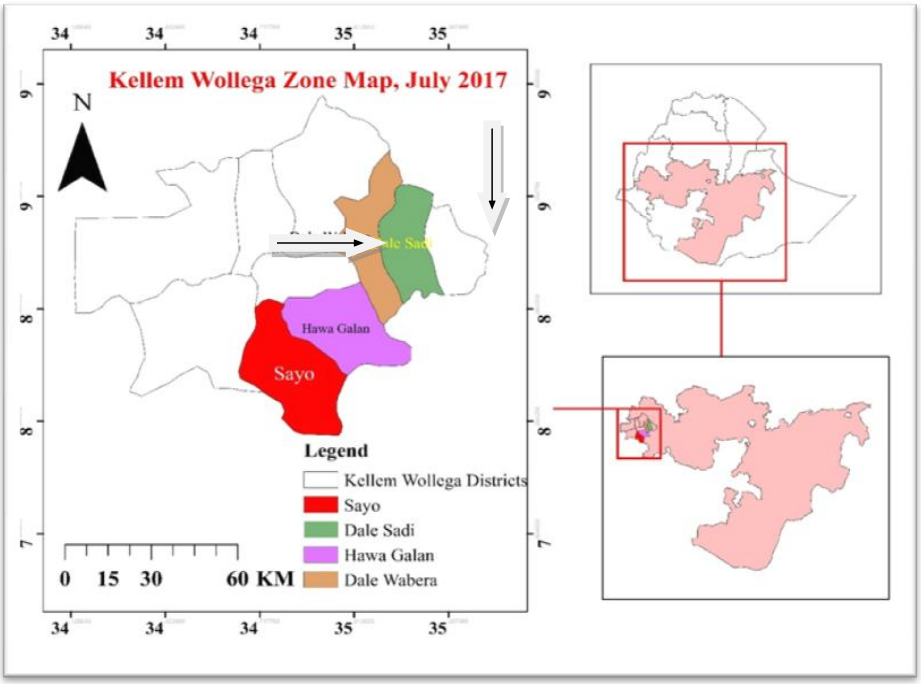
89.5 % is rural agricultural households (GWAO, 2016). The Woreda has a total of 28 kebeles, of which 26 are rural based peasant associations and 2 are urban dwellers Associations Kebeles. From total rural passant associations 18 of them categorized to mid highland agro-ecology and 8 kebeles allocated to lowlands agro-ecology. The altitude of the Woreda varies from 1650 meters to 1700 meters above sea level. It receives average annual rainfall of 720 mm and has an annual temperature range of 9^0c-18^0c.

Dale sadi district

Dale sadi is situated at about 550 km West of Addis Ababa. It is bordered by: Illubabor to the South, Dale wabera to the West, Aira to the North and Lalo kile to the East. The area lies between 08°N 25 56 to 08°N 58 05 and 034°E 33 41 to 035°E 28 48 and has average altitude of 1150 meters above sea level. The area has temperature range of 33-35°C with more agricultural crops and people in rural of the country. The climatic condition alternates seasons from March to April. The winter dry seasons (November to February) with mean annual rain fall of 1200mm

Dale wabera district

Dale Wabera Woreda is situated at about 570km west of Addis Ababa, Western Ethiopia, and The altitude of the area ranges from 1100 to 1800 m.a.s.l. The mean minimum and maximum temperature of Woreda are 11.0–15.5°C and 26.1–34°C, respectively. The Agro ecology of woreda varies between long summer rain fall (June to September) and winter dry season (December to March) with annual rainfall ranging from 1300 to 1600 mm. The livelihood of the society largely depends on mixed livestock and crop production. The total land cover of the Woreda is about 1132.02 km.



Materials Used

Three improved varieties of haricot bean namely; ICUP 0056, Glp-2 and Nasir, with local check were tested for their yield performance as well as agronomic practices with full participation of farmers in the study areas. The spacing between seed and rows were 10cm and 40cm respectively. Each experimental plot had 10mx10m with a gross area of 100 m^2.

Site and farmers selection

To achieve the above mentioned objective sites and farmers were selected with the Woreda agricultural and natural resource offices which suit our demonstration project. Accordingly potential Woredas were selected based on their haricot bean production. From each Woreda host kebeles were selected based Haricot bean production potential and accessibility (representativeness of PA's).

Farmers' selection criteria

Before starting field work formation of FRG (Farmers Research Group) was done based farmers willingness, land ownership (appropriate plot for project), accessibility of land, trusted farmer within the community, willingness and ability to transfer the technology to other farmers were used as criteria to select farmers.

Results and discussions

Training given to farmers and agricultural experts

Training was given for farmers and agricultural experts. Training on Haricot bean production, management practices and post harvest handling were given in 2007 and 2008. The table below illustrates the number of farmers and experts participated on the training during project life span.

Table 1: Training given for farmers and experts

Year	Participants						
	Experts (DA + SMS)			Farmers			Subtotal
	Male	Female	Total	Male	Female	Total	
2007	17	3	20	42	9	51	71
2008	12	2	14	34	7	41	55
Total	19	5	34	76	16	92	**126**

The table above indicates that about 126 trainees participated on the training given on Haricot bean production, management practices and post harvest handling.

Yield Performance of Technology

Agronomic data and grain yield were recorded by the researchers and development agents to evaluate the performance of varieties. Accordingly agronomic data and farmer's perception were recorded and analyzed. The results of combined analysis revealed that the mean yield of variety ICAP 0056 is the highest among demonstrated haricot bean varieties. It gave 19.80qt/ha while GLP-2, Nasir and the local

gave 16.72, 14.00 and 12.30 quintal per hectare, respectively. There is statistically significant difference between the yield obtained from ICAP 0056 & GLP-2 and the local check. On the other hand, yield obtained from Nasir variety has no statistically significant difference as compared to the local.

Table 2: Combined agronomic Analysis of Haricot Bean Varieties.

varieties	DDTF	DTM	PH (cm)	NP	SP	Gyld (qt/ha)
Ecup	43.5ab	91.214a	87.3^{ab}	18.22^{a}	8.44^{a}	19.80^{a}
Glp-2	43.14b	91.214a	83.26^{bc}	17.14^{a}	$8..04^{ab}$	16.72^{b}
Nasir	43.42ab	89.86a	88.8^{a}	16.00^{b}	6.46^{bc}	14.00^{c}
Local	45.72a	92.36a	78.33^{c}	13.86^{c}	5.08^{b}	12.30^{c}
Lsd	2.49	3.22	6.147	3.30	1.99	0.5
Cv	2.015	2.016	2.015	2.0357	2.016	2.10
F-test	ns	Ns	**	**	**	**

Source: On Farm Demonstration Data

Hint: DTF-days to 50% flowering, DTM-days to 90% maturity, PH-plant height, cm-centimeter, NP-number of pod per plant, SP-seed per pod and Gyld (qt/ha)-grain yield in quintal per hectare.

The results of combined analysis revealed as the mean yield of variety ICAP 0056 is the highest among demonstrated haricot bean varieties. It gave 19.80qt/ha while GLP-2, Nasir and the local gave 16.72, 14.00 and 12.30 quintal per hectare, respectively. There is statistically significant difference between the yields obtained from ICAP 0056, GLP 2, and the local check. On the other hand, yield obtained from Nasir variety has no statistically significant difference as compared to the local.

Farmer's participatory assessment and evaluation

Moreover, farmers had shown their own way of selecting a variety for their localities. These parameters include grain yield, grain quality and suitability for storage. Accordingly, farmers selected first Icap 0056 for its grain yield and they selected Nasir for its good grain quality (variety brilliance) and long shelf life without deterioration.

Table 3: Participatory evaluation and ranking of varieties by farmers

No	Varieties name	Rank by Woreda			
		Guliso	D/sadi	D/wabera	Perception of farmers
1	ICAP 0056	2nd	1st	1st	Grain yield , grain quality, very good for consumption and marketable at local market
2	GLP 2	3rd	4th	3rd	Grain yield, Low variety brilliance susceptible to disease
3	Nasir	1st	2nd	2nd	Long shelf life without deterioration marketability and variety brilliance
4	localn	4th	3rd	4th	Low yielder and highly susceptible to disease

Conclusion

Agronomic data and farmer's perception were recorded and analyzed. The results of combined analysis revealed that the mean yield of variety ICAP 0056 is the highest among demonstrated haricot bean varieties. It gave 19.80qt/ha while GLP-2, Nasir and the local gave 16.72, 14.00 and 12.30 quintal per hectare, respectively. There is statistically significant difference between the yield obtained from ICAP 0056 & GLP-2 and the local check. On the other hand, yield obtained from Nasir variety has no statistically significant difference as compared to the local. More over this famers evaluated varieties by setting their own criteria. Accordingly farmers selected first Icup 0056 for its grain yield and they selected Nasir for its good grain quality (variety brilliance) and long shelf life without deterioration.

Recommendations

Based on objectively measured traits and farmers' preferences to varieties, varieties ICAP 0056 and *Nasir* were selected to be scaled up and disseminated for the target community among the demonstrated haricot bean varieties in the study areas.

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Pre-extension Demonstration and Participatory Evaluation of Improved Groundnut Technology in D/Sadi and D/Wabera Woredas of Kellam Wollega Zone

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Abstract

The trial was carried out during 2008 and 2009E.c cropping seasons in Dale Sedi and Dale Wabera Woredas by selecting two Kebeles from each Woreda based their ground nut production potentials. Two varieties (Manipinter and sartu) with local check were evaluated with the objective of selecting adaptable and best performing groundnut variety with the participation of farmers. The spacing between plots and rows were 60cm and 10cm respectively. Each experimental plot had 10m x10m with a gross area of 100 m^2. Grain yield, Plant height, number of pod per plant, number of seed per plant was recorded to evaluate the performance of varieties under experiment. Analysis of variance was done to see the variation among varieties across Woredas and the combined analysis of the two Woredas was undergone. The mean grain yields of manipinter, Sartu and local check were 21.36qt/ha, 16.87qt /ha 18.42qt/ha. The combined analysis of variance over these Woredas revealed that varieties were not significantly varied for all agronomic traits considered in the trial. But there is a yield advantage of 13.76% quintal of manipinter variety over local. Farmers evaluated technology using their awn criteria, accordingly they selected manipinter variety by all criteria, more over this farmers criticized the space between kernels which is too small for earthling up and makes plant to grow erect and then, the peg cannot reach the soil which then reduce yield of Groundnut. Generally based on objectively measured traits (yield) and farmer's preference we recommend Manipinter variety of ground nut to be scaled up and address many more farmers within the zone.

Key words*: Evaluation, Farmers, Grain Yield, Groundnut, Yield advantage.*

Introduction

Groundnut (*Archis hypogea*) is one of the most important oil crops grown by small holder farmers. It is an excellent source of oil which thrives under hot, semi-arid conditions and as a legume; groundnuts improve soil fertility by fixing nitrogen. It requires fewer inputs than many other crops, giving a high return per unit of land, and hence is appropriate for small-scale farmers (Okello *et al* , 2010).Groundnut is an important food and feed crop, which also serve as a significant source of cash in developing countries that contribute significantly to food security and alleviate poverty (Pande et al., 2003; Upadhyaya et al., 2006). Groundnuts have several uses. In many countries, groundnut cake and haulms (straw stems) are used as livestock feed. It is a high value crop that can be marketed with little processing; however, it is extremely versatile and can be used in a wide range of products. Processed groundnut is used in diversified ways including groundnut butter which is used as spread for bread or biscuits, in cookies, sandwiches, candies and frostings or icings. Moreover, it is also used as a substitute for milk in the preparation of *"maciyato"* during fasting days in Ethiopia. Groundnut is also used to prepare children's food ("fafa") and used daily

as roasted “ocholonie” or “Kolo”. It is a good source of calcium, iron and vitamins (Alemayehu *et al*, 2014).

Many farmers in west and kellem wollega zones grow old varieties and hence fail to benefit from the modern products of crop improvement. One of the reasons for low adoption of new varieties is that farmers have little exposure to new varieties, or the varieties do not satisfy their preferences and needs.As a result of this fact adaptation trial of improved groundnut varieties was done on station by the Haro Sebu Agricultural Research Center. More over this, since it is paramount important to test technology under farmers management condition, participatory on farmers' field evaluation and demonstration of the technology was done in order to taste the feasibility, relative advantage and compatibility of the technology in line with the existing local condition. This will in turn hasten the adoption rate and dissemination of the technology. 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. The activity was intended to achieve the following objectives.

Objectives

1. To demonstrate and evaluate the well performed groundnut varieties under farmers’ management conditions.
2. To enhance the skill and knowledge of farmers in groundnut production and management practices.
3. To strengthen linkage among farmers, researchers, development agents and other stakeholders

Methodology

Description of the study area

Kellam wollega Zone

Kelam Wollega is one of the zones of the Oromia Region in Ethiopia. This zone is named after the former province of Wollega, whose western part lay in the area Kelam Wollega now occupies. Project locations were Hawa Gelan, Dale Sedi, and Seyo Woredas in this zone.

Dale sadi Woreda

Dale sadi is situated at about 550 km West of Addis Ababa. It is bordered by: Illubabor to the South, Dale wabera to the West, Aira to the North and Lalo kile to the East. The area lies between 08°N 25 56 to 08°N 58 05 and 034°E 33 41 to 035°E 28 48 and has average altitude of 1150 meters above sea level. The area has temperature range of 33-35°C. The climatic condition alternates seasons from March to April. The winter dry seasons (November to February) with mean annual rain fall of 1200mm.

Dale wabera Woreda

Dale Wabera Woreda is situated at about 570km west of Addis Ababa, Western Ethiopia, and The altitude of the area ranges from 1100 to 1800 m.a.s.l. The mean minimum and maximum temperature of Woreda

are 11.0–15.5°C and 26.1–34°C, respectively. The Agro ecology of woreda varies between long summer rain fall (June to September) and winter dry season (December to March) with annual rainfall ranging from 1300 to 1600 mm. The livelihood of the society largely depends on mixed livestock and crop production. The total land cover of the Woreda is about 1132.02 km

Site and farmers selection

To achieve the above mentioned objective sites and farmers were selected with the Woreda agriculture and natural resource offices which suit our demonstration project. Accordingly potential Woredas were selected based on their ground nut production. From each Woreda host kebeles were selected based on ground nut production and their accessibility.

Farmers' selection criteria

Before starting field work formation of FRG (Farmers Research Group) was done based farmers willingness, land ownership (appropriate plot for project), accessibility of land, trusted farmer within the community, willingness and ability to transfer the technology to other farmers were used as criterias to select farmers.

Materials used

Two improved varieties of groundnut namely; manipinter and sartu, with local check were tested for their yield performance with full participation of farmers in the study areas. The spacing between seed and rows were 10cm and 60cm, respectively. Each experimental plot had 10mx10m with a gross area of 100 m^2.

Method of data collection and analysis

Data was collected both by the researcher and development agents of host Kebele. Development agents were provided with data recording sheet and orientation on how to record data since they were nearby to the trial and can frequently supervise the trial. The collected data was analyzed using SPPS and SAS softwares.

Results and Discussions

Training given for farmers and other stakeholders

In order to enhance farmer's knowledge about the technology training was given for target community on groundnut production and management.

Table 1. Number of farmers and experts participated in training in Dale Sedi and D/wabera Woredas

No	Woreda	Participant				
		Farmers 1		Experts (DAs and SMS)		Total
		Male	Female	Male	Female	
2	D/Sadi	17	5	3	0	25
3	D/Wabera	16	4	3	0	23
Total		33	9	6	0	48

Field day was organized in D/sadi Woreda on which large numbers of stakeholders' mainly from non FRG member farmers, and experts who are working in extension were participated in field day to learn and share their knowledge.

Yield performance of groundnut over location

The analysis of variance revealed that there is no significant difference in yield of the tested ground nut varieties with the highest magnitude of manipinter yield 21.36qt/ha and 18.42qt/ha, 16.87qt/ha yield values of local and sartu, respectively. In general manipinter variety performed better in yield fallowed by local and sartu varieties.

Table 2: Combined mean yield and agronomic traits for tested groundnut varieties in Dale Sedi and D/wabera Woredas

Varieties	DTF	DTM	PH (cm)	NPP	SPP	Gyld (qt/ha)
Manipinter	44.87^{a}	158.00^{ab}	50.24^{a}	65.8^{a}	1.78^{ab}	21.36^{a}
Sartu	39.63^{b}	154.87^{b}	53.50^{a}	55.17^{a}	1.95^{a}	16.87^{a}
Local	44.75^{a}	159.12^{a}	48.95^{a}	59.90^{a}	1.68^{b}	18.42^{a}
Lsd	2.04	3.26	8.52	14.72	0.24	5.38
Cv	4.50	2.00	15.94	23.25	12.83	26.88

Hint: DTF-days to 50% flowering, DTM-days to 90% maturity, PH-plant height in cm-centimeter, NPP-number of pod per plant, SPP-seed per pod and Gyld (qt/ha)-grain yield in quintal per hectare.
Economic cost of production was collected. But since there is no difference in cost of production we took yield advantage of varieties.

$$\text{Yield advantage of manipinter} = \frac{\text{Yield of manipinter} - \text{yield local}}{\text{Yield of local}} * 100$$

$$21.36-18.42/18.42*100 = 15.96\%$$

Based on the result of this demonstration trial farmers get yield advantage of 15.96% when they produce manipinter variety rather than producing the local variety.

Farmers Evaluation of Technology

Another important part of this research was participatory evaluation of the technology by the farmers. Farmers evaluated technology by setting their own criteria, and shown their own way of selecting a variety for their localities. These parameters include grain yield, grain quality and grain size. Accordingly, farmers selected Manipinter first by all criteria they set (for its grain yield, grain quality and grain size). Hence, it is a paramount important to include farmers' preferences in a variety selection process. Therefore, based on objectively measured traits and farmers' preferences, Manipinter variety of groundnut was selected to be scaled up and disseminated for the target community among the demonstrated groundnut varieties in the study areas.

More over this, farmers evaluated the space between plants which is 10cm between kernels. They highly refused to take this spacing, because of several reasons among them, it is not suitable for earthling up and since the space is very small there is high competition for resource which makes the plant to grow erect, and which then makes the peg not to reach the soil and penetrate the soil, and then reduce productivity of technology.

Table 3. Participatory evaluation and ranking of varieties by farmers

No	Varieties name	Rank			Perception of farmers
	Woreda	Guliso	D/sadi	D/wabera	
1	Manipinter	1nd	1st	1st	Grain yield , grain quality(good grain fill),
2	Sartu	2rd	2nd	3rd	Grain yield (low yield), taste (sweat when used for kolo), susceptible to disease
3	Local	3rd	3rd	2nd	Grain yield(low grain fill) and susceptible to disease

Conclusion

Two varieties (manipinter and sartu) including local check were evaluated with the objective of identifying the best performing groundnut variety with full participation of farmers. It was carried out on 14 farmers' field and one FTC during 2008 and 2009E.c cropping season in Dale Sedi and D/wabera Woredas. Different agronomic traits like days to flowering, days to maturity, plant height, and number of seed per pod, number of pod per plant and yield data were collected and analyzed by researcher. Farmers evaluated the technology by setting their own parameters which include grain yield, grain quality, grain size and the space between plants were major evaluation criterias farmers used. The analysis showed that no significant variation among the varieties tested in the trial. Manipinter variety gave higher yield relative to the rest varieties in both Woredas followed by local. Economic cost of production was collected, but since there was no variation in cost of production we took yield advantage of varieties and

recommend manipinter variety which has 15.96% of yield advantage over the local variety for further scaling up of technology. In order to enhance stakeholders knowledge concerning technology training and field day were organized in D/sadi Woreda.

Recommendations

Analysis of variance showed no significant variation in grain yield of technology, so economic cost of production was collected, but since there was no variation in cost of production we took yield advantage of varieties and recommend manipinter variety of groundnut to be scaled up on large scale.Farmer's refused to take space between plants which is 10cm between kernels, which they believe it makes plants to grow erect as a result of increased competition and hinder the peg to reach the soil and penetrate the soil, there by affect production. Therefore, the authors recommend biological researcher to work on the space of this technology.

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Pre scaling up of Improved Chickpea Varieties in Habro and Oda Bultum Districts of West Hararghe Zone, Ethiopia

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Abstract

The study was conducted during the 2013 main cropping season to promote improved chickpea variety on farmer's field and creates awareness among stakeholders on its production in the study area. Habro and Oda Bultum were selected based on potential production of chickpea. Kebeles from the two districts were selected collaboratively with Office of agriculture and Kebele officials. A total of seventy (70) farmers from both district were participated for the activity. A total of 11.6 kuntal of seed were disseminated to farmers and 8.9 hectare of land was covered by improved variety. Yield data and farmers feedback on the varieties were collected and analyzed through descriptive statistics and narration. The result of the study showed that a total 351.7 kuntal of seed were harvested from farmer's field. Training was organized to enhance farmers know how on chickpea production and management. In addition, mini field day was organized to facilitate dissemination of the varieties for other farmers and the participant of field day preferred Minjar variety in terms of its seed quality, seed size, early maturity and disease resistance over other improved varieties and local check. So, concerning body should scale up the variety further in similar agro ecology to improve chickpea production and productivity of farming community.

Key words: *Chickpea, scaling up, field day, farmer's selection criteria*

Introduction

Chickpea is grown in more than 50 countries (89.7% area in Asia, 4.3% in Africa, 2.6% in Oceania, 2.9% in Americas and 0.4% in Europe). India is the largest chickpea producing country accounting for 64% of the global chickpea production (Gaur PM, *et.al*, 2010). Chickpea is the third most widely-grown legume crop in the world. According to Menale K. *et.al*, 2009 chickpea is highly nutritious crop; it is used as human and animal feed and is one of the more inexpensive sources of protein. Chickpea also has the ability to capture and use atmospheric nitrogen, thus contributing to soil fertility in otherwise nutrient-limited soil. Most production and consumption takes place in developing nations in the Mediterranean, western and southern Asia, and Sub-Saharan Africa.

Chickpea is one of the major pulses grown in Ethiopia, mainly by subsistence farmers usually under rain fed conditions. It is one of the main annual crops in Ethiopia both in terms of its share of the total cropped pulse area and its role in direct human consumption. It is grown widely across the highlands and semi-arid regions of the country (Bejiga et al. 1996). Chickpea is the most important pulse crop in Ethiopia, where the whole seeds are eaten fresh, cooked or boiled or in the form of dhal which is prepared by splitting the seed in a mill and separating the husk. Floor made by grinding the seed is one of the chief ingredients of everyday diet for those suffering from Uric Acid problem. The dry stems and leaves and husk after threshing are feed to livestock.

The chickpea provides an important source of food and nutritional security for the rural poor, especially those who cannot produce or cannot afford costly livestock products as source of essential proteins. The consumption of chickpea is also increasing among the urban population mainly because of the growing recognition of its health benefits and affordable source of proteins. In the export market, chickpea contributes a significant portion of the total value of pulse exports. For example, chickpea constituted about 48% of the pulse export volumes in 2002. During this period of time, the exported volume accounts about 27% of the total quantity of chickpea production while the balance remains for domestic market (Shiferaw et al. 2007).

Two types of chickpea, Kabuli and Desi, are currently produced in Ethiopia. Kabuli or garbanzo type is usually large seeded with seed size ranging from 6–8 mm and smooth cream white seed coat colour. The production of Kabuli types is currently limited to few pockets, primarily in Eastern Shewa region where access to improved varieties has been promoted through better linkages with the research and extension system. Desi type chickpea, traditionally widely grown in the country, is small seeded with seed size ranging from 3–6 mm, and hard and reddish-brown colored seed coat (Bekele and Hailemariam, 2007).

The total cultivated area of chickpeas increased from 140,244 ha to 167,569 ha between 2002/03 to 2004/05, but the national average yield remains less than 1 t/ha (CSA 2006), indicating limited adoption of new high-yielding and stress tolerant varieties. Yields of chickpeas in the majority of traditional smallholding farms very low due to lack of improved technology concerning the crop. Similarly lack of improved variety was a major problem in chickpea production in West Hararghe in general which hinder production and productivity of smallholder farmers. Therefore, Mechara agricultural research center and Debrzit agricultural Research center collaboratively conduct demonstration of improved chickpea varieties on farmer’s field then recommended Minjar, Natoli & Habru for further scaling up to enhance production and productivity of smallholder farmers. Therefore, this activity was designed to promote improved varieties of chickpea on farmer’s field and creates awareness among different stakeholders on the crop production.

Research Methodology

Description of the Area

The activity was conducted in Habro and Oda Bultum districts of west Hararghe zone. Habro and Oda Bultum districts were located at 404 km and 362 km from Addis Abeba, respectively. Those two districts were known for chickpea production relative to other districts of west Hararghe zone. Specifically the activity was undertaken in four Peasant Associations of which Bareda, Abdi Gudina & Haro Chercher from Habro district and Kara from Oda Bultum district. Generally, agro ecologies of the two districts were summarized as follows.

Table 1: Summary of Habro and Oda Bultum Agro-ecologies

Name of the district	Agro-ecology						
	Altitude(m.a.s.l)		Temperature(^{0}c)		Rainfall(mm)		Soil Type
	Min.	Max.	Min.	Max.	Min.	Max.	
Habro	1600	2400	16	20	650	1000	Black sandy & loam soil
Oda Bultum	1040	2500	25	28	900	1100	Dominant in loam & clay soil

Source: Farming System Study of Habro (Aman T. & Anteneh T., 2010) & Oda Bultum (Aman T. Anteneh T. & Fekede G., 2010)

Methods of Site and Experimental Farmers Selection

Habro and Oda Bultum district were selected based on potential of chickpea production. Communication with district Agricultural Office (AO) and expert has been conducted to make the activity more participatory and select appropriate Kebele for Chickpea production in the study area. Accordingly, Bareda, Abdi Guddina, Haro Chercher and Kara Kebeles were selected based their potential production of chickpea in relation to other kebeles. Additionally, discussions were held with respective kebele officials and DAs to select farmers on which the activity conducted. These criteria includes: Farmers interest to the crop, model farmers, accessible of site, ability to risk taker, farmers who afford two timed of land for this experiment, farmers who manage their field on time(land preparation, sowing, weeding, harvesting, threshing) and others. Accordingly, a total of seventy (70) farmers were selected to conduct the activity and each farmer allocates 0.125 hectare for improved variety of chickpea.

Table 2: Summary of selected Kebele, farmers and area covered by improved crop

No.	district	Kebele/PAs	No. of Fs participated	Area of land covered by improved varieties in Hec
		Haro Chercher	19	2.4
1	Habro	Bareda	17	2.2
		Abdi Guddina	18	2.3
2	Oda Bultum	Kara	16	2
Total			**70**	**8.9**

Methods of Data Collection and Analysis

Different 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 preference toward the varieties in relation to their agro ecology. Finally, the collected data (quantitative data) was analyzed by using average and frequency distribution while qualitative data were analyzed through qualitative interpretation.

Results and Discussion

Disseminated seed and its performances under Farmer's Condition

Habro and Oda Bultum districts were potential chickpea producing from west Hararghe Zone. Because of this three improved varieties of chickpea were pre scaled up to improve its production and productivity. A total of 11.6 kuntal of seed were disseminated to farmers and 8.9 hectare of land was covered by improved variety. Therefore, a total 341.7 kuntal of seed were harvested from farmer's field. Table 4 showed that yield summery of each variety (Minjar, Natoli, Habru and local check) on farmers' circumstance and total field harvested from each variety. The result indicated that the average yield of Minjar, Natoli and Habru variety is 38.7, 43.2 and 37.4 kuntal per hectare, respectively. Table below indicated that improved varieties of these three improved verity of chickpea were disseminated in the study area.

Table 3: Summary of yield performance of the varieties per hectare

No.	Variety Name	Total area planted in hectare	Average yield per hectare	No. Fs participated	Total yield harvested
1	Minjar	3.4	38.7	27	131.6
2	Natoli	1.4	43.2	11	60.5
3	Habru	4	37.4	32	149.6
Total		**8.9**		**70**	**341.7**

Source: Our Computation, 2014.

Awareness Creation & Capacity Building on Chickpea Production in the study area

Additionally, farmer's field day was organized to facilitate experience sharing among farmers to get feedback and promote the technology to other stakeholders. Accordingly, participant of field day compared each variety with local and preferred Minjar variety due to its seed quality, seed size, early maturity and disease resistance over other improved varieties and locally used variety. On the other hands, training was given farmers, DAs and expert of agricultural offices to enhance their knowhow on chickpea production and management.

Table 4: Training participant on chickpea production and management

No.	Type of participant	No. of participant		Total participants
		Male	Female	
1	Farmers	29	3	32
2	Developmental agents	6	2	8
3	Experts	1	1	2
Over all total		**36**	**6**	**42**

Conclusion and Recommendation

The study was conducted in Habro and Oda Bultum districts of West Hararghe Zone. Four kebeles namely, Abdi Gudina, Bareda, Haro Chercher and Kara were used and a total of 11.6 kuntal of seed were distributed which covered 8.9 hectare land on 70 farmers field. A total of 341.7 kuntal of seed were harvested from the total land allocated. Mini field day was organized to create awareness on the crop and the participants preferred Minjar variety for further dissemination due to its seed quality, seed size, early maturity and disease resistance over other improved varieties.

Chickpea is legume crop grown for food and market purpose in study area and play greater role in ensuring household food security at household level. Therefore, concerning body should give attention for further popularization of improved variety in the study area and similar agro ecology with package of recommendation.

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On-farm Demonstration and Evaluation of improved Forage Grasses for Feed Resource and Soil Conservation Purpose on Bund under Smallholder Farmers at West Hararghe Zone

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Abstract

The activity was conducted during the 2012 and 2013 main cropping season at Oda Bultum and Gemachis districts of West Hararghe Zone to evaluate and promote promising forage crops under smallholder condition and to identify best performing forage species used for both feed improvement and natural resource conservation. A total of fourteen farmers, one protected area and one FTC were used for the experiment. Four improved forage grass crops namely Rhodes grass, Vetivar grass, Elephant/Napier grass and Panicum coloratum grass were demonstrated on farmers filed. One bund was used for each forage grass on each farmer's field.

According to farmer selection criteria in terms of biomass, germination ability, soil erosion protection, sweetness and preference by livestock, early achieve to livestock feeding, bund coverage, easily for seed multiplication and regeneration revealed that Rhodes grass and panicum colloratum grass were selected among others. Therefore, Rhodes grass and panicum colloratum grass were recommend for further scale up /out for Oda Bultum and Gemachis districts and other similar agro-ecologies. The unions, research organization, Agricultural Development office, NGOs, livestock agency office, farmers cooperative focus on fattening and others organization those mainly focus on livestock fattening and milking will have to promote and scale up/out those forage grass in reducing feed shortage of West Hararghe zone.

Key words: *Forage, Soil conservation, Grasses, Demonstration*

Introduction

One of the bottlenecks to increase livestock production in Ethiopia is the shortage of feed for different animal species. In order to improve the shortage of livestock feed in crop livestock production system, it is important for farmers to integrate forage production in the farming system. Establishing reliable forage production depends on the availability of reliable supplies of quality forage seeds/cuttings (Alemayehu, 1997; FRG, 2008) and locally producing forage seed ensures sustainability and it is economical.

Ethiopian grasslands account for over 30% of the land cover and constitute to 66 percent of feed resources for livestock (CSA, 2011). Natural pasture, crop residue, improved pasture and forage, agro industrial by products and other by-products like food and vegetable residual are major livestock feed resources of which the first two contribute the largest feed type (Alemayehu, 2003).

The study conducted by Abdi E.,et al, 2013 at Daro Lebu, Oda Bultum, Gemachis and Chiro districts revelead that the major feed resource available among crop residues are cereal straw such as maize and sorghum which accounts 45.1% followed by cereal straw and sweet potato vines and tubers accounting for 18.3%. The study result on one hand as reported by cattle keepers revealed that feed shortage is the major constraint of livestock production ranking first with the index of 0.455 followed by animal health, fair selling price as market problem, land shortage and water shortage problem with an index value of 0.098, 0.080, 0.068, and 0.066 respectively. Farmers in the study area were well known in preparation of bund of their lands to protect soil erosion problems and for its best practices and indigenous knowledge in cattle fattening. Enhancing the production and productivity in the area with available indigenous technical knowledge will help the improvement of the sector in increasing the sector contribution to national and agricultural GDP.

Objectives

- To evaluate and promote promising forage crops under smallholder Farmers.
- To identify best performing forage species used for both feed improvement and natural resource conservation.

Research Methodology

Description of the Study Area

Oda Bultum is one of the districts found in west Hararghe zone. The capital town of the district is named as Baddessa is located at 08054, 3180N, 0400, 0210E. Its Altitudinal range is from 1040 - 2500 m.a.s.l, the average altitude of the district is 1770 m.a.s.l. From the total land area/topography of the district; 60% is plain and 40% is steep slope. The annual rain fall is 900 mm-1100 mm). It has a mean maximum and mean minimum temperature of 28 ^{0}C and 25 ^{0}C; respectively. The maximum rainfall and minimum rainfall is 1200mm and 900 mm (DOA, 2012).

Gemechis is one of districts of West Hararghe. It is one of the fourteen districts in West Hararghe zone located at 343 km east of Addis Ababa and about 17 km south of Chiro, capital town of the zone. It shares borders with Chiro district in the west and north, Oda Bultum district in the south and Mesala district in the east (DOA 2012). The district is found within 1300 to 2400 meters above sea level (m.a.s.l). It receives an average annual rainfall of 850 mm. The district has bi-modal distribution in nature with small rains starting from March/April to May and the main rainy season extending from June to September/October. The average temperature is 20 ^{0}C (DOA 2012).

Farmers and Site selection Methods

The experiment was conducted for two executive years at Oda Bultum and Gemachis districts of West Hararghe zone. The experiment was conducted at Oda Bultum (Midagdu Burka Misoma and Bakanisa Peasant Associations) and Gemachis (Sororo, Madariya, Wal argi and Kuni Segariya Peasant Associations) districts. Totally 14 (fourteen) farmers, one protected area and one Farmer Training Center experimental lands were used for evaluation. Sites and farmers were selected with District Agricultural Development Office based on accessibility for experiment, interest of farmers, availability of free bunds on farmers land, willingness of to manage trials, gender balance and willingness to allocate trials.

Four improved forage grass crops namely Rhodes grass, Vetivar grass, Elephant/Napier grass and Panicum coloratum grass were demonstrated on farmers filed and delivery to each farmers with recommended seed rate. Data and management was collected and made by researchers/extension agent and farmers, respectively. Follow up and super vision were takes

place at each experimental land uniformly. Farmers' feedback assessment data record sheet was prepared prior to conducting farmers' field day. A group of participants composed of 11 up to 12 and different discipline (integration of farmers up to researchers) were established in to four groups. Each group had their own leader and secretary, to collect farmers' idea and feedback during observation of filed. Then, each group results were compiled to gather at the end of field day and comminuted to participants through facilitator of program.

Table 1: Summary of activity conducted for two years at Oda Bultum and Gemachis districts.

Forage grass crops	Districts	Pas	No. of farmers/others	Number of bund covered
Rhodes grass	Oda Bultum	Burka Misoma	2	4
Vetivar grass		Midagu	2	4
Elephant grass		Bakanisa	3 farmers and 1 FTC	4
Panicum Colloratum grass	Gemachis	Sororo	2	4
		Madariya	2	4
		Kuni Segariya	2	4
		Wal-argi	1 farmers and 1 protected area	4
Total			**16**	**28**

Source: own result, 2014

Method of Data Collection and Analysis

During life span of the activity different data and farmers selection criteria were collect through supervision on prepared data collection sheet by researchers and DA of the PA. The collected data (quantitative data) was analyzed by using average and frequency distribution while qualitative data were analyzed through qualitative interpretation.

Result and Discussion

Mini field was organized in 2004/05 cropping season at Oda Bultum district on Midagdu peasant association. Accordingly, a total of 39 farmers (26 males and 3 females) and seven (7) extension workers were participated. During that, participants were select forage grass according to their biomass, germination ability, soil erosion protection, palatability by livestock, early achieve to livestock feeding, bund coverage, easily for seed multiplication and regeneration were considered. Table 2 below revealed that Rhodes grass and Vetivar grass were selected by surrounding farmers.

Table 2: Farmers feedback results

Forage grass crops	Participant's selection criteria's (%)								Rank
	Biomass	Germination ability	Easily for seed multiplication	Soil erosion protection	Preference by livestock	Bund coverage	Early for feeding	Regeneration	
Panicum colloratum grass	76.1	71.7	80.4	63	71.7	71.7	71.7	609	2nd
Elephant grass	41.3	26.1	50	45.7	45.7	30.43	54.4	71.7	4th
Rhodes grass	89.1	80.4	89.1	78.3	84.8	82.6	84.8	80.4	1st
Vetivar grass	30.4	65.21	60.9	41.3	54.4	44	65.24	55	3rd

Source: own result, 2014

According to table 2, farmers' feedback results revealed that 89.13 percent and 76.1 percent of participants were select Rhodes and panicum colloratum grass in terms of its biomass than elephant and vetivar grass which account 41.3 percent and 30.43 percent, respectively. Germination ability was one of the most important selection criteria to identify the best performed forage grasses. Accordingly, Rhodes and panicum colloratum grass were highly germinated than others grasses which accounts 80.4 percent and 71.7 percent, respectively. Soil erosion protection capacity and bund coverage were linked with germinated/survived forage grasses. Rhodes and panicum colloratum grass were palatable by livestock, which accounts 84.8 percent and 71.7 percent, respectively.

Elephant and vetivar grass palatability indicates 45.7 percent and 54.35 percent, respectively. This was indicates Rhodes and panicum colloratum grass were highest palatable than elephant and vetivar grasses. This was observed when each forages grass feeds were delivered for livestock during field days was conducted. Rhodes and panicum colloratum grass germination ability were highest due to sown by seed rather than cuttings/nodes. This was results to achieve early for feeding with short period of time. Accordingly, Rhodes and panicum colloratum grass were achieve for feeding within short period of time that accounts 84.8 percent and 71.7 percent, respectively. In terms of regeneration ability, Rhodes and elephant grass were accounts 80.4 percent and 71.4 percent, respectively.

Conclusion and Recommendation

According to farmer selection criteria in terms of biomass, germination ability, soil erosion protection, palatability and preference by livestock, early achieve to livestock feeding, bund

coverage, easily for seed multiplication and regeneration revealed that Rhodes grass and panicum colloratum grass were selected among others.

Therefore, Rhodes grass and panicum colloratum grass were recommend for further scale up /out for Oda Bultum and Gemechis districts and other similar agro-ecologies. The unions, research organization, Agricultural Development office, NGOs, livestock agency office, farmers cooperative focus on fattening and others organization those mainly focus on livestock fattening and milking will have to promote and scale up/out those forage grass in reducing feed shortage of West Hararghe zone and boost the economy by reducing poverty and addressing food security.

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On Farm Demonstration of Improved Faba bean (Vicia faba L.) Technology in Gemachis, Chiro and Tullo Districts of West Hararghe Zone, Oromia National Regional State of Ethiopia

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Abstract

The experiment was carried out in Gemachis, Chiro and Tullo districts of West Hararghe Zone with the objectives of enhancing production and productivity of faba bean on farmers` fields and to improve linkage among stakeholders and create awareness on improved faba bean varieties. Three kebeles were selected purposively based on faba bean production potential. Accordingly, Walenso Defo kebele from Gemachis, Arbarakate kebele from Chiro District and Terkanfata kebele from Tullo district were selected. Seven farmers and one Farmers Training Center were participated depending on their interest to the technology, managing the experiment, have appropriate land for the experiment and taking the risk of experiment. Two improved varieties namely Hachalu and Tumsa with local variety were demonstrated and evaluated on farmer's field. The treatment was demonstrated on 100m^2 plot size and DAP 100kg/ha at the time of sowing were applied to each demonstration plot. Both quantitative and qualitative data were collected through observation, group discussion on field day and data recording sheet. Descriptive statistics like mean and tabulation and inferential statistics were used to analyze the crop performance and yields while qualitative data were analyzed through simple ranking and summarization. Partial budget analysis was also used to analyze the economic benefit gained from the experiment. The result of the study indicated that Hachalu was ranked first in terms of yield, seed color and disease resistance. Hachalu variety has more economic advantage than both Tumsa and local variety. Therefore, Hachalu variety was recommended for further popularization and scaling up in study area and similar agro-ecology.

***Keywords**: Faba Bean, Demonstration, Varieties, Yield, On-farm, Technology*

Introduction

Pulses are important food crops due to their high protein and essential amino acid content. The seeds of pulse crops are typically made up of 20-25% protein compared to 6-10% protein content in major cereal crops. Pulses are also rich in dietary fiber and usually have only small amounts of oil. The protein of pulse seeds is high in the amino acids lysine and methionine, making pulses nutritionally complementary to cereals, which are deficient in these two essential amino acids. Pulses are the main source of protein in the diet of vegetarians, and feature prominently in the traditional cuisine of virtually every region of the globe (Sitou and Mywish, 2011).

The main faba bean producers are China (1.65 Mt), Ethiopia (0.61 Mt), France (0.44 Mt), Egypt (0.29 Mt) and Australia (0.19 Mt) (FAOSTAT, 2009). It is a hardy crop and can withstand rough climates, especially cold ones. China is the largest producer of Faba beans which gives East Asia the largest share

in world total area harvested (38%) and total production (42%). The next largest faba bean growing regions are Sub Saharan Africa and MENA, each covering 19% and 18% of world area, respectively (Sitou and Mywish, 2011). Faba bean is a valuable protein-rich food that provides a large sector of the human populations in developing countries with a cheap protein source thus partly compensating for the large deficiency in animal protein sources. It is one of the earliest domesticated food legumes and is now cultivated on large areas in many countries due to its high nutritive value in terms of energy and protein contents (24-30%) (Sahile *et al*., 2009)

Grain legumes occupy about 13% of cultivated land in Ethiopia and their contribution to agricultural value addition is around 10%. Pulses are the third-largest export crop of Ethiopia after coffee and sesame, contributing USD 90 million to export earnings in 2007/08 (IFPRI, 2010). In total, the area cultivated with the selected legumes is more than 1 million hectare but production per hectare is low and far below the potential production (USAID, 2011). Common bean and chickpea are major legumes, with both a production of more than 200,000 MT grain. On the world market, Ethiopia ranks 6th in chickpea production and 14th in production of common bean. Among African countries, Ethiopia is the largest producer of both chickpea and common bean (ICRISAT, 2011).

In Ethiopia, faba bean is the crop that has the highest absolute production, and the largest area cultivated. Ethiopia is also the second largest producer of faba bean in the world after China (Ronner and Giller, 2012). Faba bean is the most important pulse crop in terms of area coverage and total annual production in Ethiopia. This crop has manifold advantages in the economic lives of the farming community in the high lands of the country. It is a source of food, feed, cash to farmers and also play significant role in soil fertility practices. However, currently its share in the countries pulse export is small. Faba bean covers 427,696.80ha leading the pulse category in area and production in the country (CSA, 2017). The productivity of faba bean varieties under traditional farming system is found to be around 0.7ton/ha, which is very small. However there is a possibility to improve the situation using improved varieties, which can give a better yield than the one's widely used now. The study was conducted participatory variety selection of different improved varieties which were developed by different research centers at farmer’s field and Farmer Training Center (FTC). Therefore, two varieties were recommended namely Hachalu and Tumsa for further promotion on farmers` fields. Thus, this study was initiated to enhance production and productivity of faba bean on farmers` fields and to improve linkage among stakeholders and create awareness on improved faba bean varieties.

Methodology

Description of the Study Area

The study was conducted in Chiro, Gemachis and Tullo districts of the West Hararghe zone of the Oromia National Regional State. Chiro which is the capital town of Zone is located in West Hararghe Zone of the Oromia National Regional State at about 324Km East of Addis Ababa. The district is divided into three major agro-ecological zones. These are lowland with 22 *kebeles*, midland with 13 *kebeles* and highland altitude with 4 *kebeles*. The district bordered with Mieso in the North, Gemachis in the South, Guba Koricha in the West and Tullo in the East. The district is mainly characterized as steep slopes and mountains with rugged topography, which is highly vulnerable to erosion problems. It has a maximum and minimum temperature of 23°C and 12°C, respectively and the maximum and minimum rainfall of

1800 mm and 900 mm, respectively (Gosa, 2016). Rainfall type is bimodal and erratic in nature. Main rainy season is from June to September for the highland and midland areas and from March to April for the lowland. Short rainy *season* is from March to May for highland and midland and for that of lowland around July. The amount of the rainfall is relatively adequate in the highland and midland than the lowland (Gosa, 2016).

Gemachis district is one of the fifteen districts in West Hararghe zone, which is located at 343km East of Addis Ababa and about 17km South of Chiro, which is the capital town of the zone. The district is situated at the coordinate between 8^0 40'0" and 9 ^{0}04'0" N and 4^0 50'0" and $41^0$12'0"E. The soil of the study area was dominantly loamy soil (Desalegn *et al*., 2016). Gemachis town is located on the top of a hill and its climate is 70% cold and cloudy. The woreda has many small towns located 20–45 miles away from each other. Sogid, Sire, Metadab and Degaga are the major one in the area. Transportation for commuting is a major problem of the woreda ().

Tullo district has 45,670 hectares of land area and located 370km southeast of Addis Ababa. The altitude of the district is 1750 meters above sea level with mean annual rainfall of 1850ml and mean annual temperature of 23°C. The production system is mixed type in which extensive husbandry management of livestock have been practiced (Tulu and Lelisa, 2016).

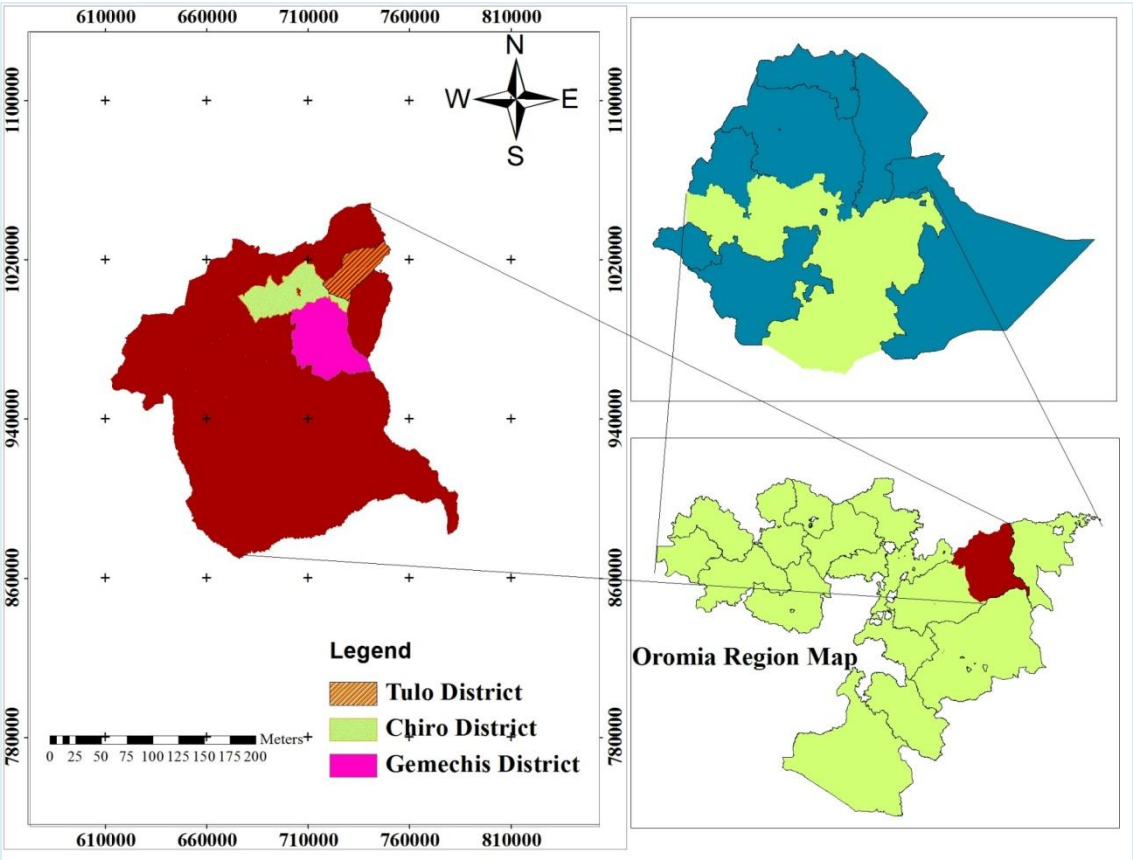

Figure 9. Map of the study area

Farmers and Site Selection

The activity was conducted for one year in Gemachis, Chiro and Tullo districts of West Hararghe Zone. Walenso Defo *kebele* from Gemachis district, Arbarakate *kebele* from Chiro district and Terkanfata *kebele* from Tullo district were purposively selected depending on their faba bean production potential. Eight farmers were selected based on their interest to the technology, being model farmer, managing the experiment and have appropriate land for the experiment.

Research Design

Two improved faba bean varieties namely Hachalu and Tumsa were demonstrated and evaluated with local variety. The experiment was demonstrated on 10m by10m (100m^2) demonstration plots and DAP100kg/ha at the time of sowing was applied to each demonstration plot with recommended seed rate. Row sowing methods were applied with 10cm between plant and 40cm between rows. The required management like weeding, thinning out and urea application at the growing stage were applied to the treatments.

Table 1. Number of farmers participated and area covered in study area

Districts name	*Kebele*	No. of trail farmers	Area covered (m^2)
Gemachis	Walenso Defo	3	300
Chiro	Arbarakate	3	300
Tullo	Terkanfata	2	200
Total		**8**	**800**

Source: Own computation, 2017

Data collection methods

Both quantitative and qualitative data were collected through observation, group discussion on field day and data recording sheet. Data like farmer preference on disease and pest resistance, early maturity, drought tolerant, grain color, and yield data were collected through the prepared data collection sheet/record sheet by organizing mini field day and observation on farmer's field.

Data Analysis

Descriptive statistics like mean and tabulation were used to analyze the crop performance concerning yield and yield components.. Inferential statistic like independent t-test was used to analyze mean yield comparison of improved varieties along with local variety. The qualitative data were analyzed through simple ranking and summarization. Partial budget analysis was also used to analyze the economic benefit gained from the experiment.

Results and Discussion

Crop performance on the farmer's field

The mean yield of Hachalu and Tumsa were accounted that 20.14Qt/ha and 16.45Qt/ha with standard deviation of 17.88 and 12.20, respectively and the mean and standard deviation of the local variety were 19.83Qt/ha and 16.73, respectively (Table 2). The mean yield of Hachalu variety was greater than both Tumsa and local varieties due to highly adaptable to the environment. Similarly, the studies conducted by other author in Bale Zone of Ethiopia indicated that Hachalu variety was high yielder than Tumsa variety (Ashenafi and Mekuria, 2015).

Table 2. Yield summary of the faba bean varieties on farmers field (N=8)

Varieties	Min	Max	Sum	Mean	Std. Dev.	Yield difference from local	% yield increase over local check
Hachalu	7.02	51.47	161.09	20.14	17.88	0.31	1.56%
Tumsa	5.47	39.44	131.63	16.45	12.20	-3.38	-
Local	5.52	49.91	158.63	19.83	16.73	-	-

Source: Our result, 2017

The result on Table 2 indicated that maximum yield were scored from Hachalu variety (51.47 qt/ha). Yield increased in percentage of improved variety of Hachalu over local check were 1.56%. This indicated that using improved variety of Hachalu were relatively more productive than local variety with the same area and management. The minimum yield was scored due to insufficient rainfall encountered in the area. There was no statistical difference between the yield of improved varieties and local check on farmer's field at 5% significance level.

Capacity building and experiment evaluation

Mini field day was organized on faba bean technology with consideration of different stakeholders (Farmers, Development agents and Experts of the district) at Arbarakate kebele of Chiro Zuria district. Thus, twenty six (26) male and five (5) female households were participated on field day organized at Chiro (Arbarakate kebele). Extension personnel (one male) and three male development agents were also participated with farmers to evaluate the experiment. For variety selection on field, researcher has divided farmers into three groups with combination of Development agents (DAs) and Subject Matter Specialist (SMS). The group of farmers and DAs leaded by SMS putted their own criteria to evaluate the technology by observing on field. Each group has given his own value to the experiment on demonstration plot. As it was discussed in Table 4 the values given by group of farmers were summarized and its average was ranked by their participation.

Table 18. Participant's preference on faba bean varieties on mini field day

Varieties	PE	SS	B	SS	DR	DrR	EM	PH	TS	Rank
Hachalu	4.7	4.3	4	4.17	4.3	4.3	3.5	4.5	33.77	1st
Tumsa	3.5	3	3.7	3.5	4.3	4.7	3.5	7	29.9	2nd
Local	3.58	4	4.4	4.3	2.5	2.83	4.5	3.7	29.81	3rd

Note: 5=Excellent, 4=very good, 3=good, 2=Fair, 1=Poor

PE= Plant establishment, SS= Stem strength, NB= number of branches, SS=seed size, DsR= disease resistance, DrR= drought resistance, EM= early maturity, PH= plant height and TS= total score

Source: Own result, 2016

A group of farmers, development agents and experts have selected Hachalu and Tumsa variety as a first and second, respectively based on overall averages of selection criteria's listed above (Table 4).

Economic benefit gained

Costs incurred and benefit gained from the project is discussed in detail as follows. The result of Table 5 and 6 indicated that maximum gross margin of 30,204.38Birr/ha and net benefit of 14,394Birr/ha were gained from Hachalu variety with same inputs and costs incurred to it with Tumsa during the project life time. Minimum gross margin of 24,680.63Birr/ha and least net benefit of 8,871Birr/ha were recorded from Tumsa variety (Table 4 and 5).

Table 4. Cost incurred to the projects

Varieties	**Cost of inputs (ETB)**				
	Plough	**Sowing**	**Seed**	**Fertilizer**	**Total**
Hachalu	6670	5340	2500	1300	15,810
Tumsa	6670	5340	2500	1300	15,810
Local	6670	5340	2300	1300	15,610

Source: Our result, 2017

Table 5. Net benefit gained from the project

Variety	Average Yield (kg/ha)	Market price of output Birr/kg	TR(P*Q)	TC	Net Benefit
Hachalu	2013.625	15	30,204.38	15,810	14,394
Tumsa	1645.375	15	24,680.63	15,810	8,871
Local	1982.875	15	29,743.13	15,610	14,133

Source: Our result, 2017

Conclusions and Recommendations

The result of the study indicated that Hachalu variety has maximum mean yield and 1.56% more yield advantage than local variety. Based on yield obtained and farmers preferences, Hachalu variety was selected than Tumsa and local varieties. The independent t-test result implied that there was no statistical difference between the yield of improved varieties and local check on farmer's field at 5% significance level. The partial budget analysis result implied that Hachalu variety has more economic advantage than local variety. Therefore, Hachalu variety was recommended for further scaling up and popularization in study area and similar agro- ecologies.

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Pre-scaling up of Improved Finger Millet Technologies: The Case of Daro Lebu and Habro Districts of West Hararghe Zone, Oromia National Regional State, Ethiopia.

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Abstract

Absence of hierarchy of technology dissemination is a factor that affects technology utilization and adoption by the end-users. This study investigated pre-scaling up of improved finger millet varieties in Daro Lebu and Habro districts. Enhancing production and productivity of improved finger millet varieties through improving knowledge and skills of farmers and creating linkage among actors is the major objective of the activity. A total of 160 farmers were addressed in four kebeles and two districts of West Hararghe zone. Site and farmers have been selected purposively based on potential production of the commodity and others criteria's. Both qualitative and quantitative data are collected and analyzed using narration and descriptive as well as inferential statistics using SPSS software, respectively. Extension services such as advisory, inputs, training and field day were delivered and organized for the farmers, extension agents and others stakeholders in the area. Awareness creation was also conducted on improved finger millet production through media exposure and printed extension materials on field days. The average yield obtained from a hectare of land is accounted that 28.31 and 20.88 quintals for Boneya and Tadesse varieties, respectively. Therefore, scaling up of improved finger millet varieties for wider community over locations should be strengthen and conducted by government sectors, non-governmental organizations and others private sectors for improving production and productivity of the crop thereby addressing food security in a sustainable manner.

Key words: *Scaling up, Improved Varieties, Technologies, Finger millet, Linkages, Awareness*

Introduction

Finger millet (*Eleusine coracana* (L.) Gaertn) subspecies *coracana* belongs to the family Poeceae (Hilu *et al*., 1976). It was earlier thought that cultivated *E. coracana* originated from *E. indica*, of which the distribution is quite wide, from Africa eastwards to Java. Millets are the most important cereals of the semi-arid zones of the world. For millions of people in Africa and Asia they are staple crops. Among millet crops, finger millet figures prominently; it ranks fourth in importance after sorghum, pearl millet and foxtail millet (Global Crop Diversity Trust [GCDT], 2012). The global annual planting area of finger millet is estimated at around 4-4.5 million hectares, with a total production of 5 million tons of grains, of which India alone produces about 2.2 million tons and Africa about 2 million tons. The rest comes from other countries in South Asia. The important finger millet growing countries in eastern and southern Africa have been especially the sub-humid regions of Ethiopia, Kenya, Malawi, Tanzania, Uganda, Zaire, Zambia and Zimbabwe. Similarly in South Asia the crop is largely grown in India, Nepal and, to some

extent, in Bhutan and Sri Lanka. Finger millet is reported to be grown in both China and Japan to a limited extent.

The archaeological findings of finger millet from Ethiopia date to about the third millennium BC (Hilu *et al*., 1979). The crop is mainly grown in the northern, north western and western parts of the country, especially during the main rainy season. The national annual production area of finger millet in 2016/17 cropping season is estimated at around 456,171.54 hectares, with a total production of 10.3 million quintals (Central Statistical Agency [CSA], 2017). Similarly, the annual finger millet area production in 2016/17 cropping season at Oromia region is estimated at 89,584.80 hectares, with a total production of 2 million quintals. A total of 45,698 farmers produced finger millet in 2016/17 cropping season at West Hararghe zone.

Finger millet cultivation is more widespread in terms of its geographical adaptation as compared to other millets. It has the ability to withstand varied conditions of heat, drought, humidity and tropical weather (GCDT, 2012). Also it has high nutritional value and excellent storage qualities. Its grain contains 9.2% protein, 1.29% fat, 76.32% carbohydrates, 2.24% minerals, 3.99% ash and 0.33% calcium. In Ethiopia, the grain is used for making native bread, *injera*, porridge, cake, soup, traditional breakfast called "*Chachabsa*" malt, local beer, and distilled spirit (*Areki*) alone or in mixture with *teff*, maize and barley (Asfaw *et al*., 2011; Wadajo, 2015). Finger millet can be stored for period up to ten years or more without deterioration and weevil damage. Nevertheless, its productivity is very low mainly due to shortage of improved varieties (Birhanu, 2015), weeds, insect (termite), diseases (blast), rat damage, shortage of rainfall worm attacks improper application of inputs (fertilizers and seed) and traditional management practices (Tefera and Adane, 2013).

Generation and dissemination of new improved varieties, training and demonstration on crop production and management were strategies revealed by different authors for improving production and productivity of the crop (Tefera and Adane, 2013). Under research circumstances once new technologies released, verified and adapted, the next step is conducting pilot test/demonstration on small number of farmer's field. All full packages of technology were shown to the farmers in participatory way. Then, selected technologies were settled for further popularization and scaling up to create awareness towards technologies thereby improving livelihoods and food security status of the households in mandate area.

Similarly, adaptation trial under research station and pilot test were conducted on finger millet varieties on farmer's field. Accordingly, *Boneya* (27.5Qt/ha) and *Tadesse* (24.5Qt/ha) were outstanding varieties in resistance of drought, yield and other parameters than local cultivar. Again in 2012, popularization and promotion of *Boneya* variety was conducted both in Habro and Daro Lebu districts. A total of 51 farmers, seven *kebeles* and 4.5 hectare of land have been addressed through technology promotion and popularization programs. Therefore, the activity was initiated in order to pre scaling improved finger millet variety in Daro Lebu and Habro districts to improve smallholder's productivity and production.

Objectives

1. To enhance production and productivity of smallholders farmers through providing improved variety of finger millet in the study area.
2. To strengthen linkage among actors and partners by creating rate of dissemination.

3. To improve farmers' knowledge and skill on production of finger millet in the study area.

Methodology

Description of the study area

Daro Lebu is one of the districts found under West Hararghe Zone. The capital town of the district Mechara is found at about 434 km South East of Addis Ababa. The district is situated between $7^{o}52'10''$ and $8^{o}42'30''$ N and $4^{o}023'57''$ and $41^{o}9'14''$ E. at $08^{o}35'.589''$North and 40° 19'114"East. The district is characterized mostly by flat and undulating land features with altitude ranging from 1350 up to 2450 m.a.s.l. Ambient temperature of the district ranges from 14^{0}C to 26^{0}C with average of 16^{0}C with average annual rainfall of 963 mm/year. The pattern of rain fall is bimodal and its distribution is mostly uneven. Generally, there are two rainy seasons: the short rainy season '*Belg*' lasts from mid-February to April whereas the long rainy season '*kiremt*' is from June to September. The rainfall is erratic; onset is unpredictable, its distribution and amount are also quite irregular. Consequently most *kebeles* frequently face shortage of rain; hence moisture stress is one of major production constraints in the district (Daro Labu District Office of Agriculture and Natural Resource [DLDoANRO], 2016). The district has an estimated total population of 239,222, of whom 122, 386 were males and 116,836 were females; 23,609 of its population were urban dwellers, whereas 215, 613 were rural dwellers (CSA, 2013).

The district covers an area of 210, 280 hectares and divided in to 37 *kebeles* and 3 rural towns of which 23 *kebeles* in lowland and 17 *kebeles* are in mid-land areas. The livelihood of the people in the district is predominantly dependent on mixed farming. Crop and livestock production are the major means of livelihood of the rural community. Most commonly grown crops include maize, sorghum, groundnuts, coffee, *khat* and haricot been. The major animals kept in the area are cattle, goats, sheep's, donkeys, chickens and bees (DLDoANRO, 2016).

Habro district is another district in West Hararghe zone of Oromia region. The district has an altitude range from 1600-2400 m.a.s.l. The mean annual rainfall of the district is 1010 mm and the annual temperature ranges from 5-32°C (Habro District Office of Agriculture and Natural Resource [HDoANRO], 2016). The rainfall pattern in the area is uni-modal with high amount of rainfall occurring during the main rainy season between June to September (*Kiremt*) and the short rainy season stretching from March to June (Belg). The highest rainfall is received in August. The agro-ecology of the district comprises highland (19%), mid-altitude (50%) and lowland (31%) areas (Mengistu *et al*., 2016). It occupies a total area of 725 km^2 i.e. about 4.2% of the zonal total area. The district has an estimated total population of 244,444; of whom 126,176 were men and 118,268 were women (CSA 2013).

Mixed crop-livestock agriculture is a common farming system in the study area. The main crops grown in the area are cereals such as *teff (Eragrostis tef)*, maize *(Zea mays)*, wheat *(Triticum aestivum*), barley *(Hordeum vulgare*), haricot bean (*Phaseolus vulgaris*) and sorghum (*Sorghum bicolor*) and cash crops such as coffee (*Coffea arabica*), *chat* (*Catha edulis*), pepper (*Capsicum species*) and onion (*Alluim cepa*). The major animals kept in the area are cattle, goats, donkeys, chickens and bees (HDoANRO, 2016).

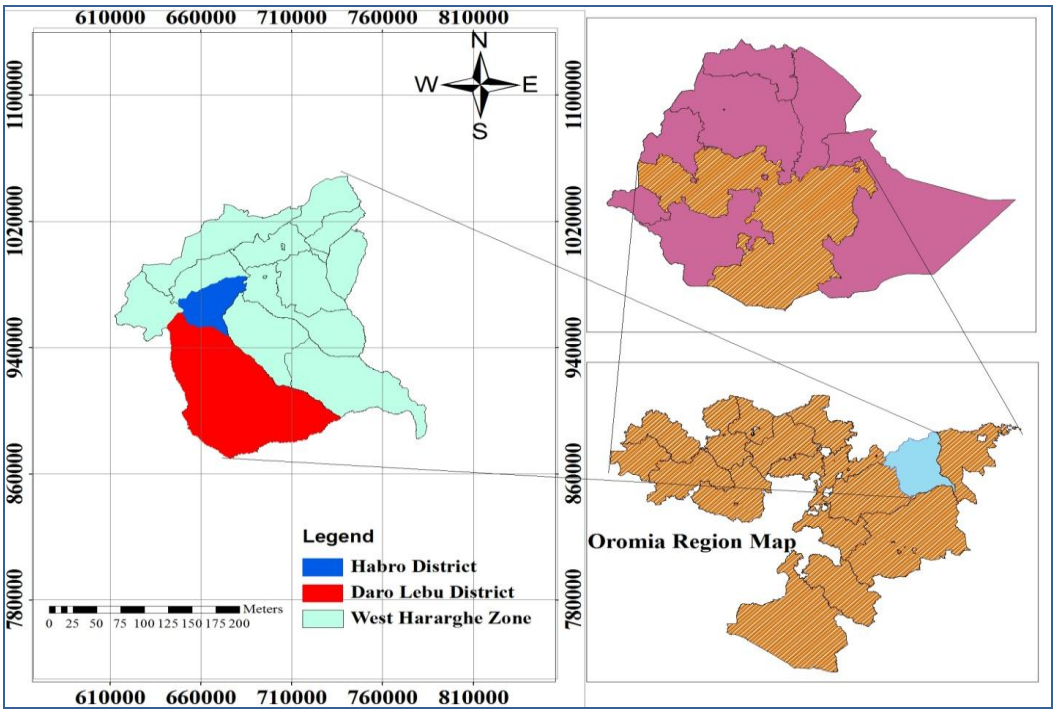


Figure 1. Map of study areas
Source: Own design, 2017

Overview of production of finger millet in Western Hararghe Zone

Finger millet is one of the cereal crops produced other than maize, sorghum, *teff* and other cereals crop in the area. It is one of top six cereal crops produced next to sorghum, maize, barely, *teff and* wheat in the area in 2014 (CSA, 2015). The average yield obtained from the crop was accounted 14.91Qt/ha. The data obtained from Central Statistical Authority of Ethiopia indicated that the number of producers of finger for last five years was relatively increased from year to years (Figure 2). But, improved seed shortage and drought are affecting production and productivity of finger millet in the area.

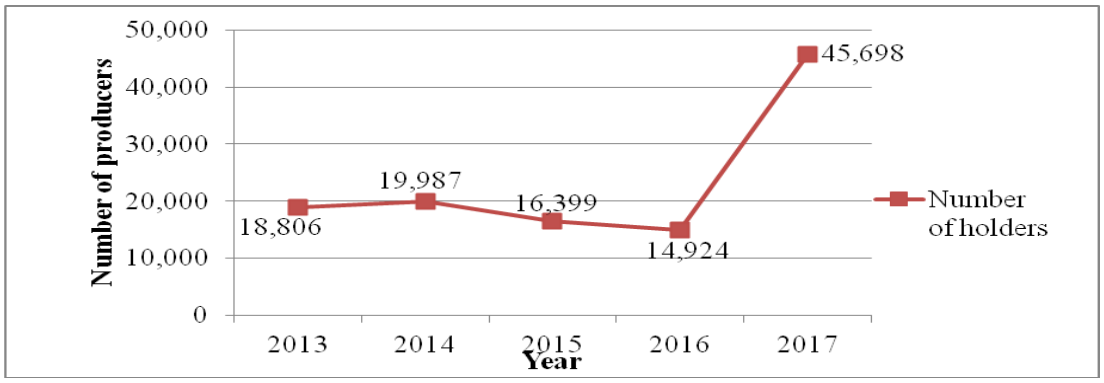


Figure 2. Finger millet producer in West Hararghe Zone for last five years.

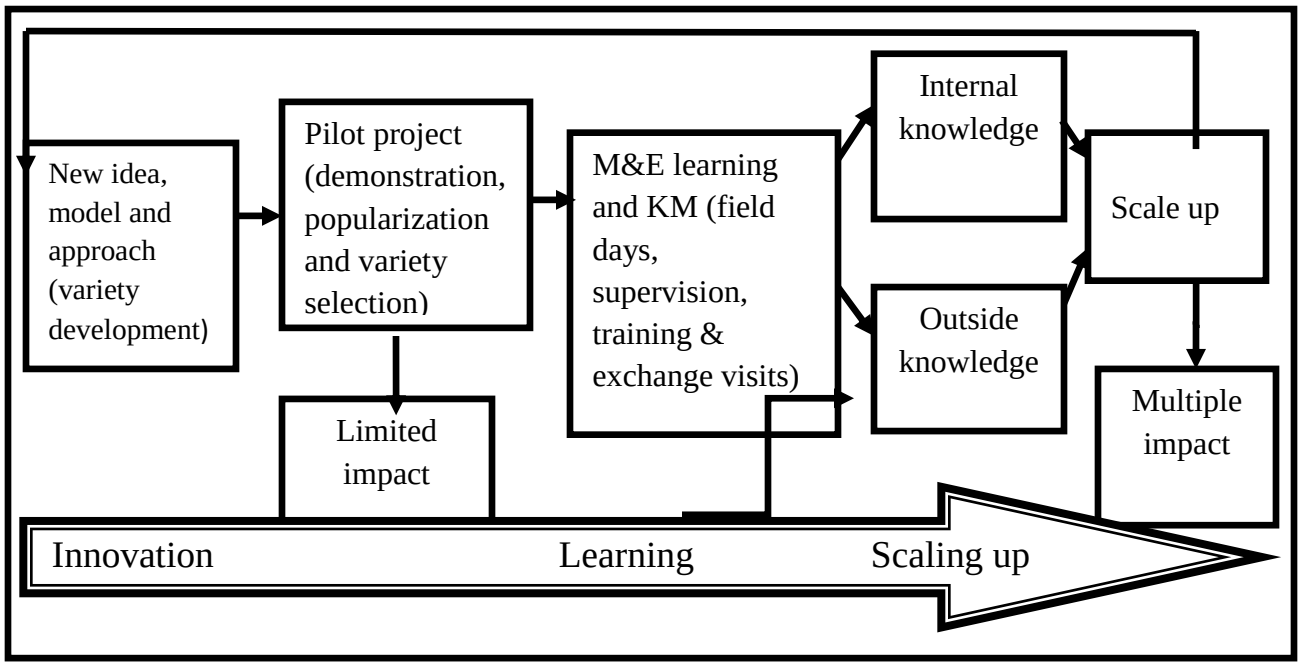
Source: CSA, 2013-2017

Site and farmer selection

The study was conducted for one year in 2016 at Daro Lebu and Habro districts of West Hararghe zone. Expert meeting were undertaken for site and farmer selection. Thus, major finger millet producing PAs and farmers were selected in collaboration with district Agricultural and Natural Resources Office. Accordingly, two *kebeles* from each district were selected purposively based on finger millet production potentials. A total of 160 farmers were selected from two districts based on the selection criteria like working ability of farmer, gender balance, willingness to allocate land for scaling up, willingness to take whether the research result or risk, promise to manage the field and ability to cooperate and interest to the crop and agro-ecology of the area. An average of 0.125ha of land is used for the activity on each of the selected farmers.

Finger millet scaling up process

Based on result of demonstration and evaluation conducted on farmers' field in 2009 and 2010 in Habro and Daro Lebu districts, promotion of the two selected varieties namely *Boneya* and *Tadesse* was conducted in 2011 and 2012 by increasing number of farmers and locations to create wider awareness and use of the technologies through field days, media exposure and other mechanisms. Accordingly, scaling up of improved finger millet varieties was conducted on large number of farmers and over locations to create large impacts.



Source: Adopted from Linn et al. (2011)
Figure 3. Innovation, learning and scaling up linkages in agricultural technologies

Types of Data and Methods of Data Collection

Qualitative and quantitative data were collected through close supervision and following up of the activity with joint action of the stakeholders. Data record sheet has been developed to collect the data. Thus, field observation, contacting the target farmer and focus group discussion during the field visit were the data collection methods. Biological data such as yield data and farmers' preference toward the variety were collected from farmer's field.

Methods of Data Analysis

Qualitative data like farmers' preference was analyzed by descriptive analysis and narration while quantitative data was analyzed by using SPSS v.20 software.

Method of communicating the result

Field days, building local farmer to farmer networking, training and print materials (Leaflets, banners, posters, mass media/TVO, etc) were the methods of communicating the result in order to create impact in the project location.

Improved varieties of finger millet traits

Both varieties of finger millet described in Table 1 are produced for long period of time in Ethiopia. *Boneya* variety is released by Bako Agricultural Research Center operated under Oromia Agricultural Research Institute whereas *Tadesse* variety is released by Melkassa Agricultural Research Center that operated under Ethiopian Institute of Agricultural Research. The varieties are different in morphological characteristics.

Table 1. Traits of improved finger millet varieties

Variety	Year of release	Area of adaptation		Maturity days	Yield (kg/ha)		Production Status
		Altitude (m)	Rainfall (mm)		On-research field	On- farm field	
Tadesse	1999	1600-1900	≥700	120-130	3000-4500	2700	under production
Boneya	2002	1400-1900	1200-1300	145	2500-3000	2200	under production

Source: EARO, 2004

Results and Discussions

Seed distribution

Based on fact and figure obtained during earlier conducted demonstration and promotion experiment, both varieties shown better performance in terms of yield, drought tolerant and others parameters than local cultivars. The varieties were recommended both by farmers and researchers interest for further dissemination and multiplication in the area. Accordingly, *Boneya* and *Tadesse* varieties seed were

multiplied by the center and supplied for further dissemination. A total of two *kebeles* and 160 farmers from both district produced improved finger millet varieties in 20 hectares of lands (Table 2). A total of 5.6 quintals of improved varieties delivered to the farmers, of which 2.66 quintals were *Boneya* and 2.94 quintals were *Tadesse* variety. The required amount of fertilizer rate is covered by the farmers themselves to apply cost-sharing extension approach.

Table 2. Summary of inputs procured to the farmers

District	*Kebeles*	Varieties	Farmers	Amount given (Qt)	Area covered (Ha)
Daro Lebu	Kotara	*Boneya*	38	1.33	4.75
	Kortu	*Tadesse*	37	1.295	4.625
Habro	Lugo	Tadese	47	1.645	5.875
	Garbi Goba	Boneya	38	1.33	4.75
	Total		160	5.6	20

Source: Own results, 2016

Advisory services

Advisory services are one of extension services given to the farmers through public and private extension systems. In our country, advisory service is highly dominated by public extension system that is given through extension agents, researchers and agricultural professionals. Farmers obtained advisory services from beginning up to the end of activity on improved finger millet varieties and practices. The advisory services are given to the farmers at different stages of productions mainly by researchers and extension agents. During seed distribution, a sort of orientation on row preparation and sowing and fertilizer application is given by researchers to selected farmers for production purposes. During supervision, information on weeding practices, harvesting and overall management required for the varieties were delivered to producing farmers mainly by researchers, extension agents and experts.

All agronomic practices and packages of technologies required for the varieties have been applied on farmer's field. But, all farmers did not apply the agronomic practices required for the varieties on their field. Broadcast sowing; reduce number of seed rate and increasing and decreasing farm allocation to finger millet varieties were problems observed on some of farmers' field.

Training of farmers and development agents

Besides advisory services, training was prepared for the farmers, extension agents and agricultural experts on finger millet agronomic practices, production and pre-harvest and post-harvest managements to improve knowledge, skills and attitudes of trainees. As indicated in Table 3, a total of 15 farmers, 9 extension agents and 7 agricultural experts were participating in training program. Due to budget shortage, all farmers did not participate in training program. Out of 160 finger millet producer farmers, 15 model farmers were selected by different criteria's such as role model, ability to transmit information, communicator and others. Extension agents and participant farmers transmitted information shared from training to the non-participant farmers. Participatory training method was followed during implementation of training program for sharing knowledge's, skills and experiences own on finger millet productions.

Table 19.Training participants on finger millet production and management

Districts	Farmers			Development Agents			Experts		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
Daro Lebu	7	0	7	3	0	3	3	0	3
Habro	7	1	8	5	1	6	4	0	4
Total	14	1	15	8	1	9	7	0	7

Source: Own results, 2016

Field day

Field day is one of extension services and methods used to transmit information and awareness creation for larger audience. Field day can be organized at different stages in crop production systems. It can be two or three times which the stages are at vegetative, flowering and maturity depending on crop type and nature produced. Field day is used as tool to address large number of farmers, even invited farmer who did not produce improved finger millet varieties to create massive awareness and large impacts on technologies for further production and scale up on farmers field. Not only farmers but also others stakeholder were also invited to participate on the program. In addition, during field day mass extension methods e.g. leaflets, banner and Radio/Television were used to reach large audience.

Accordingly, a total of 88 farmers, 8 development agents and 22 experts from district government offices and research office were participating on field day (Table 4). Besides, the field day, the program was transmitted on news program by Oromia Broadcasting Network to disseminate information for wider community. A total of 120 leaflets were distributed for the participants which describes the production, agronomic practices and overall managements of improved finger millet varieties. Finally, at the end of visit during field day, group discussion was conducted to grasp farmer's feedback on strength and weakness of improved finger millet varieties. Besides, constraints in agricultural production (weeds like striga, wilt on chickpea and climate change); needs and interest of farmers on others improved varieties such as early maturing sorghum and chickpea and timely distribution of seeds are points rose by participants on the program. Accordingly, *Tadesse* variety was more preferred than *Boneya* variety due to its color, number of branches, height, drought tolerance and yield advantages.

Table 4. Participants of field day in Habro district

Location of field day	Types of varieties	Participants								
		Farmers			Development agents			Experts		
		M	F	T	M	F	T	M	F	T
Habro district (Lugo and Garbi Goba *kebeles*)	*Boneya* and *Tadesse* varieties	82	6	88	7	1	8	20	2	22

Note: M stands for Male, F stands for Female and T stands for Total
Source: Own results, 2016

Yield obtained from finger millet varieties

Mean yield of finger millet varieties

The average yield obtained from farmers per unit area is accounted 6.04 and 2.98 quintals for *Boneya* and *Tadesse* varieties, respectively. Similarly, the average yield obtained from a hectare of land is accounted 28.31 and 20.88 quintals for *Boneya* and *Tadesse* varieties, respectively. The independent sample t-test indicated that there was significant difference between *Boneya* and *Tadesse* varieties of finger millet crops in terms of total yield per unit area and total yield per hectare at 1% and 5% significance level, respectively (Table 5). *Boneya* variety was higher yielder than *Tadesse* variety on farmer's field due to high number fingers per plants, disease and drought tolerant. But, the studies conducted in North Western Ethiopia indicate that *Tadesse* variety was high yielder than *Boneya* variety on farmer's field due to agro-ecologies, disease effect, soil character and field management and other factors (Molla, 2012).

Table 5. Mean yield of finger millet varieties in study area

Yield components	Varieties	N	Mean	Std. Dev.	t-value
Yield per unit area	*Boneya*	17	6.04	3.95	3.019**
(Qt/0.125ha)	*Tadesse*	59	2.98	2.49	*
Total yield per hectare	*Boneya*	17	28.31	13.14	2.063**
(Qt/ha)	*Tadesse*	59	20.88	13.06	

*** and ** indicates significant at 1% and 5% level

Source: Own computation, 2017

Yield comparison against location

Production of crops is different from place to place due to environmental conditions, farmer's indigenous knowledge on farming, soil characters, extension services, infrastructure and others factors. The average yield of finger millet varieties per hectare in Habro and Daro Lebu districts farmers are accounted 31.88 and 13.20 quintals, respectively (Table 6). Farmers in Habro district have more experience on finger millet production than farmers in Daro Lebu district. The independent sample t-test indicated that there was significant difference between Habro and Daro Lebu districts producers of finger millet crop in terms of total yield per unit area and total yield per hectare at 1% significance level. Farmers in Habro district have been producing more cereal crops than Daro Lebu district farmers due to soil character of the area suitable for cereal and other food crops whereas cash crops is mainly produced by Daro Lebu district farmers.

Table 6. Mean yield obtained from finger millet varieties in study area

Yield components	Districts	N	Mean	Std. Dev.	t-value
Yield per unit area	Habro	38	5.68	3.18	7.346***
(Qt/0.125ha)	Daro Lebu	38	1.65	1.14	
Total yield per hectare	Habro	38	31.88	9.94	8.529***
(Qt/ha)	Daro Lebu	38	13.20	9.14	

*** indicates significant at 1% level

Source: Own computation, 2017

Yield comparison against earlier studies

Finger millet improved varieties trials were conducted at different stages to address large number of farmers based on their needs and interest towards technologies at different locations. Adaptation trials of finger millet varieties were conducted at Mechara research stations in 2008 through comparing over four varieties. Accordingly, *Boneya* and *Tadesse* varieties were recommended for further evaluation in similar agro-ecologies due to high yielder, disease and drought tolerant than other varieties. Based on result obtained during adaptation stages, demonstration and promotion have been conducted on farmer's field at Habro and Daro Lebu districts in 2009 and 2012 to evaluate and create demand towards technologies under farmer's contexts, respectively. The results obtained from the study indicate that *Boneya* variety was high yielder than *Tadesse* variety on farmer's field and on-stations.

The yields obtained during demonstration stage from *Boneya* and *Tadesse* varieties were decreased by 9 and 6.5 quintals from adaptation trials stage, respectively (Table 7). The experiments were managed on-stations during adaptation stages by researchers and other supportive staffs. Day to day monitoring and follow up, continuous management and full agronomic packages were implemented on-stations than on farmer's field which created yield difference on similar crops between farmers and research fields. In general, yield obtained from finger millet varieties at adaptation trial stage is higher than demonstration and scaling up stages due to above factors whereas yield obtained during demonstration and scaling up stages was close each other by varieties due to implemented under farmers conditions.

Table 7. Stages of improved finger millet varieties production in the area

Varieties	Yield (Qt/ha)		
	Adaptation stage	Demonstration stage	Scaling up stage
Boneya	37	27.5	28.31
Tadesse	31	24.5	20.88

Source: Own computation, 2017

Conclusions and Recommendations

Conclusions

The number of finger millet producers in West Hararghe zone was relatively increased from year to years due to dissemination of improved agricultural technologies increament from earlier years.Path of improved agricultural technologies in agricultural research centers started from technologies development up to impact evaluation on farmer's livelihoods. Adaptation of improved finger millet trails was conducted in 2008 whereas demonstration is conducted in 2009 and also popularization is implemented in 2012 in Habro and Daro Lebu districts to create large impacts on farmer's views.

Extension services such as improved finger millet varieties, advisory services during follow up, training and field day were delivered and organized jointly to the farmers, extension agents, experts from different disciplines and others stakeholders. Besides, awareness rising program such as media exposure, printed extension materials and group discussion were conducted to boost technologies for large number of users.

The average yield obtained from a hectare of land is accounted 28.31 and 20.88 quintals for *Boneya* and *Tadesse* varieties, respectively. The yield difference occurred due to high number fingers per plants, disease and drought tolerant of *Boneya* over *Tadesse* varieties in the area. The independent sample t-test result indicate that there was significant difference between *Boneya* and *Tadesse* varieties as well as Habro and Daro Lebu districts in terms of yield per unit area and hectare at 1% and 5% significance level, respectively.

Yield obtained from finger millet varieties at adaptation trial stagewas higher than demonstration and scaling up stages due to day to day monitoring and follow up, continuous management and full agronomic packages conducted by researchers at research fields whereas yield obtained during demonstration and scaling up stages was close to each other by varieties due to implemented under farmers' conditions.

Recommendations

Based on results obtained and conclusions made, the following recommendations are given to responsible body.

- Path way of agricultural technologies dissemination and transfer should be strengthened more than current ways to address large number of farmers.
- It is advisable to apply cluster approach for technology scaling up under farmers fields to address large number of farmers and to protect quality of seed for further multiplications.
- It is better to strengthen current awareness raising program through using different communication techniques.
- It is better to reduce yield gap between research and farmers field through applying continuous management and full agronomic practices on farmer's field.
- It is better to scale up improve finger millet varieties on large number of end-users through horizontal and vertical scaling up approach to create impacts on farmers livelihoods.

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Demonstration of Maize-Soy bean Intercropping Practices on Smallholder Farmers in Daro Lebu and Habro Districts of West Hararghe Zone, Oromia National Regional State of Ethiopia

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Abstract

The experiment was carried out in Daro Lebu and Habro districts of West Harerghe Zone with the objectives of evaluating maize-soy bean intercropping practices under farmers' condition and creates awareness on soya bean production and its purpose for smallholder farmers. Two kebeles were selected purposively based on intercropping practices and their production potential to the selected crops. Three farmers and one Farmers Training Center were participated depending on their interest to the technology, managing the experiment, have appropriate land for the experiment and taking the risk. Improved variety of Maize (Melkassa -2) and Soya bean (Awassa-95) were selected for intercropping and evaluated on farmers' field. The experiment has three treatments Maize sole, Soya bean sole and Maize-

soya bean intercropping. Each treatment was designed on 100m^2 demonstration plots. 32kg/ha of DAP at the time of sowing were applied to maize sole with the recommended seed rate. Both quantitative and qualitative data were collected through observation, group discussion on field day and data recording sheet. Quantitative data collected were analyzed by descriptive analysis and inferential statistics while qualitative data were analyzed trough simple ranking and summarization. The land equivalent ratio result indicated that intercropping of Maize (Melkassa-2) with Soya bean (Awassa-9) has more yield advantage than sole crop. Therefore, intercropping of maize (Melkassa-2) with Soya bean (Awassa-95) was recommended for further popularization and scaling up in study area and similar agro ecology.

Key words: *Maize, Soya Bean, Demonstration, Evaluation, Intercropping, Land Equivalent Ratio*

Introduction

Cropping system is very important for weed control, considering that weeds can cause great damages to crops and decreased yield (Videnović *et al*., 2013). Smallholder farmers are the most important food insecure in Sub-Saharan Africa (Food and Agriculture Organization [FAO], 2011), who mainly practiced subsistence farming agricultural characterized by low productivity due to soil nutrient depletion (Mugwe *et al.,* 2007). Improvement in productivity of cereals and legumes especially maize and legumes would improve farmers' income and reduce poverty of smallholder. Maize (*Zea may* L.) has been recognized as a common and dominant main component crop in most intercropping systems because of its complementary effects in many legumes crops. Therefore, in maize-legumes intercropping system maize with more than one crop recorded higher yields implying that maize-based cropping system is a good strategy of maximizing land use efficiency in the face of land scarcity (Owusu *et al.*, 2015). In Bangladesh Maize is a very common, popular and multi uses cereal crop at present situation. Every year a huge amount of maize grain is required as feed and fodder for poultry and livestock sector and most of them are imported (Sarker *et al.*, 2013).

In Ethiopia, 36,635.79ha of total land were covered by soy bean production under peasant holdings (Central Statistical Agency [CSA], 2017). Soy bean is one of the pre-eminent crop in providing cheap and inexpensive protein (40%) and oil (20%) which determines the economic worth of the crop on the globe (Thomas and Erostus, 2008). In West Hararghe Zone, chat/sorghum, chat/maize, chat/sweet potato, sorghum/legumes and maize/legumes are of the common types of intercropping system practiced by farmers (Kinde *et al.,* 2015). Out of this, intercropping system cereal-legume intercropping is widely practiced in West Hararghe Zone. Hence, the use of such cropping system in the study area is attributed to high density of population to assure yield stability and maintaining a sustainable yield over the year.

But, plant population, time of sowing, row sowing and other agronomic practices are major gaps observed on intercropping practices under farmer's field. An improved agronomic practice on maize-soya bean intercropping has been generated to the areas on research fields. The agronomic study was conducted on maize soy bean intercropping systems under research fields in the area. The yield advantages of intercropping over sole cropping of maize (Melkasa-2 variety) and soy bean (Awassa-95 variety) were recommended with its agronomic practices (Wondimu *et al.,* 2016). This study did not consider farmers preferences and demonstrated to the farmers at different locations to address gap observed under farmer's

field. Hence, the study was initiated to evaluate maize-soy bean intercropping practices under farmer's condition and to create awareness on soy bean production for smallholder farmers in the study area.

Methodology

Description of the Study Area

Daro Lebu is one of the districts found under West Hararghe Zone. The capital town of the district is Mechara that found at about 434 km South East of Addis Ababa. The district is situated between $7^{o}52'10''$and $8^{o}42'30''$ N and $4^{o}023'57''$ and $41^{o}9'14''$E. The district is characterized mostly by flat and undulating land features with altitude ranging from 1350 up to 2450 m.a.s.l. The ambient annual temperature of the district ranges from 14°C to 26°C with average of 16°C and with average annual rainfall of 963mm/year. The pattern of rainfall is bimodal and its distribution is mostly uneven. Generally, there are two rainy seasons: the short rainy season '*Belg*' lasts from mid-February to April whereas the long rainy season '*kiremt*' is from June to September. The rainfall is erratic; onset is unpredictable, its distribution and amount are also quite irregular. Consequently most *kebeles* frequently face shortage of rain; hence moisture stress is one of major production constraints in the district (Daro Labu Woreda Agriculture and Natural Resource Office (DLWANRO, 2015).

Habro district is similarly found in West Hararghe zone. The district has an altitude range from 1600-2400 m.a.s.l. and annual rainfall of 650mm and 1000mm while the average temperature of the district is 18°C. The dominant soil type of the district is black sandy and loam (Aman and Anteneh, 2010). Habro district consists of *Weynadega* (mid-highland) (57%), *Kola* (lowland) (25%) and *Dega* (highland) (18%) agro climatic zones. It occupies a total area of 725 km^2 i.e. about 4.2% of the zonal total area. The rainfall pattern in the area is uni-modal with high amount of rainfall occurring during the main rainy season between June to September (*Kiremt)* and the short rainy season stretching from March to June (*Belg*). The highest rainfall is received in August. The mean annual temperature was 20°C with the hottest months being March, April and July (Dereje, 2013).

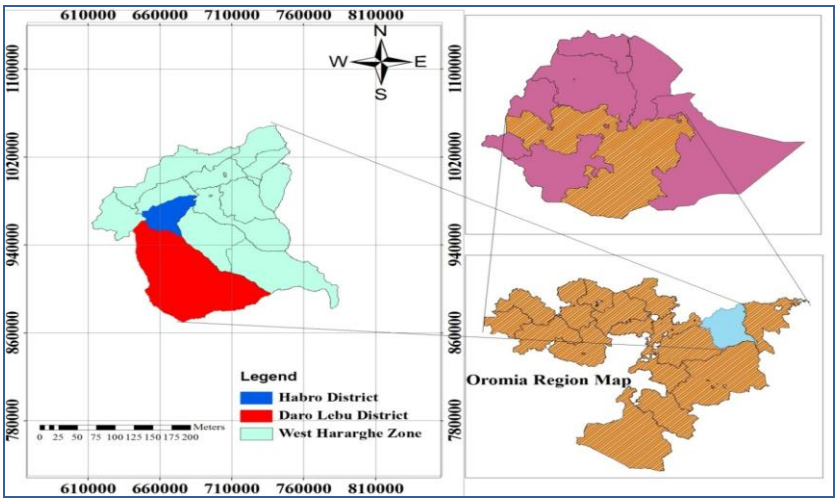

Figure 10. Map of study areas
Source: Own design, 2017

Farmers and Site Selection

The activity was conducted for one year in Daro Lebu and Habro districts of West Harerghe zone. Sakina *kebele* from Daro Lebu and Kufa Kas *kebele* from Habro District were selected purposively based on intercropping practises and their production potential to the selected crops. Three farmers and one FTC were participated depending on their interest to the technology, managing the experiment and suitable land for the experiment.

Research Design

Improved variety of maize (Melkassa -2 variety) and soya bean (Awassa-95 variety) were selected for intercropping and evaluation on farmers' field. The experiment has three treatments which were maize sole, soya bean sole and maize-soya bean intercropping. Each treatment was intended to demonstrate on 10m by 10m (100m^2) of land. Appropriate seed rate and fertilizer, 0.25kg for maize and 0.32 gm seed soya bean and 32kg/ha DAP at the time of sowing were used for maize and soya bean intercropping whereas 0.25kg of seed for maize and 0.6kg for soya bean and 1kg of DAP and 0.5kg of UREA were used for maize sole cropping. Distance of 75cm and 25cm between row and plant were applied for sowing of maize (Melkassa-2 variety). Soya bean were sowed with the distance 37.5 cm between row and 10cm between plants. The populations of maize and soya bean were 100% of maze seed were intercropped with 53.3% of soya bean as additive series between two maize rows. (Philip *et al*., 2014) also used the intercrop of maize and soy bean in 100% of the sole maize population and 53.3% of soy bean population intercropped as additive series between the two maize rows.

Soya bean were sowed two weeks late after maize crop were sowed to avoid light and moisture competition. Similar to this study, Lulyalya and Eliakira (2016) concluded that sowing time of soya bean has significant effect on yield and yield components.

Table 1. Number of farmers and area used for demonstration purpose

Districts name	*Kebele*	No. of trail farmers	Area covered(m^2)
Daro Lebu	Sakina	3	900
Habro	Kufa Kas	1	300
Total		4	1200

Types of Data and Methods of Data Collection

Both quantitative and qualitative data were collected through observation, group discussion on field day and data recording sheet. Data like farmer preference on disease and pests, drought tolerant and yield were collected through the prepared data collection sheet/record sheet by organizing field day and observation on farmers' field. In addition, cost of inputs (seed, fertilizer, labor, land, etc) and outputs gained were collected by asking farmers and traders in the area.

Method of Data Analysis

Quantitative data were analyzed through descriptive (mean and standard deviation) and inferential (paired t-test) statistics while qualitative data were analyzed trough simple ranking and summarization.

According to Mostafa *et al*. (2013) indicated that land equivalent ratio (LER) is the most important issues in intercropping practices that helps to identify the yield advantage of sole crop over intercropped crops and calculated using the following formula.

$$LER = \sum \frac{\text{Yield of each plant in intercropping}}{\text{Maximun yield of plant in single culture}} \text{ ---------- (1)}$$

Economic benefit was analyzed through gross monetary advantage analysis. According to formula used by Sarker *et al.*, (2013) gross monetary advantage (GMA) was calculated by multiplying yields of the component crops by their respective current market price for both varieties of soy bean and maize yield and subtracting its total variable costs ,then dividing its product to total cost to obtain benefit cost ratio (GMA).

GMA= [(Q*P)-TVC)]/TC……. (2)

When Q is the output /yield gained, P is the current price of the crops and TVC is total variable cost or, GM= TR-TVC, where GM (gross margin), TR (total revenue) and TVC (total variable cost) GMA (BCR) =TR/TC, when BCR, TR and TC, benefit cost ratio, total revenue and total cost of the project, respectively.

Results and Discussion

Yield performance

Maize yield

The yield summary obtained from both maize and soya bean was discussed in detail (Table 2). The mean yield obtained from maize sole (Melkassa-2) and maize intercropping were accounted that 10.85Qt/ha and 10.68Qt/ha, respectively. Similarly, the results of yield obtained by other author in similar location from maize sole and maize intercropped were recorded that 21.67Q/ha and 20.11Qt/ha, respectively (Wondimu et *al.*, 2016). The difference in yield was observed due to presence of extreme drought in the study area in last year. The yield obtained from released maize (Melkassa-2) variety was accounted 45-55Qt/ha (EARO, 2004).

Soya bean yield

The mean yield obtained from Soya bean sole and intercropping were accounted that 3.53Qt/ha and 1.51Qt/ha, respectively (Table 2). As it was shown on the Table 2, yield of intercropped maize and soya bean gained were very low due to moisture, fertility and sun light competition occurred besides the occurrence of drought in last year.

Table 2. The mean yield obtained from maize and soy bean sole and intercropping practices.

Treatments	Yield harvested in Qt/ha (N=4)			
	Min	Max	Mean	Std. Dev.
Maize sole	4.00	26.80	10.85	10.77
Soya bean sole	0.20	7.90	3.53	3.52
Maize (intercropped	4.30	17.30	10.68	5.38
Soya bean intercropped	0.00	3.00	1.33	1.51

Source: Own result, 2017

Statistical mean comparison of the crops

The paired t-test was conducted to identify the statistical difference between sole cropping and intercropping practices on maize and soy bean crops on farmer's field. The result indicated that there was no statistical significant difference between the yield of intercropped and sole on farmers' field at 5% significance level.

Table 3. Paired t-test of sole and intercropping (N=4)

Treatments	**Mean**	**Std. Dev.**	**t-value**	**Sig.**
Maize sole Maize with soy bean	18.75	12.78	.029	0.978
Soy bean sole Soy bean with maize	2.34	2.31	2.023	0.136

Source: Own result, 2017

Economical yield advantage of the crops

Land equivalent ratio

The land equivalent ratio result showed that intercropping was more advantageous than sole crop in the area. The total LER of 1.36 shows that 36% more land would be needed to produce the combined yields of both crops if they were to be grown as pure stands (Table 4).

Table 4. Land equivalent ratio result of the crop

Crop	Intercrop yield in Qt/ha	Sole crop yield in Qt/ha	Partial LER
Maize	10.68	10.85	10.68/10.85=0.98
Soya bean	1.33	3.53	1.33/5.33=0.375
Total LER	-	-	**1.36**

Source: Own result, 2017

Gross monetary advantage

The yield difference observed between crops under both (sole and intercropped) practices have great role on creating gaps on economic returns gained from the activity. The price of the crop has obtained from traders that buy from farmers in the area.

Table 5. Gross benefit gained from the crops

Treatments	Mean yield (Qt/ha)	Price of output Qt/Birr	TR (P*Q)
Maize sole	10.85	900	9,765.00
Soya bean sole	3.53	1500	5,295.00
Intercropped maize	10.68	900	9,612.00
Intercropped soya bean	1.33	1500	1,995.00

Source: Own result, 2017.

The variable cost of inputs such as seed, fertilizer and labor were assessed through asking farmers in the area. The result of Table 6 indicated that the total labor forces required have their own difference to implement sole cropping and intercropping practices. Intercropping practices have advantages in reducing cost of fertilizer than sole cropping practices due to soy bean have great role in improving soil fertility status of farmer's field.

Table 6. Cost incurred for the inputs used for production

Treatments	Cost of inputs (ETB)			
	Seed	Fertilizer	Labor	Total
Maize sole	252.5	2900	6000	9,152.50
Soya bean sole	750	0	6000	6,750.00
Maize with soya bean	652.5	510	7200	8,362.50

Source: Own result, 2017

The result of gross margin advantage analysis indicated that the highest gross margin was obtained from maize intercropped with soya bean 3,244.50Birr with benefit cost ratio (BCR) of 0.71 (Table 7). Thus, economically intercropping of maize with soya bean have more advantage than sole crop in terms of intensive use of land to produce more production and productivity with fixed cost of inputs.

Table 7. Net benefit gained from the implementation of crops production.

Treatments	TR (ETB)	*TVC (ETB)	GM (ETB)	GMA(BCR)
Maize sole	9,765.00	9152.50	612.50	0.56
Soya bean sole	5,295.00	6750.00	-1,455.00	0.14
Maize with soya bean	11,607.00	8362.50	3,244.50	0.71

*TVC includes cost of inputs (seed, fertilizer, labor and plough cost).

Source: Own result, 2017.

Capacity building and experiment evaluation

Training was given for the farmers and stakeholders selected from Daro Lebu and Habro districts. Nine farmers (eight male and one female), three DAs (two male and one female and four male experts were

participated from Daro Lebu and Habro districts. Mini field days was also organized for evaluation of experiment and selecting better practices as well as assess farmer preferences for wider scaling up. Accordingly, nineteen male and one female household were participated on mini field day organized at Daro Lebu district (Sakina *kebele*). The participants point out that sole cropping practices have better performance than intercropped practices of maize and soy bean crops. Farmers did not consider and compared the economic advantage of both practices rather giving their opinions through observing performance of the crops on the fields.

Conclusions and Recommendations

The experiment was conducted on four farmers' field with three treatments on each field. Maize (Melkaassa-2 variety) and soya bean (Awassa-95 variety) were used for intercropping and sowing alone to evaluate on farmers field. The experiments were evaluated on 10m by 10m ($100m^2$) area of land with recommended agronomic practices. The results of study showed that mean yield gained from maize sole and maize intercropped accounted 10.85qt/ha and 10.68qt/ha, respectively. The mean yield gained from soya bean sole and intercropped were also accounted 3.53qt/ha and 1.33qt/ha respectively.

The paired t-test result indicated that there was no statistical difference between the yield of intercropped and sole practices on farmers' field at 5% significant level. The results of LER revealed that intercropping of maize with soya bean have 36% more yield advantage than sole crop practices. Economically, intercropping of maize with soya bean have more advantage than sole crop in terms of intensive use of land to produce more production and productivity with least cost of inputs. Therefore, intercropping of Maize (Melkassa-2 variety) with Soya bean (Awassa -95 variety) is recommended for further scaling up and popularization in study area and similar agro ecology with its full package of agronomic practices.

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On Farm Demonstration and Evaluation of Improved Lowland Sorghum Technologies in Daro Lebu and Boke districts of West Hararghe Zone, Oromia National Regional State, Ethiopia

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Abstract

The experiment was carried out in Daro Lebu and Boke districts of West Harerghe Zone with the objectives of evaluating lowland sorghum varieties onfarmers' field and creates linkage among stakeholders. Three kebeles were selected purposively based on sorghum production potential, two kebeles from Daro Lebu and one kebele from Boke district. Five farmers and one Farmer Training Center were participated depending on their interest to the technology, managing the experiment, have appropriate land for the experiment and taking the risk at the time of failures. Two improved varieties namely Ethiopian Sorghum Hybrid-1 and Chare with local check were demonstrated and evaluated. The experiment was demonstrated on 100m^2 demonstration plots and DAP 100kg/ha with Urea (50kg at the time of sowing and at growing stage) were applied to one demonstration plot with the seed rate of 10kg/ha. Both quantitative and qualitative data were collected through observation, group discussion on field day and data recording sheet. Descriptive statistics, gross margin analysis and independent t-test were used to analyze collected data. While qualitative data were analyzed through simple ranking and summarization. The result of the study indicated that Ethiopian Sorghum Hybrid-1 was ranked first in terms of yield, drought tolerant, biomass, early maturity, and seed color and disease resistance. The result of independent t-test indicated that mean comparison of Ethiopian Sorghum Hybrid-1and Chare along with local check were statistically significant at 5% significant level on mean yield performance and have more economic advantage than local variety at the study area. Therefore, Ethiopian Sorghum Hybrid-1 was recommended for further popularization and scaling up in study area and similar agro-ecologies.

Key words: *Sorghum, Demonstration, Evaluation, Early Maturity, Marginal Analysis, Varieties*

Introduction

Sorghum [*Sorghum bicolor* (L.) Moench] is a viable food grain for many of the world's most food insecure people who live in marginal areas with poor and erratic rains and often poor soils. It is the fifth most important cereal crop in the world (WWW.IE.Com, 2012). Sorghum is cultivated in wide geographic areas in the Americas, Africa, Asia and the Pacific. It is the third important cereal (after rice and wheat) in India. It is the second major crop (after maize) across all agro ecologies in Africa. In West Africa, especially in Burkina Faso, it is the staple crop and produced in low-input cropping systems. Sorghum is a major food and nutritional security crop to more than 100 million people in Eastern horn of Africa, owing to its resilience to drought and other production constrains.

It is a staple food crop on which the lives of millions of poor Ethiopians depend. It has tremendous uses for the Ethiopian farmer and no part of this plant is ignored. Besides being a major source of staple food

for humans, it serves as an important source of feed and fodder for animals. Sorghum exhibits a wide geographic and climatic adaptation. It also requires less water than most cereals; hence it offers great potential for supplementing food and feed resources. Sorghum grows in a wide range of agro ecologies most importantly in the moisture stressed parts where other crops can least survive and food insecurity is rampant (Tekle *et al*., 2014).

In Ethiopia, the total land of Sorghum production under peasant holdings covers about 456,171.54/ha (Centeral Statistical Agency [CSA], 2017). The main sorghum producing regions are Oromia and Amhara, accounting for nearly 80 percent of the total production. The leading sorghum producing zones are East and West Hararge in Oromiya and North Gondar and North Shoa in Amhara. Two regions, SNNPR and Tigray, are relatively less important, contributing 11 and 4 percent of the national production, respectively. Ethiopia is the second largest producer of sorghum, after the Sudan (Demeke *et al*., 2013).

In moisture stress area the grain-filling stage was the most important constraint, followed by insect pests, particularly stalk borer. Although drought is largely unpredictable, the farmers dealt with frequent drought events by either growing a diverse set of traditional cultivars from different maturity types, shifting from late-maturing to early-maturing cultivars, or replacing sorghum with tef or chickpea (Beyene *et al*., 2016).

Sorghum is the dominant cereal crop grown in Western Hararghe zone and preferred cereal after teff for preparing flat bread (injera), which is stable food in Ethiopia. As it is adapted to a wide range of environments it is largely produced in the highlands, medium and lowland regions. Even though sorghum dominantly grown in the zone, most of smallholders farmers use landrace variety of sorghum which result in low yield, susceptible to disease and take long period of time to harvest. Crop production in the study area totally depends on rainfall availability which is highly sensitive to climate change (Fekede *et al*., 2016). Based on practical problem of shortage of improved variety of sorghum and shortage of rain fall in the zone especially in low land areas, Mechara Agricultural Research Center has been conducted adaptation trail of improved lowland sorghum variety to select well adapted variety to agro-ecology of the area in previous cropping season. Therefore, this activity was initiated with objectives for to demonstrate and evaluate improved lowland sorghum technologies and create linkage among researcher, farmers, extension agent and other stakeholders.

Methodology

Description of the Study Area

Daro Lebu is one of the districts found under West Hararghe Zone. The capital town of the district Mechara is found at about 434 km South East of Addis Ababa. The district is situated between $7^{o}52^{'}10^{''}$ and $8^{o}42^{'}30^{''}$ N and $4^{o}023^{'}57^{''}$ and $41^{o}9^{'}14^{''}$ E. at 08° 35'.589"North and 40° 19'114"East (Abduselam, 2011). The district is characterized mostly by flat and undulating land features with altitude ranging from 1350 up to 2450 m.a.s.l. Ambient temperature of the district ranges from 14^{0}C to 26^{0}C with average of 16^{0}C with average annual rainfall of 963 mm/year. The pattern of rain fall is bimodal and its distribution is mostly uneven. Generally, there are two rainy seasons: the short rainy season '*Belg*' lasts from mid-February to April whereas the long rainy season '*kiremt*' is from June to September. The rainfall is

erratic; onset is unpredictable, its distribution and amount are also quite irregular (Asfaw *et al*., 2016). Consequently most *kebeles* frequently face shortage of rain; hence moisture stress is one of major production constraints in the district (Darolabu Woreda Agriculture and Natural Resource Office (DLWADO, 2015).

Boke is one of districts of West Hararghe zone known for coffee production. It is located at 391 km East of Addis Ababa and about 69 km south of Chiro, capital town of the zone. The district receives an average annual rainfall of 850 mm and average temperature is 20 ^{o}C. It shares borders with Chiro district in the west and north, Oda Bultum district in the south and Mesala district in the East (Fekede *et al*., 2016). The district is found within 1300 to 2400 meters above sea level (Boke District Agriculture and Natural Resource Office [BDAO], 2013).

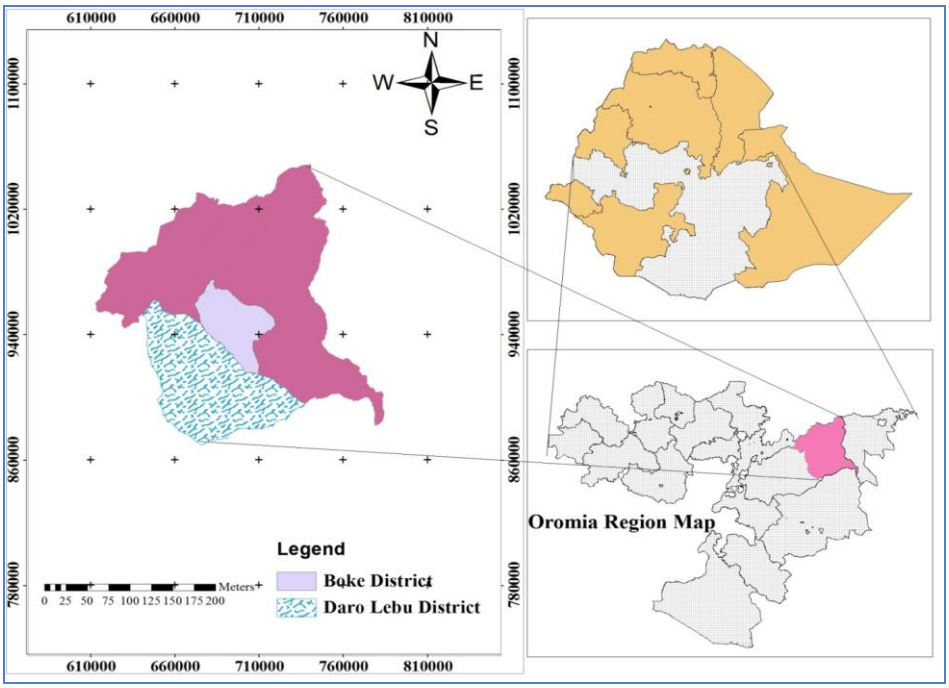

Figure 11. Map of study areas
Source: Own design, 2017

Farmers and Site Selection

The activity was conducted for one year in Daro Lebu and Boke districts of West Harerghe zone. Gadulo and Gudis *kebeles* from Daro Lebu as well as Dololo *kebele* from Boke district were purposively selected based on their sorghum production potential. Five farmers and one FTC (Farmer Training Center) were selected based on their interest to the technology, model farmers, managing the experiment and have appropriate land for the experiment.

Research Design

Two improved sorghum variety namely ESH-1 and Chare were demonstrated and evaluated with local variety. The experiment was demonstrated on 100m^2 demonstration plots and DAP 100kg/ha and Urea

(50kg/ha at the time of sowing and growing stage) were applied with the seed rate of 10kg/ha. Drilling sowing methods were applied in the row with fertilizer. The required management like weeding, thinning out and urea application at the growing stage were done by the farmers.

Table 1. Number of farmers participated and area covered in study area.

Districts Name	*Kebeles*	No. of trail farmers	Area covered(m^2)
Daro Lebu	Gadulo	2	600
	Gudis	3	900
Boke	Dololo	1	300
Total		6	1800

Source: Own results, 2017

Types of Data and Methods of Data Collection

Both quantitative and qualitative data were collected through observation, group discussion on field day and data recording sheet. Data like farmer preference on disease and pest's resistance, early maturity, drought tolerance, grain color, biomass, and yield data were collected through the prepared data collection sheet/record sheet by organizing field day and observation on farmer's field.

Method of Data Analysis

Descriptive statistics, gross margin analysis and independent t-test were used to analyze quantitative data. Farmer's preference were collected and analyzed by using simple ranking method in accordance with the given value (De Boef and Thijssen, 2007). The formula of ranking method used was specified as: $Rank=\Sigma^{N}/n$……1

Where **N**, is value given by group of farmers for each variety based on the selection criteria and **n** is number of selection criteria used by farmers.

Descriptive statistics

Descriptive statistics like mean were used to analyze the crop performance akin to yield and yield components of the experiment harvested from demonstration plot.

Gross Margin Analysis

Gross margin analysis is very useful and in a situation where fixed capital forms a negligible portion of production. It is the difference between gross income and the total variable costs (Mohammed *et al.*, 2015). According to (Ayinde *et al*., 2016) gross margin is expressed as:- GM = TR – TVC…… (2)

Where GM = Gross Margin TR = Total Revenue TVC = Total Variable Cost

Average rate of returns (ARR) was also obtained. This was done by dividing total gross margin (GM) by the total cost of production per hectare.

Results and Discussions

Crop performance on the farmers' field

The mean yield of ESH-1 and Chare were 20.9 and 16.3 with standard deviation of 15.13,and 14.08, respectively and mean and standard deviation of the local variety were 9.42 and 14.04, respectively in terms of kg/ha (Table 2). The mean yield of local variety was less than both improved (ESH-1 and Chare) varieties due to intolerant to drought.. The result of independent statistical test indicated that there was statistical difference between the yield of improved ESH-1 and Chare varieties demonstrated on farmers' field at 5% significant level. But, from the results of adaptation trial done on ESH-1 and Chare varieties at Mechara Agricultural Research Center ESH -1 were recorded mean yield of 38.67 and Chare 29.22 (Kinde *et al.*, 2016). The difference in yield was observed due to presence of extreme drought in the study area last year.

Table 2.Yield summary and mean comparison of sorghum varieties on farmer's field

Varieties	Yield harvested in Qt/ha (N=6)							
	Min	Max	Mean	Std. Dev.	t-value	Sig.	yield difference from local	% yield increase over local check
ESH-1	0.30	43.30	20.9	15.13	7.426**	0.018	11.48	121.9
Chare	0.12	33.20	16.3	14.08	6.704**	0.022	6.88	73
Local	.00	32.10	9.42	14.04			-	-

** indicates significant at 5% significant level
Source: Own results, 2017

The result of finding depicts that the demonstrated and evaluated improved varieties have high grain yield ESH-1 43.3Qt/ha and Chare 33.20Qt/ha where as local has grain yield of 32.10Qt/ha. Yield increased in percentage of improved variety of ESH-1 and Chare over local check were 121.9% and 73%, respectively. As it was discussed the yield difference was very huge between improved varieties and local check due to difference in drought tolerance between improved and local variety.

Capacity Building and Experiment Evaluation

Training was given for awareness creation at Daro Lebu district (Gadulo and Gudis *kebeles*) before implementing the activity. Thus, eight farmers (seven male and one female) and three development agents (one female and two male) participated on training from Daro Lebu district (Gudis and Gadulo *kebeles*). Field day was organized at two *kebeles* of Daro Lebu district to create awareness for participants. Accordingly, thirty eight (38) male and ten (10) female households participated on mini field day organized at Daro Lebu district (Gudis and Gadulo *kebeles*). Experts and DAs also participated with farmers to evaluate and preferring the experiment. For variety selection on field, researcher has divided farmers into three groups with combination of development agents and experts. The group of farmers and development agents leaded by SMS (subject matter specialists) putted their own criteria to evaluate the technology by observing on field. Each group has given his own value to experiment each demonstration

plot. As it discussed in Table 3, the values given by each group of farmers were summarized and the average value is ranked by participants.

Table 3: Participant's preference of the variety selection on field day

Varieties	Selection Criteria's (Score out of five)									
	HS	SC	Bms	EM	DsR	DrR	SG	PH	TS	Rank
ESH-1	4.6	4.8	3	3.6	4	4.4	3	3	30.4	1
Chare	3.8	3.6	2.8	4.2	4	4	3.2	3.6	29.2	2
Local	2.25	1.6	4.2	2	3	1.4	4.75	3.6	22.8	3

Note: 5=Excellent, 4=very good, 3=good, 2=Fair, 1=Poor
HS= Head Size, SC= Sead Color, Bms= Biomass, EM= Early Maturity, DsR= Disease Resistance, DrR= Drought Resistance, SG= Stay Green, PH= Plant height and TS= Total score
Source: Own results, 2016

The result revealed on Table 4, farmers, development agents and experts have selected ESH-1 and Chare variety as a first and second with all average values given by farmers.

Cost-benefit analysis result

The result on Table 4 implied that highest profit and returns were gained from ESH-1 and Chare varieties. A total of 7,050Birr (seven thousand and fifty birr) profit from a hectare of land was obtained from ESH-1 variety that profit and highest returns to investment of 51%. A total of 2,450Birr profit from a hectare of land was accounted from Chare variety and 18% returns to investment were gained. Negative profit was recorded from local variety due to low yield gained by the effect of drought in the study area. Therefore, we conclude that using improved seed were economically profitable than local variety in the study area.

Table 4. Gross margin of sorghum demonstration per *kebeles*

Variety	Yield (Qt/ha)	market price of output Qt/Birr	Fertilizer cost in ETB	Seed cost in ETB	Labor cost in ETB	TVC	TR(P*Q)	GM (profit)	Return to investment
ESH-1	20.9	1000	5450	900	7500	13850	20,900	7,050	0.51
Chare	16.3	1000	5450	900	7500	13850	16,300	2,450	0.18
Local	9.42	1000	5450	600	7500	13550	9,420	-4,130	-0.3

Source: Own result, 2017.

Conclusions and Recommendations

Conclusions

The study was conducted in Daro Lebu and Boke districts of West Hararghe zone. A total of six farmers participated to evaluate varieties on farmer's field. Three treatments (two improved varieties) and one local check were used for evaluation purpose. Out of demonstrated variety, ESH-1 was selected as first by

fulfilling farmer's evaluation and selection criteria's. In addition, high yield is counted from ESH-1 over Chare variety and local check cultivars. The independent t-test implied that there was also statistical significant difference between the yield of improved (ESH-1) and Chare varieties at 5% significance level. Both varieties (ESH-1 and Chare) have more economic profit than local variety.

Recommendations

Therefore, ESH-1 was recommended for further scaling up in study area and similar agro-ecologies. It is required to popularize through clustering and farmers to farmer linkage is required to disseminate this technology widely in the study area.

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Participatory Demonstration and Evaluation of Improved Bread Wheat Technologies in Bale and West Arsi Zones, Oromia National Regional State, Ethiopia

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Abstract

Participatory on-farm demonstration of improved bread wheat technologies was carried out in Agarfa, Gassara, Sinana and Ginnir districts of Bale zone and Adaba and Dodola districts of West Arsi zone using two recently released varieties, namely, Oborra and Sannate against the farmers' variety (Hidassie). The main objective of the study was to demonstrate and evaluate improved bread wheat technologies in order to enhance farmers to select best fit variety/ies for their localities. FRG approach was followed to implement demonstration process; accordingly, gender inclusive one FRG was established in each kebele with 20 members. The demonstration was under taken on single plot design of 10m x 10m area for each variety with the spacing of 20cm between rows and recommended seed and fertilizer rates. Mini-field day was organized at each respective site on which different stakeholders ware participated and experiences were shared. Yield data per plot was recorded and analysed using descriptive statistics, while Farmers' preference to the demonstrated varieties was identified using focused group discussion and summarized using pair wise and simple ranking methods. Participant farmers were enhanced to set their own selection criteria and their criteria were almost similar in all locations. Accordingly, Sannate variety was selected due to its high disease tolerance ability, grain yield, seeds per Spike (≥60) and tillering capacity (≥10), fertile tillers of the variety. Since, all participant farmers selected Sannate, it is important to proceed to the task of scaling up/out of Sannate in all demonstration sites and similar agro-ecologies.

Key words: *Farmers' preference, Selection criteria, demonstration, FRG approach, Bread 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 1.7 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, 2016). In 2015/16 cropping season, wheat annual production in Ethiopia was about 4.2 million tons cultivated on 1,664,564.62ha land (CSA, 2016).

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 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, 2016). 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).

To this end, developing high yielding, disease resistant and stable varieties that can meet increasing food demand of the growing population is very important. 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 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. Among these, more than 10 bread wheat varieties (Pavon-76, Tusie, Madda Walabu, Sofumar, Digalu, Danda’a, Sanate, Huluka, Hidase, Shorima) with relative resistant to diseases, are commercial and in production. These varieties are widely grown by farmers in Bale and west Arsi zones.

However, it was clearly seen from field observations that bread wheat varieties specifically Kubsa, Galama, Abola, Simba, Millenium, Digalu and Mandoyu are losing their genetic potential due to wheat rusts diseases epidemics (especially stem rust). Rust is currently becoming the major threat for wheat production in these zones as well as in the country. Besides, potential productivity is also 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 and low use of recommended full packages.

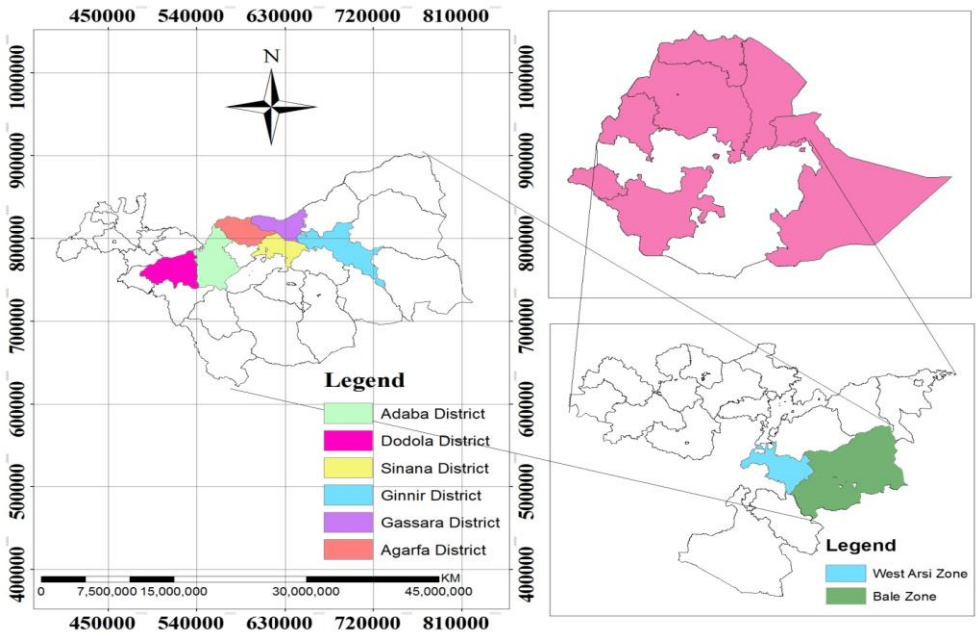
Thus, to tackle these interrelated problems, one bread variety (Oborra) recently released in 2015 with full recommended packages for production. Hence undertaking participatory demonstration, evaluation and validation of such improved wheat technologies with the participation of farmers and other stakeholders in the study zones is highly important. Farmers have to select the best-bet performing variety by comparing with the existing commercial varieties. Farmers' low or lack of participation and failure to select the appropriate varieties is a costly mistake.

Therefore, this activity was initiated to introduce, undertake participatory demonstration, evaluation and validation of recently released improved bread wheat varieties with joint participation of farmers, agricultural experts, researchers and other stakeholders in Bale and West Arsi Zones of Oromia National Regional State, Ethiopia.

Methodology

Description of the study area

The research was carried out in Adaba and Dodola districts of West Arsi zone and Sinana, Agarfa, Gassara and Ginnir districts of Bale zone, Oromia National Regional State (ONRS), Ethiopia. West Arsi and Bale zones are among the 20 Administrative zones located in south eastern parts of Oromia, Ethiopia. The districts were selected purposively based on their potential to wheat production.



Site and farmers' selection

Site selection

Participatory demonstration of improved bread technologies were conducted in four districts (Agarfa, Gassara, Sinana and Ginnir) potential bread wheat producing districts of Bale zone. Whereas two Districts (Adaba and Dodola) were selected from West Arsi zone. Purposive sampling methods were employed to select five representative districts from the two zones based on their potential for bread wheat production. From each district two representative Kebeles were also selected purposefully based on their accessibility and production potential of the crop.

Farmers' selection

Participatory approach using Farmers Research Extension Group (FRGs/FREGs) were the main strategy used during demonstration of the technology. Selection of FRGs/FREGs members was based on farmers' willingness to be held as member, accessibility for supervision of activities (vicinity), good history of compatibility with groups and genuineness and transparency to share innovations to other farmers. Consequently, one FRG/FREG having 20 members with the composition of resource rich, medium and poor category of farmers including men, women and youth farmers was established at each Kebele.

Table1: Number of FRG members established in each demonstration site

District & kebeles	FRGs/FREGs (No)	Members by Gender				
		Adult (Male)	Adult (Female)	Youth (Male)	Youth (Female)	Total
Ginnir (Walta'i Atota and Aqasha)	2	21	15	3	1	40
Sinana (Hawusho & Gamora)	2	20	15	4	1	40
Agarfa (Ali & Sabaja)	2	22	14	2	2	40
Gassara (Nake Nagawo & Ba/ Guranda)	2	23	16	1	0	40
Adaba (Washa & Ejersa)	2	24	16	0	0	40
Dodola (Katta Baranda & Kachama Chare)	2	23	15	1	1	40
Total	**12**	**133**	**91**	**11**	**5**	**240**

Trial farmers' selection

Having suitable and sufficient land to accommodate the trials, willingness to contribute the land, vicinity to roads so as to facilitate the chance of being visited by many farmers, initiatives to implement the activity in high-quality, good in field management and willingness to explain the technologies to others were criteria used to select the hosting farmers. Accordingly, two to three representative trial farmers

from each FRG/FREG were selected at each kebele (with the help of group members and DAs). 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.

Materials used and Field design

Sinana Agricultural Research Center was the source of all agricultural inputs (seed of improved varieties, fertilizers-DAP/NPS and UREA, herbicides-Pallas 45 OD). An improved bread wheat variety (**Oborra**) with one standard check (**Sannate**) and one farmer's variety (Hidassie) was planted on selected farmers' land with simple plot design (10m x 10m) in the main cropping season.

The varieties were treated with full recommended bread wheat production and management packages. Row planting method and other crop management practices were employed during the research work. A 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 sufficient soil moisture. The recommended inorganic fertilizer rate 100/100 kg/ha UREA/DAP was applied with split application of ***Nitrogen:*** 1/3 at planting time and 2/3 at tillering stage of the crop. 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.

Technology demonstration and evaluation methods/techniques

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

Participatory selection of demonstrated varieties

The target beneficiaries of improved agricultural technologies are strongly inclined to their preferences. These preferences will cause them to give up less favored good crops/varieties for more favored ones. So, consulting the intended end users to assess which quality/ies of a particular variety they desire (to be considered in plant breeding program) is highly important. Because, it will not only be resource saving in terms of preferred variety promotion/dissemination, but also time saving and fast adoption (Dan, 2012).

Farmers' perception on the performance of improved bread wheat varieties were tested at each district and analyzed using Pair Wise Ranking. Pair Wise Ranking was used as a tool to summarize farmers' preference towards important variety traits (Boef and Thijssen, 2007). Thus, a total of **300 participants** from **six** districts (242 farmers, 35 DAs and supervisors and 18 experts) and 5 researchers were participated on the selection of the varieties at maturity stage of the crop. First, the evaluators were grouped in to small manageable group (one group had 10 members including one group leader and one secretary). At each district, kebele and trial site, brief orientation was given to the evaluators on how to integrate researchers' criteria to their own criteria to select the demonstrated varieties in order of their

importance, how to carefully assess each variety by considering each criteria and using rating scale, how to organize collected data, how to make group discussion and reach on consensus, and finally report through their group leader at the end.

Training of farmers and development agents

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.

Field day

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

Data type and method of data collection

Both qualitative and quantitative data were collected direct field observation/measurements, key informant interview and focused group discussion (FGD). Yield data per plot in all locations were recorded. Total number of farmers participated on training, field visits and mini field days were recorded by gender composition. Farmers' preference to the demonstrated varieties (likes and dislikes, which is the base for plant breeding process and perceptions towards the performance of the technologies) was identified.

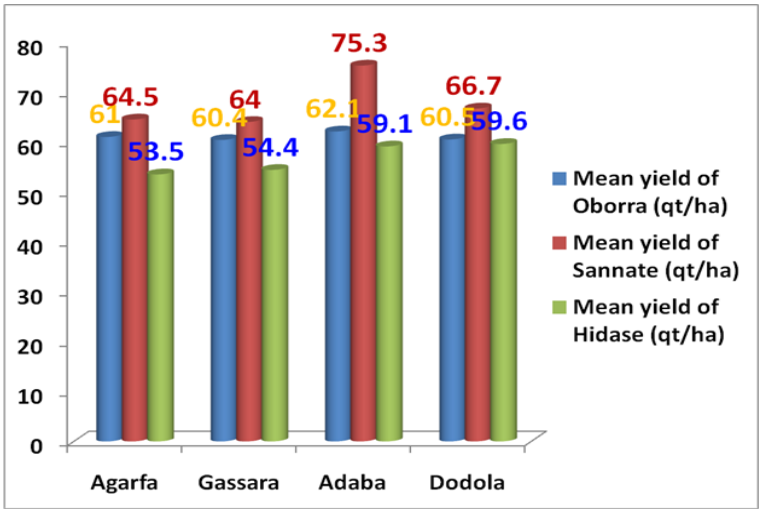
Data analysis

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

Results and Discussions

Yield performance of Demonstrated varieties

Sannate shows highest yield than Obora and Hidassie in all demonstration sites (Agarfa, Gassara, and Adaba and Dodola districts). Moreover, the result is presented graphically as below.



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

At Dodola district

Yield advantage % for Sannate= $\frac{\text{66.7 qt/ha – 59.6 qt/ha}}{\text{59.6 qt/ha}}$ X 100 = 11.91 %

Yield advantage % for Oborra= $\frac{\text{60.5 qt/ha – 59.6 qt/ha}}{\text{59.6 qt/ha}}$ X 100 = 1.51 %

Table 2: Comparison of yield advantage of improved varieties

District	Mean yield of farmer's variety (qt/ha)	Mean yield of improved bread wheat varieties (qt/ha) and yield advantage over the check			
	Hidase	Sannate	%	Oborra	%
Agarfa	53.5	64.5	20.56	61	14.02
Gassara	54.4	64	17.65	60.4	11.03
Adaba	59.1	75.3	27.41	62.1	5.08
Dodola	59.6	66.7	11.91	60.5	1.51

Farmers' Selection and Preference

Farmers' perception on the performance of improved bread wheat varieties were tested at each district and analyzed using Pair Wise Ranking. A total of 300 participants from **six** districts (242 farmers, 35 DAs

and supervisors and 18 experts) and 5 researchers were participated on the selection of the varieties at maturity stage of the crop. The following table describes the selection traits of in order of importance for the demonstrated varieties.

Table 3: Pair wise ranking result to rank variety traits in order of importance

Code	Variety Traits	Tillering	Disease Tolerance	Spike Length	Spikelets/ Spike	Seeds/ Spike	Crop stand	Biomass Yield	Seed colour	Yield	Score	Rank
1	Tillering										5	4th
2	Disease Tolerance	2									8	1st
3	Spike Length	1	2								3	6th
4	No. of Spikelet/Spike	1	2	3							2	7th
5	Seeds per Spike	5	2	5	5						6	3rd
6	Crop stand	1	2	6	6	5					4	5th
7	Biomass Yield	1	2	3	4	5	6				0	9th
8	Seed colour, hard, soft	1	2	3	4	5	6	8			1	8th
9	Overall yield	9	2	9	9	9	9	9	9		7	2nd

The result showed that disease tolerance (especially to Yr and Sr) was the most preferred bread wheat variety trait followed by overall yield, seeds per Spike (≥60) and tillering capacity (≥10) fertile tillers of the variety (Table 3). Furthermore, farmers were given the chance to compare each variety to the other ones with regards to the values based on identified criteria.

Table 4**:** Comparing of the varieties based on important variety traits

No	District	Variety Trait	Oborra (Mean)	Sannate (Mean)	Hidase (Mean)
1	Sinana	Tillering (count) (≥10)fertile tillers	12	14	11
		Seeds per spike (≥60)	48	73	51
		Crop stand (%)	85	90	85
2	Agarfa	Tillering (count)	8	9	7
		Seeds per spike (count)	72	73	74
		Crop stand (%)	85	95	85
3	Gassara	Tillering (count)	10	12	10
		Seeds per spike (count)	56	73	69
		Crop stand (%)	85	90	80
4	Adaba	Tillering (count)	8	9	8
		Seeds per spike (count	45	60	51
		Crop stand (%)	85	95	80
5	Dodola	Tillering (count)	9	9	7
		Seeds per spike (count)	45	65	53
		Crop stand (%)	80	90	80

The FGD result showed that the participant farmers ranked the varieties based on their preferences and degree of satisfaction after they made detail discussions and debates on the variety traits.

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

No	Varieties	Rank	Reasons
1	Oborra	**2nd**	Lack of uniformity on heading and maturity, Medium tillering capacity, disease tolerant (Yr, Sr), medium crop stand, attractive seed colour and hard seed for market, good yield
2	Sannate	**1st**	High tillering (≥10), seeds/spike (≥60), disease tolerant (Yr, Sr), good pl.ht, very good crop stand, very good yield, strong stem and good for black soil like MW, poor seed colour for market, shattering problem in case of off-season rain
3	Hidase	**3rd**	Susceptible to diseases (Yr,Sr), Medium tillering capacity, soft seed for market, medium crop stand, good yield

Conclusion and Recommendations

Suitable and accepted bread wheat variety/ies for the study areas were identified and ranked based on participant farmers assessment and grain yield data. According to pair wise ranking result, wheat disease problem is the priority concern of the farmers for sustainable production system in the study districts. Among the demonstrated varieties Sannate has performed well than Oborra and farmer's variety (Hidase) in all parameters. Oborra is less performed than Sannate and Hidase. Besides, Oborra lacks uniformity and not recommended for pre-scaling up activity. Thus, Sannate is recommended for wider scaling up/out activity in the districts. Oborra variety should be maintained by Breeders for its good seed color and other merits to be used for breeding purpose at SARC on-station. Hidase variety preferred for its yield by some farmers in Adaba and Dodola districts with the availability of fungicides.

Moreover, the prevalence of wheat rust epidemics in the wheat belt areas (Bale and West Arsi) is a very serious production hindering problem. Thus, crossing/hybridization rather than selection (for continuous varietal development and replacement) should be the priority research work in breeding program. Commodity integration (crop rotation) should be practiced for the sustainability of production system in the study zones. IPM/IDM and fungicides verification for agro-chemical utilization (last option) should be in place for the sustainability of wheat production in the study zones.

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Participatory Demonstration and Evaluation of Improved Fenugreek Technologies in mid altitude areas of Bale Zone, Oromia National Regional State, Ethiopia

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Abstract

The study was initiated with the main objective of demonstrating, evaluating and popularizing recently released fenugreek technology under farmers' management condition in mid-altitude areas of Bale zone. An improved variety Ebisa was demonstrated and compared with Hunda'ol (standard check) and local variety by employing FRG approach. The demonstration was under taken in Ginnir and Goro districts which are the potential spice producing districts of Bale zone by selecting two kebeles from each district. The demonstration was laid out on single plot of 10m x 10m areas for each variety by applying the recommended full packages. Accordingly, the varieties were demonstrated on twelve farmer's field in which each of the farmer's field used as replication of the trial. Yield data on plot base was recorded and analyzed using descriptive statistics while farmers' preference to the varietal attributes was identified and ranked using pairwise ranking and simple ranking methods. Mini-field day was organized in each kebele to facilitate the way in which experts and farmers can participate in varietal evaluation and selection based on their selection criteria. The average yield of Ebisa (18 qtha^{-1}) is lowest than Hunda'ol (19.5 qtha^{-1}) and local variety (18.2 qtha^{-1}). Furthermore, farmers selected Hunda'ol and the local variety respectively. Hunda'ol was selected due to its high number of fertile tillers, seeds/plant, disease tolerance, attractive seed color for market (deep yellow), seed size (plump seed for market), good plant height, early maturity, good pod setting, good crop stand and good yield. Thus, Hunda'ol is recommended for wider scaling up/out activity in the districts.

Key Words*: Fenugreek Technology, Farmers' preference, Selection criteria, FRG Approach, Variety Evaluation*

Introduction

Fenugreek is indigenous to countries on the Eastern shores of the Mediterranean, but widely cultivated in India, Egypt, Ethiopia, Morocco and occasionally in England (Polhil and Raven, 1981; Davoud*et al*., 2010). Ethiopia is a homeland for many spices, such as korerima, long red pepper, Black cumin, white cumin, coriander, fenugreek, turmeric, sage, cinnamon, and ginger (ACP, 2010). Ethiopia has become one of the largest consumers of spices in Africa. People use spices to flavor food and use them to make medicines and perfumes (Kirtikar and Basu, 1975). The uses of the seeds (sources of protein, fat, minerals and dietary fiber) and leaves of fenugreek are diverse (Kochhar *et al*., 2006).

Fenugreek (*Trigonellafoenum-graecum* L.) is one of the most important seed spice crops in Ethiopia in general and in the mid-altitudes of Bale in particular. Fenugreek covers about 13,174.7ha of land in Ethiopia with a total annual production of 58,871.9 quintals (Masresha, 2010). From 1,652,844.19 hectares of land allocated for pulse crops in 2015/2016 production season, fenugreek covered 29,837.65 hectares of land from which 356,537.64 quintals of grain was produced with the productivity of 11.95 qt/ha (CSA, 2016). In Bale zone, 39,147.90 ha of land was covered by pulse crops and 742,143.83 quintals of grain was produced in 2015/16 cropping season. The share of fenugreek was 18,643.80 quintals (CSA, 2016).

Goro and Ginnir districts of Bale zone is known for its production potential of spices. A total of 1,515ha land is covered with Fenugreek every year (BZADO Office, 2015). In Bale, 18,643.80 quintals of fenugreek grain was produced in 2015/16 cropping season (CSA, 2016). It is mainly produced by small holder farmers for commercial purpose. In spite of its importance and the potential available in the area, the crop was not utilized due to a shortage of improved varieties and crop management packages.

The gap between current production and consumption levels could only be closed by expansion of improved fenugreek technologies through institutional innovation, making the research and extension system problem solving, demand-driven and client oriented for efficient distribution of the technologies among the end users. Thus, developing high yielding, disease tolerant/resistant and stable variety/ies that can meet increasing demand of spice market, improve the income and livelihood of farmers are very important. Consequently, the research system have been making continuous 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.

By keeping this fact in view, *Ebisa* variety of fenugreek was recently released by Sinana Agricultural Research Center. However, the variety was not evaluated under farmers' condition. Participatory technology evaluation on farmers' management condition may have many advantages, such as increased and stable crop productivity, faster release and adoption of varieties, better understanding farmers' criteria for variety selection, enhanced biodiversity, and increased cost effectiveness, facilitated farmers learning and empowerment (Sperling et al, 2001).

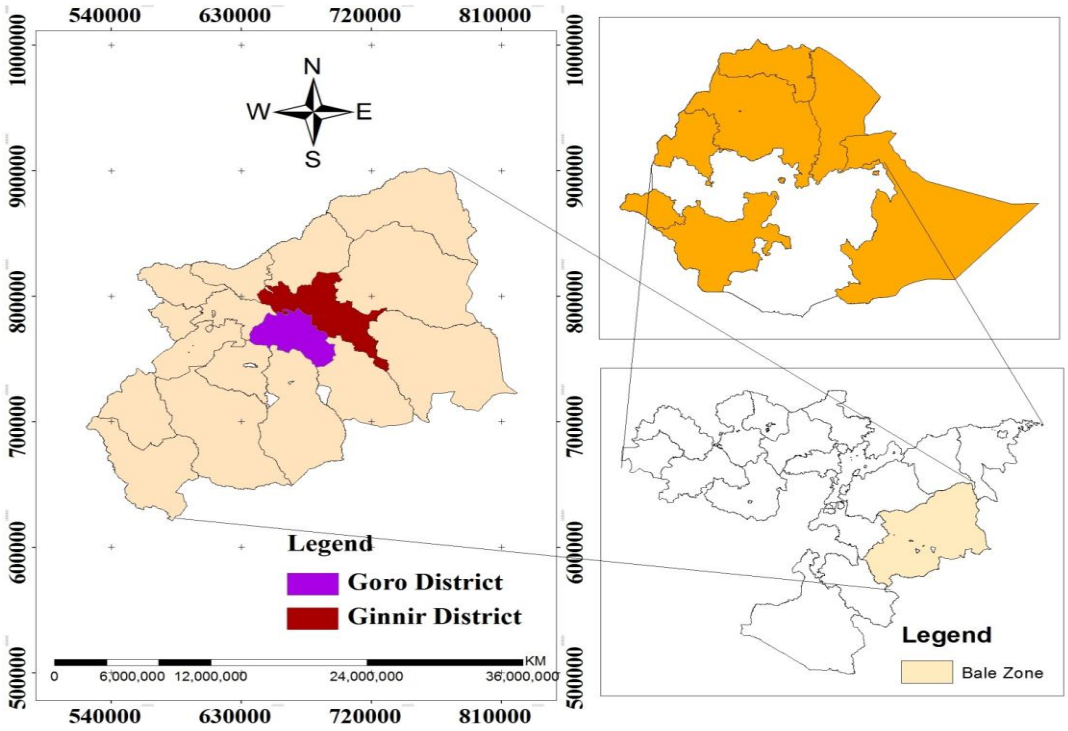
Hence, participatory demonstration of Ebisa variety of fenugreek with one standard check (Hunda'ol) and one local check was undertaken at Goro and Ginnir districts of Bale zone with the aims of demonstrating and evaluating improved fenugreek technologies, building famers`, development agents' and experts'

knowledge, skill and attitude on fenugreek production and management practices with the required quantity and quality and recommending the best selected variety/ies, to end users towards the improvement of spice production and productivity.

Methodology

Description of the study area

The research was carried out in Goro and Ginnir districts of Bale zone, Oromia National Regional State (ONRS), Ethiopia. Bale zone is among the 20 Administrative zones of the ONRS and located in southeastern Oromia. The districts were selected purposively based on their potentiality to fenugreek production.



Site and farmers' selection

Site selection

Participatory demonstration of improved fenugreek technologies were undertaken in the main season (Bona) for one year (2016/17) in Goro and Ginnir districts of Bale zone. Purposive sampling methods were employed to select the two representative districts based on their potential for fenugreek production. From each district two representative kebeles were also selected purposefully based on their accessibility and production potential of the crop.

Trial farmers' selection and Farmers (FRGs/FREGs) formation

Farmer-participatory approach and FRGs/FREGs were the main strategy during demonstration of the technology. Selection of FRGs/FREGs members was based on farmers' willingness to be held as member, accessibility for supervision of activities (vicinity), good history of compatibility with groups and genuineness and transparency to share innovations to other farmers. Consequently, one FRG/FREG having 20 members with the composition of resource rich, medium and poor category of farmers including men, women and youth farmers was established at each kebele.

Three representative trial farmers from each FRG were then selected at each kebele (with the help of group members and DAs). 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. Having 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 criteria used to select the hosting farmers. Trial farmers were considered as replications. The trial was conducted on 6 farmers' field in 2 districts. In addition, Farmers Training Centers **(**FTCs') were also used as demonstration site.

Materials used and Field design

The varieties were planted on a single plot design on 100m2 for each variety, considering trial farmers as replication. SARC was the source of agricultural inputs (seed of Ebisa and Hunda'ol with 20 kg/ha seed rate**,** fertilizers- no recommended fertilizer rates and agro-chemicals in case needed during the implementation of the activity). Seed of local check was purchased from the local market. Hosting farmers provided their land with compensation from SARC. Row planting method and other crop management practices were employed during the research work. Depending on weed infestation, two effective hand weeding were applied; the first at one month after sowing and the second at two months after sowing of the varieties. No agro-chemicals (herbicides, fungicides and insecticides) were sprayed on the plots.

Technology demonstration and evaluation methods/techniques

FRG approach was used as technology demonstration approach. FRGs/FREGs members and other follower farmers were encouraged to participate on different extension events organized at each site. These were mechanisms used to enhance farmer-to-farmer learning and information exchange such as trainings, field visits/tours, field days, etc. Roles and responsibility sharing among actors for implementation of the activity was also made at the inception of the activity. Agreement was made with farmers, DAs, supervisors and experts on responsibility sharing since the activity needs collaborative work and partnership. SARC was the source of agricultural inputs (seed of Ebisa and Hunda'ol with 20 kg/ha seed rate) and hosting farmers provided a plot size $100m^2$ of their land for the activity.

Participatory on field assessment and evaluation of the varieties was also conducted to select the best among the varieties based on participating farmers' criteria. The target beneficiaries of improved

agricultural technologies are strongly inclined to their likes and dislikes (preferences). These preferences will cause them to give up less favored good crops/varieties for more favored ones. So, consulting the intended end users to assess which quality/ies of a particular variety they desire (to be considered in plant breeding program) is highly important. Because, it will not only be resource saving in terms of preferred variety promotion/dissemination, but also time saving and fast adoption (Dan, 2012). Thus, participatory assessment and evaluation of the varieties were undertaken with experts, DAs, farmers and researchers at maturity stage of the crop.

The evaluation process used focus group discussion (FGD). A total of 154 participants (126 farmers, 16 DAs and supervisors and 8 experts from two districts) and 4 researchers were participated on evaluation of the varieties. First, the evaluators were grouped in to small manageable group (one group had 10 members including one group leader and one secretary). At each district, kebele and trial site, brief orientation was given to the evaluators on how to integrate researchers' criteria to their own criteria to select the demonstrated varieties in order of their importance, how to carefully assess each variety by considering each criteria and using rating scale, how to organize collected data, how to make group discussion and reach on consensus, and finally report through their group leader at the end. The report is finally anaysed and presented as a tool to summarize farmers' preference towards important variety traits as as described by Boef and Thijssen, (2007).

Training of farmers and other stakeholders

Training was given to farmers, DAs, and agricultural experts on fenugreek production techniques and management packages. Stakeholders such as zonal 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.

Mini Field Day

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

Data type and method of 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.

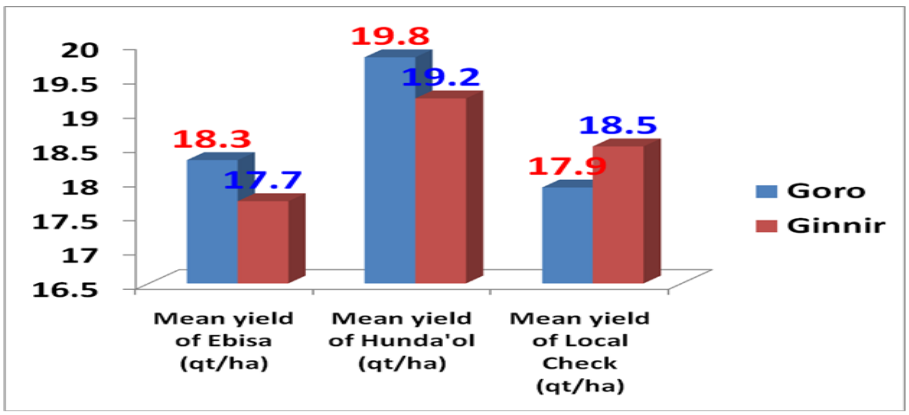
Data analysis

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 Discussions

Yield performance of Demonstrated varieties

Even though, Ebisa variety of fenugreek is recently released improved variety, it couldn't bet the yield performance of Hunda'ol. The varieties were also stable in yield across locations.



Yield advantage %= Yield of new variety (qt/ha)-Yield of commercial variety (qt/ha) X100
Yield of commercial variety (qt/ha)

At Goro district

Yield advantage % for Ebisa= 18.3 qt/ha – 17.9 qt/ha X 100 = 2.24 %
17.9 qt/ha

Yield advantage % for Hunda'ol= 19.8 qt/ha – 17.9 qt/ha X 100 = 10.61 %
17.9 qt/ha

Table 1: Comparing yield advantage

District	Mean yield of farmer's variety (qt/ha)	Mean yield of improved fenugreek varieties (qt/ha) and yield advantage over the check			
		Ebisa	%	Hunda'ol	%
Goro	17.9	18.3	2.24	19.8	10.61
Ginnir	18.5	17.7	-	19.2	3.78

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

Code	Variety Traits	Tillering	Disease Tolerance (PM, Rusts	Pods per plant	Seeds/ plant	Seed color (market)	Crop stand	Overall Yield	Seed size (plump for market)	Score	Rank
1	Tillering									5	2nd
2	Disease Tolerance (PM, Rusts)	**2**								3	5th
3	Pods per plant	**1**	**3**							4	4th
4	Seeds/plant	**1**	**4**	**4**						5	2nd
5	Seed color (market)	**1**	**2**	**3**	**4**					1	7th
6	Crop stand	**1**	**6**	**3**	**4**	**6**				3	5th
7	Overall Yield	**7**	**7**	**7**	**7**	**7**	7			7	1st
8	Seed size (plump for market)	**1**	**2**	**3**	**4**	**5**	6	7		0	8th

The result showed that overall yield was the most preferred fenugreek variety trait followed by tillering, seeds per plant, pods per plant, disease tolerance and crop stand of the variety. Furthermore, farmers were given the chance to compare each variety to the other ones with regards to the values based on identified criteria.

Table 3: Comparing of the varieties based on important variety traits

No.	Variety Trait	Ebisa				Hunda'ol				Local Check			
		I	II	III	**Ave**	I	II	III	**Ave**	I	II	III	**Ave**
1	Tillering (count)	11	11	8	**10**	14	15	15	**15**	10	10	10	**10**
2	Pods/plant (count)	11	12	10	**11**	18	22	20	**20**	11	21	18	**16**
3	Seeds/ Plant (count)	14	12	16	**14**	20	19	20	**20**	12	14	15	**14**
4	Crop stand (%)	80	80	80	**80**	90	95	95	**93**	90	85	85	**87**

The FGD result showed that the participant farmers ranked the varieties based on their preferences and degree of satisfaction after they made detail discussions and debates on the variety traits.

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

No	Varieties	Rank	Reasons
1	Ebisa	3rd	High infestation of powdery mildew, poor crop stand, yellowish seed colour, medium tillers, low yielder, less attractive for market
2	Hunda'ol	1st	Tillering, seeds/plant, disease tolerance (PM, Rusts), attractive seed colour for market (deep yellow), seed size (plump seed for market), good plant height, early maturity, good pod setting, good crop stand, good yield
3	Local Check	2nd	Long pl.ht. & has lodging problem, poor in tillering and pod setting, susceptible to diseases (PM, Rusts), poor seed colour (green type), not attractive for market, Late type

Conclusion and Recommendations

Suitable and widely accepted fenugreek variety/ies for the mid altitude areas were identified and ranked based on the farmers' selection criteria. Hunda'ol performed well than Ebisa and local check in all parameters. It has also attractive seed colour for market. Thus, Hunda'ol is recommended for wider scaling up/out activity in the districts. On the other hand, Ebisa showed less performance than Hunda'ol and local check. Besides, it was highly susceptible to powdery mildew and not recommended for pre-scaling up activity

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Pre-scaling up of Improved Durum Wheat Technologies in Bale and West Arsi zones of Oromia National Regional State, Ethiopia

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Abstract

Popularization of improved and widely selected durum wheat technologies was under taken in Sinana, Agarfa, Gassara, Goro, Gololcha and Ginnir districts of Bale zone and Adaba and Dodola districts of West Arsi zone with the objective of promoting improved durum wheat technologies and increase production and productivity of durum wheat in the study zones. One recently released improved durum wheat variety (Dirre) was planted on the plot size of 32mx32m and it was distributed for representative 43 farmers. Row planting method with the spacing of 20cm between rows and other crop management practices were employed during the field work. Participatory training, field visit and field days were used as an approach to disseminate and popularize the technology on which different actors (farmers, experts, researchers, unions, and farmers' cooperatives) were actively participated in partnership. Yield data and farmers' feed-back about the technology were assessed and interpreted using descriptive statistics and qualitative data analysis methods. The overall mean yield of Dirre was 62 quintal per hectare. Farmers were interested with the stand of the variety, its tillering capacity ≥10, spike length, spikelet per spike, seeds per spike ≥60), disease tolerance, seed color, crop stand and grain yield. Since, the variety was accepted by the target community, the agricultural office extension packages, farmers' cooperatives, Unions and seed enterprise organizations should focus on the extension and popularization of Dirre variety in West Arsi and Bale zones in order to improve the income of the farmers.

Key words: *Popularization, Durum wheat, Dirre variety, Actors, Farmers' feedback, pre-scaling up*

Introduction

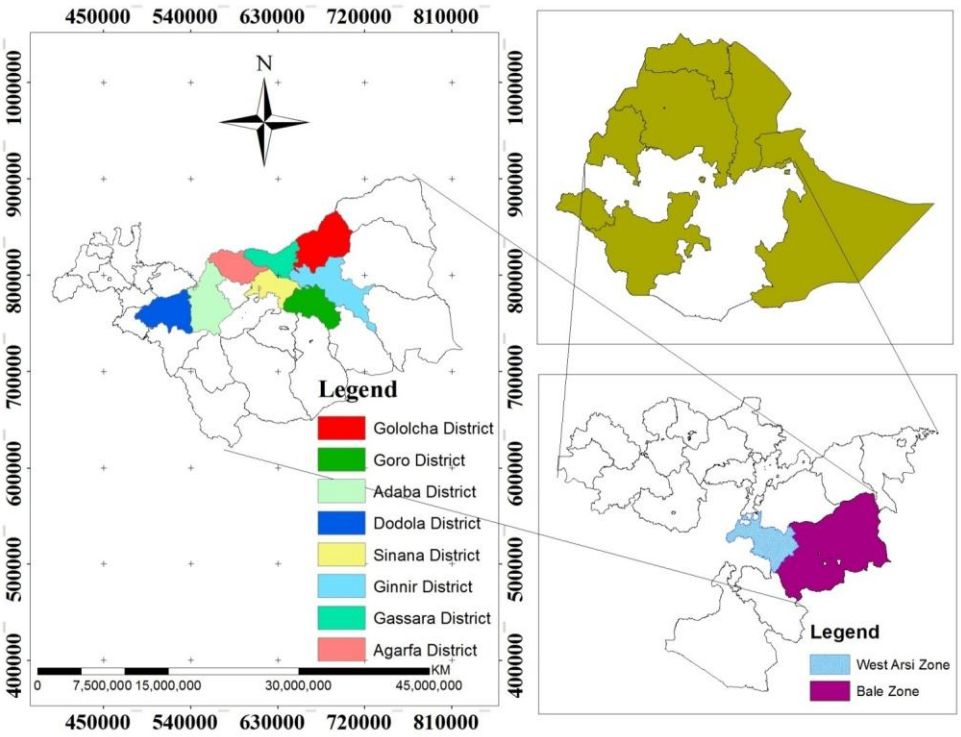
Durum Wheat produced for food and industrial purposes and used as raw materials for pasta and macaroni industries. However, due to low volumes and poor quality of national durum wheat production, pasta industries are importing huge amount of wheat and pasta every year costing about 30 million USD or >600 million Eth. Birr (Ethiopian Revenue and Customs Authority, 2013). To improve the situation, effort has been made by SARC in collaboration with Ethio-Italian Development Cooperation-Agricultural Value-chain Project in Oromia (AVCPO) in promoting durum wheat technologies as viable business opportunities for farmers through involvement of farmers' cooperatives and unions by linking with agro-industries since 2011/12.

Commercial durum wheat varieties under production including Bakalcha, Tate and Ude are losing their potential to resist disease and their protein quality decreasing from time to time. To overcome the problem, participatory on farm demonstration of recently released improved varieties of durum wheat (i.e. Dirre and Toltu) was carried out by Sinana Agricultural Research Centre. Accordingly, Dirre variety was selected by participant farmers due to the variety has some relative advantages than Toltu and Bakalcha (good tillering capacity, disease tolerance, spike length, seeds per spike, early maturity, drought tolerance, uniformity, crop stand, seed quality and yield). Since, Dirre variety was selected by the farmers during participatory demonstration, the project was initiated to scale up/out the technology in all demonstration sites and similar ago-ecologies**.** The activity envisioned to promote improved durum wheat technologies, increase production and productivity in the study zones, to create awareness, improve farmers' knowledge, skill and attitude (KSA) through multidisciplinary participatory training on durum wheat production and management packages and to strengthen stakeholders' participation, linkage and collaboration.

Methodology

Description of the study area

The research was carried out in Adaba and Dodola districts of West Arsi zone and Sinana, Agarfa, Gassara, Gololcha, Goro and Ginnir districts of Bale zone, Oromia National Regional State (ONRS), Ethiopia. West Arsi and Bale zones are among the 20 Administrative zones of the ONRS and located in south eastern Oromia. The districts were selected purposively based on their potential for durum wheat production.



Site and farmers Selection

Pre-scaling up of improved durum wheat technologies were undertaken in the main season (Bona) for consecutive two years (2015/16 and 2016/17). Sinana, Agarfa, Gassara, Goro, Gololcha and Ginnir districts of Bale zone and Adaba and Dodola districts of West Arsi zone were selected purposively as study sites based on their potential for durum wheat production. From each district two potential durum wheat growing kebeles were selected and selection of farmers were carried out in collaboration with crop extension experts from woreda Agriculture and natural resource office and Development agents (DAs). Farmers were selected by considering 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.

Material used and Field design

One recently released improved durum wheat variety and widely selected by farmers during demonstration (Dirre) was planted on the plot size of 32mx32m (1 midde).The variety was treated with full recommended durum wheat production and management packages. Row planting method and other crop management practices were employed 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 also used in the presence of sufficient soil moisture. The recommended inorganic fertilizer rate 100kg NPS and 110 kg/ha UREA 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

weedings were done; the first at one month after sowing and the second at two months after sowing of improved durum wheat variety.

All farm operations land preparation, planting, first and second weeding, agro-chemical spray, harvesting, threshing were carried out by hosting farmers with close supervision of researchers and Agricultural experts with practical orientation prior to planting until harvesting of the crop.

Stakeholder analysis (SA) and Roles and responsibility sharing

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. In enhancing durum wheat technologies dissemination, improving wheat production and productivity, the research center was closely working and has made frequent consultation with its respective stakeholders 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? were discussed upon. Finally the roles, duties and responsibilities of each actor were clearly stated and agreement was made with relevant stakeholders such as farmers, Agricultural and Natural Resource Office at different level, and unions on responsibility sharing in implementing the activity.

Table 1: Stakeholder roles and responsibilities during the implemention of the activity (2015/16)

Stakeholders	**Roles and responsibilities**
Sinana Agricultural Research Center (SARC)	➢ Coordination and facilitation ➢ Provision of durum wheat (Dirre) technologies ➢ Provision of training ➢ Technical backstopping ➢ Organize field days and ➢ Supervision and joint monitoring and evaluation with zone and district agricultural development office ➢ Follow up the revolving seed
Agriculture Development Office (at Zone, district and kebele level)	➢ Assist in site and participant farmers' selection ➢ Follow up day to day activities from zone to kebele level ➢ Assist in providing training ➢ Facilitate seed distribution ➢ Jointly organize and participate on field days
Farmers (wheat growers)	➢ Allocate land and perform required agronomic practices ➢ Actively participate in the training for capacity building (on
Cooperatives/Unions	➢ Agricultural input supply ➢ Facilitate seed marketing

Approaches followed to disseminate the technology

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 achieving 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.

Field Day

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

Field visit was also 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.

Communication methods Used

Appropriate extension approaches (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 activity.

- Telephone (fixed and/or mobile)
- Training (in-room and practical)
- Study tour or field visit or experience sharing
- Supervision, monitoring and evaluation
- Group meeting and discussion session
- Field day (to bring mass mobilization)
- Mass media (TV, Radio)
- Workshop (for status evaluation and result communication)
- Print Media in Afan Oromo (leaflets, pamphlets, flyers, posters, etc) was used for creating awareness, enhancing user knowledge and skill, changing attitude on using fully recommended packages of improved durum wheat technologies.

Data type, method of data collection and analysis

Amount of input distributed, harvested yield, total number of farmers participated on training, field visits and field days were recorded by gender composition. Farmers' feed-back (likes and dislikes, which is the base for plant breeding process and perceptions towards the performance of the technologies) was identified. The data collection method employed were field observation and focus group discussion with experts, hosting and other farmers. Descriptive statistics was used to calculate the mean yield harvested.

Results and Discussions

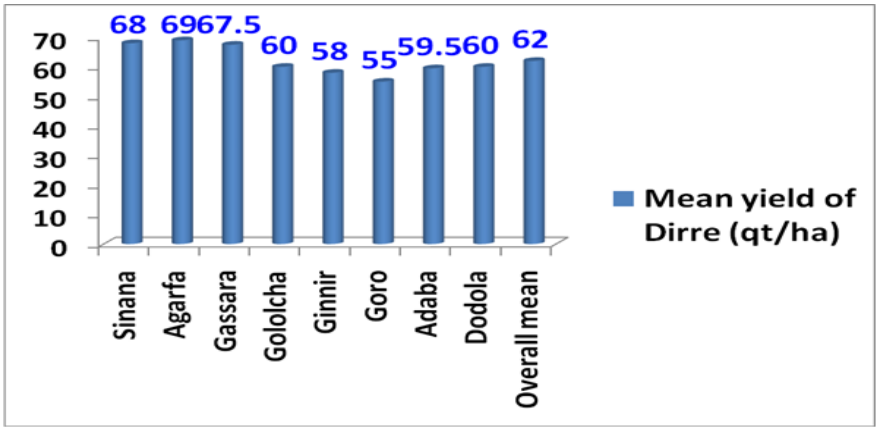
Input distribution

The distributed initial seed was used as revolving seed to reach other farmers in the area. 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 amount of input distributed and total yield harvested in two years of project duration was summarized in the following table.

Table 2: Implementation of the activity in the 1st and 2nd years

Year	Cropping season	Locations	No. of trial farmer	Amount of Seed provided for one farmer (kg)	Total amount of seed distributed (qt)	Total Area covered (ha)	Harvested seed (qt)
1	2015/16 (2008 E.C)	Gololcha Ginnir Goro	9	16	1.44	0.96	59.5
2	2016/17 (2009 E.C.)	Sinana Agarfa Gassara Adaba Dodola	34	16	5.44	3.63	225
Total			43	32	6.88	4.59	284.5

The variety (Dirre) scaled up has shown stable yield across locations. Farmer-to-farmers seed exchange mechanisms were designed to access seed of Dirre for interested farmers.



Training

Participatory training was given by SARC multidisciplinary team in the participant districts of Bale and West Arsi zone. The training was given at Dodola, Robe and Ginnir towns. The training covered topics related with durum wheat production, management and utilization (both in quantity and quality), major wheat diseases and their control measures, agro-chemicals utilizations and safety precautions, the importance of crop rotation to break cereal based mono-cropping practices in Bale and West Arsi zones through pulse crops. The training has also covered durum wheat value chain and marketing with special focus on creating strong linkage with agro-industries and among relevant actors through multi-stakeholder approach to tackle the problem in joint action through taking short-term, medium and long term actions/measures.

A total of 432 participants (320 farmers, 64 DAs and Supervisors, 36 agricultural experts and 12 researchers) were participated on the training as mentioned on table below.

Table 3: Participants of training for capacity building across districts

Participants	Districts								Total
	Adaba	Dodola	Sinana	Agarfa	Gasara	Gololcha	Ginir	Goro	
Experts	4	4	5	4	4	4	4	3	32
DAs and supervisors	8	8	8	8	8	8	8	8	64
Farmers	40	45	50	45	45	40	30	25	320
Bale zone ANRDO	-	-	-	-	-	-	-	-	4
Researchers	-	-	-	-	-	-	-	-	12
Total	52	57	63	57	57	52	42	36	432

Field Day organized

Filed days were organized at each district at physiological maturity stage of the crop in which a total of 396 participants (300 farmers from all category, 54 DAs and Supervisors, 32 agricultural experts and cooperative leaders and 10 researchers) were participated on the promotional event. Participants were

shared their best experiences especially how to preserve the quality seeds of durum wheat varieties (by cleaning combiner during harvesting or manual harvesting of the plot and other seed cleaning and preservation mechanisms). In addition, participant farmers were shared information on the local seed exchange system (informal) and the types of available improved durum wheat varieties at their hand and ways to exchange and preserve them. Finally, fruit-full discussion were undertaken among farmers and researchers especially on cereal crops based mono-cropping practices and wheat diseases problems in the sustainable production of wheat in the farming system.

Table 4: Participants of Field days in the two years

Year	Cropping season	Locations	Total participant	Farmers	DAs	Supervisors	Experts	Researchers
1	2015/16 (2008 E.C)	Gololcha Ginnir Goro	98	70	18	2	6	2
2	2016/17 (2009 E.C.)	Sinana Agarfa Gassara Dodola Gololcha Ginnir Goro	298	230	24	10	26	8
Total			**396**	**300**	**42**	**12**	**32**	**10**

Feed-back of focused group discussion (FGD)

Dirre needs early planting using the first rain shower since it has high late tillers. All participant farmers were very interested with the stands of Dirre (tillering capacity ≥10, spike length, spikelet per spike, seeds per spike ≥60), disease tolerance, seed color, crop stand and yield). Good awareness and confidence were created among stakeholders about Dirre variety (demand pull)

Exit Strategy

After pre-scaling up, the wider scaling up/out activities will be owned and handled by Agriculture and Natural Resource Office (ANRO) in collaboration with other key actors in the area and with close supervision by Sinana Agricultural Research Centre (SARC). Thus, in order to access the seed locally the selected variety (Dirre) was multiplied on one hectare by trial/hosting farmers who already obtained the seed in clustering approach by integrating different technologies and other commodities (pulses and oil crops). Popularization of the variety was also made on different extension/promotional events and during Field Day organized by ANR Offices in the main cropping season. Furthermore, this report was presented on Bale Zone Agricultural Development Partners Linkage Advisory Council (ADPLAC) annual meeting and tried to link relevant stakeholders (SARC, ANRO, Farmers, Cooperatives, Unions, OSE-Bale Branch, Private Dealers, NGOs and others) for sustainable seed supply.

Conclusion and Recommendations

Durum technologies popularized by Sinana Agricultural Research Center promoted the participation of concerned stakeholders from the beginning to the end of pre-scaling up activity. Training was given by Sinana Agricultural Research Center to farmers, agricultural experts and Unions on which a total of 432 participants (320 farmers, 64 DAs and Supervisors, 36 agricultural experts and 12 researchers) were participated. The task of popularization of Agricultural technologies needs strong promotional events like field days, workshop and participatory training. Thus, field days were also organized in each district to build the confidence of the participants especially farmers in order build their knowledge and attitude toward Dirre durum wheat variety.. the variety obtained wide acceptance from the participant stakeholders in terms of its tillering capacity $\geq$10, spike length, spikelet per spike, seeds per spike $\geq$60), disease tolerance, seed color, crop stand and yield. Interaction and active participation of important actors were also observed during the pre-scaling up activity to enhance the future adoption rate of the variety. Since, the variety was widely accepted by the target community, the agricultural office extension system, farmers' cooperatives, Unions and seed enterprise organizations should focus on the extension and popularization of Dirre variety in West Arsi and Bale zones in order to improve the income of the farmers. Furthermore, after such pre-scaling up activities, the wider scaling up/out activities should be owned and handled by extension organizations in collaboration with other key actors in the area including SARC. The genuine participation and interaction of relevant stakeholders on different promotional events organized during pre-scaling up activities should be increased so that durum wheat value chain should be strengthened and strong linkage between farmers and agro-industries is created.

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Pre-scaling up of Improved Bread Wheat Technologies in Bale and West Arsi zones, Oromia National Regional State, Ethiopia

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Abstract

Pre-scaling up of bread technologies was carried out in Sinana, Agarfa, Gassara, Goba and Dinsho districts of Bale zone and Adaba and Dodola districts of West Arsi zone. The activity was conducted by selecting two representative potential bread wheat growing kebeles in each district. Improved bread wheat variety (Sannate) which was selected by farmers during demonstration was distributed for 35 representative farmers and each farmer was given a seed which can cover the plot size of32mx32m (1 midde) with the recommended full packages. Participatory training, field visit and field days were used as an approach to disseminate and popularize the technology on which different actors (farmers, experts, researchers, unions, and farmers' cooperatives) were actively participated. Yield data and farmers' feedback about the technology was assessed and interpreted using descriptive statistics and qualitative data analysis methods. The overall mean yield of Sannate was 69 quintal per hectare. Farmers were interested with the stand of Sannate to its tillering capacity >10, spike length, spikelet per spike, seeds per spike >60, disease tolerance, crop stand and yield. Good awareness and confidence were created among stakeholders about the variety. As strengthening the capacity of end users in technology up-take and utilization is the base for technology adoption, the wider scaling up/out of the technology needs multi-stakeholder approach, commitment of actors and individuals at all stages of the further scaling up activities, especially at zone and district levels.

Key words*: Pre-scaling up, Participatory, Sannate variety, Actors, Farmers' feedback, Bread 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). Two wheat species are dominantly grown in the country. These two economically important wheat species are bread wheat (Triticum aestivum L.) and durum wheat (T. turgidum var. durum). Bread wheat is of recent introduction; durum wheat is indigenous to the Ethiopia, which is considered as 'the secondary center of diversity for tetrapod wheat. Wheat is one of the major cereal crops grown within the range of 1500 to 2800masl in Bale, Arsi, West Arsi and Shewa zones of Oromia National Regional Staten (SARC, 2014).

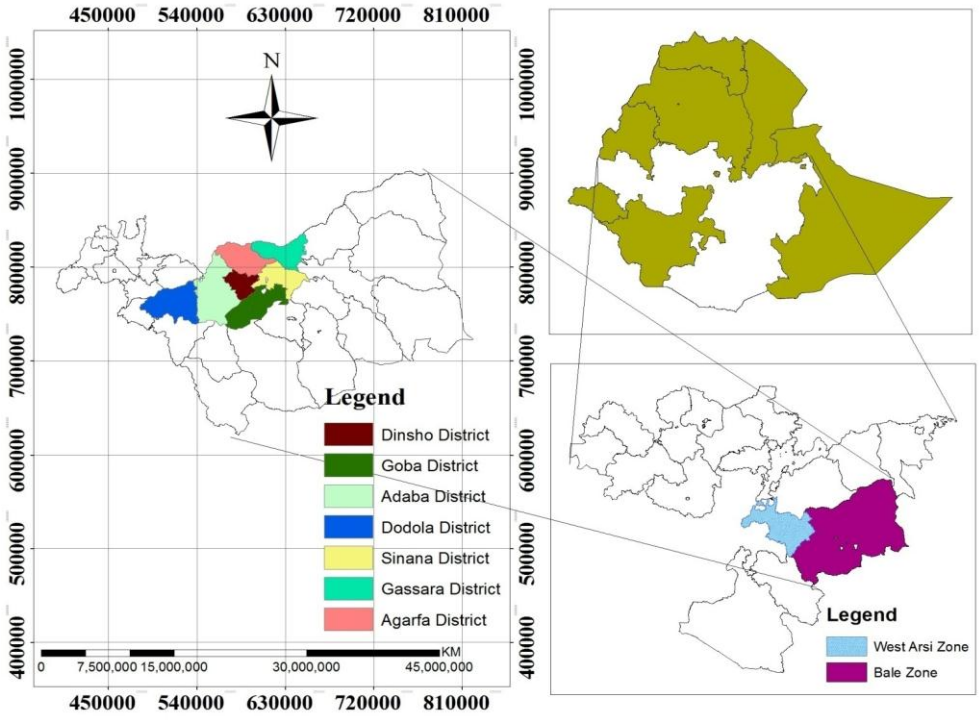
Now days, most of commercial bread wheat varieties under production are losing their potential to resist disease, especially current wheat rust disease epidemics in Arsi, West Arsi and Bale zones. Therefore, replacing these varieties with the new ones that have relatively better tolerance towards wheat rust diseases and good in yield is vital.

Yet, farmers of Bale and West Arsi zone have limited access to those wheat varieties and other related technologies. Thus, participatory demonstration, evaluation and validation of improved different bread wheat technologies with the participation of farmers and other stakeholders in Bale and West Arsi zones were carried out. Finally, farmers were let to set their own selection criteria and selected **Sannate** variety to be widely disseminated for Bale Zone and West Arsi Zone highlands. Accordingly, pre-scaling up of Sannate where initiated to address most of Bale Zone and some of West Arsi zone highlands with aims of promoting improved bread wheat technologies, increase production and productivity in the study zones, improveing farmers' knowledge, skill and attitude (KSA) through multidisciplinary participatory training on bread wheat production and management packages and strengthening stakeholders participation, linkage and collaboration

Methodology

Description of the study area

The research was carried out in Adaba and Dodola districts of West Arsi zone and Sinana, Agarfa, Gassara, Goba and Dinsho districts of Bale zone, Oromia National Regional State (ONRS), Ethiopia. West Arsi and Bale zones are among the 20 Administrative zones of the ONRS and located in southeastern Oromia. The districts were selected purposively based on their potential to wheat production.



Site and Farmers Selection

The study was undertaken in the main season (Bona) for consecutive two years (2015/16 and 2016/17). Sinana, Agarfa, Gassara, Goba and Dinsho districts of Bale zone and Adaba and Dodola districts of West Arsi zone were selected purposively as study sites based on their potential for bread wheat production. From each district two potential bread wheat growing kebeles were selected and selection of farmers were carried out in collaboration with crop extension experts from woreda Agriculture and natural resource office and Development agents (DAs). Farmers were selected by considering 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.

Material used and Field design

One recently released improved farmers selected during demonstration bread wheat variety (Sannate) was planted on the plot size of 32mx32m (1 midde). The variety was treated with full recommended wheat production and management packages. Row planting method and other crop management practices were employed 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 sufficient soil moisture. The recommended inorganic fertilizer rate 100kg NPS and 100 kg/ha UREA 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 variety.

All farm operations land preparation, planting, first and second weeding, agro-chemical spray, harvesting, threshing were carried out by hosting farmers with close supervision of researchers and Agricultural experts with practical orientation prior to planting until harvesting of the crop.

Stakeholder analysis (SA) and roles and responsibility sharing among actors

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? Finally the roles, duties and responsibilities of each participating stakeholder were clearly stated and shared for implementing the activity.

Table 1: Stakeholder roles and responsibilities in implementing the activity (2015/16)

Stakeholders	Roles and responsibilities
Sinana Agricultural Research Center (SARC)	➢ Coordination and facilitation ➢ Provision of bread wheat (Sannate) technologies ➢ Provision of training ➢ Technical backstopping ➢ Organize field days and ➢ Supervision and joint monitoring and evaluation with zone and district agricultural development office ➢ Follow up the revolving seed
Agriculture Development Office (at Zone, district and kebele level)	➢ Assist in site and participant farmers' selection ➢ Follow up day to day activities from zone to kebele level ➢ Assist in providing training ➢ Facilitate seed distribution ➢ Jointly organize and participate on field days
Farmers (wheat growers) Cost sharing	➢ Allocate land and perform required agronomic practices ➢ Actively participate in the training for capacity building (on knowledge, skill and attitude) ➢ Jointly organize and participate on field days ➢ Share skills and experiences to neighboring farmers ➢ Transfer produced seed to surrounding farmers and ➢ Finally, supply excess produced seed to cooperatives
Cooperatives/Unions	➢ Agricultural input supply ➢ Facilitate seed marketing

Approaches followed to disseminate the technology

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.

Field Day

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

Communication methods used

Appropriate extension approaches (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 activity. Print Media in Afan Oromo (leaflets, pamphlets, flyers, posters, etc) was used for creating awareness, enhancing user knowledge and skill, changing attitude on using fully recommended packages of improved bread wheat technologies.

Exit Strategy

After this pre-scaling up, in order to access the seed , the variety (Sannate) will be multiplied at least on one hectare by trial/hosting farmers who already obtained the seed in clustering approach by integrating different technologies and other commodities (pulses and oil crops). Popularization of the variety was made on different extension/promotional events and during Field Days that were organized by ANR Offices in the main cropping season. Furthermore, this report was presented on Bale Zone ADPLAC annual meeting on May 2017 and tried to link relevant stakeholders (SARC, ANRO, Farmers, Cooperatives, Unions, OSE-Bale Branch, Private Dealers, NGOs and others) for sustainable seed supply.

Data type, method of data collection and analysis

Amount of input distributed, harvested yield, total number of farmers participated on training, field visits and field days were recorded by gender composition. Farmers' feed-back (likes and dislikes, which is the base for plant breeding process and perceptions towards the performance of the technologies) was identified. The data collection method employed were field observation and focus group discussion with experts, hosting and other farmers. Descriptive statistics was used to calculate the mean yield harvested.

Results and Discussions

Input distribution

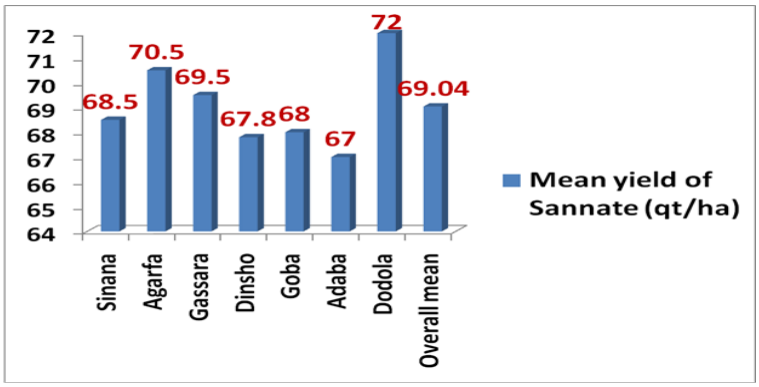
The amount of input distributed and total yield harvested in two years of project duration was summarized in the following table.

Table 2: Implementation of the activity in the 1st and 2nd years

Year	Cropping season	Locations	No. of trial farmer	Total amount of seed distribute(qt)	Total Area covered (ha)	Harvested seed (qt)
1	2015/16 (2008 E.C)	Sinana Agarfa Gassara	10	1.6	1.1	75.8
2	2016/17 (2009 E.C.)	Goba Dinsho Adaba Dodola	25	4	2.67	184
Total			35	5.6	3.77	259.8

Yield performance across districts

The pre- scaled up variety (Sannate) has shown a mean yield of 69.04 qt/ha yield. As shown on the graph below the yield gained ranged from 67-72qt/ha. The highest yield of 72qt/ha was gained at Dodola district. Farmer-to-farmers seed exchange mechanisms were designed to access seed of Sannate for interested farmers in the area.



Training on capacity building

Participatory training was given by SARC multidisciplinary team in the participant districts of Bale and West Arsi zone from 20-28/05/2016. The training was given at Dodola and Robe towns. The title of the trainingwas on available improved wheat technologies and utilization, bread wheat (both in quantity and quality) production and management packages, major wheat diseases and their control measures, agro-

chemicals utilizations and safety precautions, the importance of crop rotation to break cereal based mono-cropping practices in Bale and West Arsi zones through pulse crops (commodity) integration and on creating strong linkage among relevant actors through multi-stakeholder approach to tackle the problem in joint action through taking emergent, medium and long term actions/measures. A total of 435 participants (330 farmers, 56 DAs and Supervisors, 37 agricultural experts and 12 researchers) were participated on this training as mentioned in table below.

Table 3: Participants of training for capacity building

Participants	Districts							Total
	Adaba	Dodola	Sinana	Agarfa	Gassara	Goba	Dinsho	
Experts	5	5	5	5	5	4	4	33
DAs &supervisors	8	8	8	8	8	8	8	56
Farmers	45	50	60	55	45	40	35	330
Bale zone ANRDO	-	-	-	-	-	-	-	4
Researchers	-	-	-	-	-	-	-	12
Total	58	63	73	68	58	52	47	435

Field Day organized

Filed days were organized at each district at physiological maturity stage of the crop in which a total of 466 participants (357 farmers from all category, 58 DAs and Supervisors, 41 agricultural experts and cooperative leaders and 10 researchers) were participated. On this extension/promotional event participants shared their best experiences especially how to preserve the quality seeds of bread wheat varieties (by cleaning the combine harvester during harvesting or manual harvesting of the plot and other seed cleaning and preservation mechanisms). In addition, participant farmers shared information on the local seed exchange system (informal) and the types of available improved bread wheat varieties at their hand and ways to exchange and preserve them. Finally, fruit-full discussion were undertaken among farmers and researchers especially on cereal crops based mono-cropping practices and wheat diseases problems in the sustainable production of wheat in the farming system.

Table 4: Participants of Field days in the two years

Year	Cropping season	Locations	Total participant	Farmers	DAs	Supervisors	Experts	Researchers
1	2015/16 (2008 E.C)	Sinana Agarfa Gassara	168	127	18	6	15	2
2	2016/17 (2009 E.C.)	Goba Adaba Dodola	298	230	24	10	26	8
Total			466	357	42	16	41	10

Feedback obtained from focused group discussion (FGD)

Sannate variety needs early planting using the first rain shower since it has more late tillers. All participant farmers were very interested with the stands of Sannate (tillering capacity ≥10, spike length, spikelet per spike, seeds per spike ≥60, disease tolerance (Yr and Sr), crop stand, good plant height for mechanization and overall yield. Good awareness and confidence were created among stakeholders about Sannate variety (demand pull).

Conclusion and 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. In line with this, interaction and active participation of important actors were observed during this pre-scaling up activity to enhance the future adoption rate of the variety.

Establishing and strengthening FRGs/FREGs is one of the best approach 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 end users in technology up-take and utilization is the base for technology adoption. So, demand-driven training should be designed, the trainings, field days and field visits organized in this activity have helped to this end.

Since, the variety was accepted by the target community, the agricultural office extension system, farmers' cooperatives, Unions and seed enterprise organizations should focus on the extension and popularization of the variety in the study areas in order to improve the income of the farmers. Furthermore, after such pre-scaling up activities, the wider scaling up/out activities should be owned and handled by extension organizations in collaboration with other key actors in the area including SARC. The active participation and interaction of relevant stakeholders on different promotional events organized during the pre-scaling up activities should be increased.

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 pre-scaling up activities, especially at zone and district levels are crucial.

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Pre-scaling up of Improved Bread Wheat Technologies in Mid Altitude Areas of Bale zone, Oromia National Regional State, Ethiopia

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Abstract

Wheat is one of the major cereal crops grown within the range of 1500 to 2800masl. A pre-scaling up work of improved bread wheat varieties namely Ogolcho and Bika was conducted in Goro, Ginnir and Gololcha districts of Bale zone in 2016/17. Two potential bread wheat growing kebeles in each district were selected in which three to five hosting farmers were given the seed which was sown on plot size of 32m x 32m (One midde). Planting was done by drilling using 150 kg ha^{-1} seed rate with spacing of 20cm between rows. Fertilizer was applied with the rate of 100 kg ha^{-1} for NPS and UREA. Participatory training, field visit and field days were used as an approach to disseminate and popularize the technology on which different stakeholders actively participated. Yield data was recorded and analyzed using mean while farmers' feedback about the technology was assessed and interpreted using simple narration. The yield performance result shows as the overall mean yield of Ogolcho and Bika was 53.2 and 46.5 qtha^{-1} respectively. Similarly, farmers were interested with the stands of Bika and Ogolcho in terms of tillering, disease tolerance, spike length, seeds per spike, early maturity, drought tolerance, crop stand, seed quality and overall yield. Thus, in order to reach the target community in wider scale, the task of wider scaling up/out should be handled by extension organizations in collaboration with other stakeholders by integrating different technologies and other commodities (pulses and spice crops).

Key Words: *Pre-scaling up, bread wheat, Farmers' feedback, Stakeholders, Bale Zone*

Introduction

Agriculture is a dominant sector in Ethiopia. It contributes 51 percent to the GDP, employs nearly 85 percent of the total labor force and generates the bulk of foreign exchange. Smallholder farms are predominant, account for more than 90 percent of agricultural production and over 95 percent of the total area under cultivation.

Ethiopia is the largest producer of wheat in Sub-Saharan Africa. Recently, wheat in general has become one of the most important cereal crops (strategic crop) in terms of production and food security in Ethiopia (Tolesa, 2014). Two wheat species are dominantly grown in the country. These two economically important wheat species are bread wheat (*Triticum aestivum L.)* and durum wheat *(T. turgidum var. durum*). Bread wheat is of recent introduction; durum wheat is indigenous to the Ethiopia, which is considered as 'the secondary center of diversity for tetrapod wheat. Wheat is one of the major cereal crops grown within the range of 1500 to 2800masl in Bale, Arsi, West Arsi and Shewa zones of Oromia National Regional State (SARC, 2014).

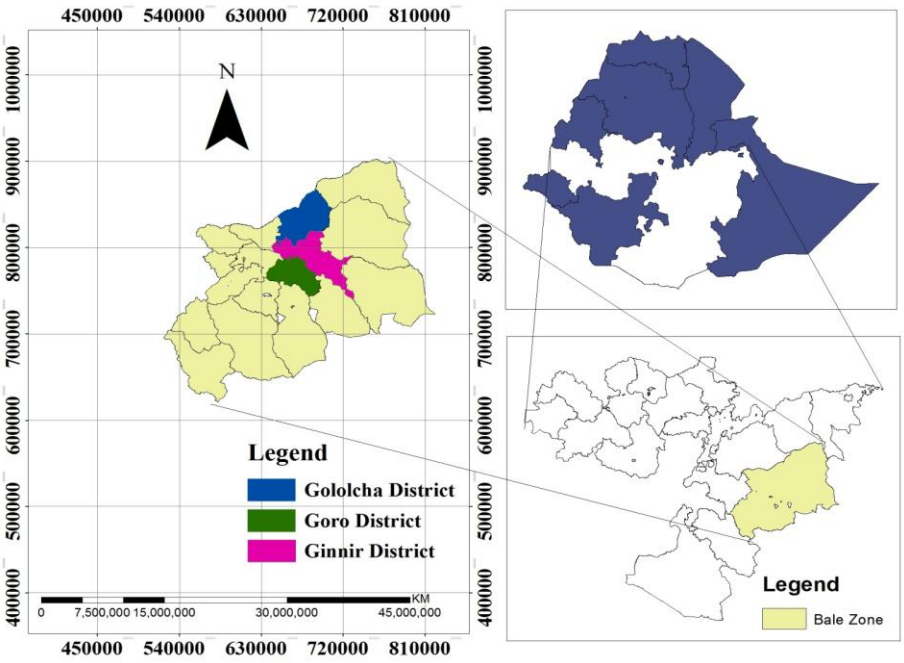
At national level, during 2015/16 cropping season 1,664,564.62 ha of land was covered by wheat (bread and durum) and over 42,192,572.23 quintals was harvested with the average yield of 25.35 quintals per hectare. Similarly, the land covered by wheat production in West Arsi and Bale zones in 2015/16 Meher production season was 120,067.9 and 143,971.78 hectares respectively. Whereas, the average yield of wheat produced from the two zones was 32.97 and 28.97 respectively (CSA, 2016). Even though, most agro-ecologies of West Arsi and Bale zones are the potential areas for wheat production, the yield obtained by farming community was below the potential. This is due to lack of improved wheat varieties, low crop management practices, diseases and insect problems and low use of recommended full packages.

Keeping this fact in view, in the last few years, efforts have been made to release varieties like Bika, Ogolcho and Dhakaba for mid agro-ecology of the zones. Yet, farmers in the mid land agro-ecology of the zone have limited access to those wheat varieties and other related technologies. Similarly, participatory demonstration and evaluation of improved bread wheat technologies with the participation of farmers and other stakeholders was conducted to select the best performing varieties for further pre-scaling up phase. Accordingly, farmers selected Bika and Ogolcho based on their own interest by setting their own selection criteria. Therefore, pre-scaling up/out of these varieties was initiated to disseminate these technologies in mid- altitudes of Bale zone with aims of promoting improved bread wheat technologies, increase production and productivity in the study zones, improving farmers' knowledge, skill and attitude (KSA) through multidisciplinary participatory trainings on bread wheat production and management packages and strengthening stakeholders participation, linkage and collaboration for further scaling up.

Methodology

Description of the study area

The research was carried out in Goro, Ginnir and Gololcha districts of Bale zone, Oromia National Regional State (ONRS), Ethiopia. The districts are found in the mid altitude areas and were selected purposively based on their potentiality to wheat production.



Site and Farmers selection

The study was undertaken in the main season of 2016/17 at Goro, Ginnir and Gololcha districts of Bale zone. The districts were selected purposively based on their potential for bread wheat production. From each district two potential bread wheat growing kebeles were selected**.** Before starting the field work, selection of farmers were carried out in collaboration with district Agriculture and natural resource office crop extension experts and Development agents (DAs). Farmers were selected by considering 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.

Material used and Field design

Two recently released improved bread wheat varieties Ogolcho and Bika were planted on the plot size of 32mx32m **("***1 midde"***).** Row planting method and other crop management practices were employed 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 sufficient soil moisture. The recommended inorganic fertilizer rate 100kg NPS and 100 kg/ha UREA 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 variety.

All farm operations land preparation, planting, first and second weeding, agro-chemical spray, harvesting, threshing were carried out by hosting farmers with close supervision of researchers and Agricultural experts with practical orientation prior to planting until harvesting of the crop.

Stakeholder analysis (SA) and Roles and responsibility sharing among actors

Pre-scaling up activity should be done by different actors in partnership through collaborative approaches. So, SA is highly important for institutional arrangement (who does what?) before embarking on the pre-scaling up activity. 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.. 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 were usied in the SA process. Finally the roles, duties and responsibilities of each actor were clearly stated and agreed in implementing the activity. The agreement was made with relevant stakeholders such as farmers, Agricultural and Natural Resource Office at different levels and unions.

Table 1: Stakeholder roles and responsibilities in implementing the activity (2016/17)

Stakeholders	Roles and responsibilities
Sinana Agricultural Research Center (SARC)	➢ Coordination and facilitation ➢ Provision of bread wheat (Bika and Ogolcho) technologies ➢ Provision of training ➢ Technical backstopping ➢ Organize field days and ➢ Supervision and joint monitoring and evaluation with zone and district agricultural development office ➢ Follow up the revolving seed
Agriculture Development Office (at Zone, district and kebele level)	➢ Assist in site and participant farmers' selection ➢ Follow up day to day activities from zone to kebele level ➢ Assist in providing training ➢ Facilitate seed distribution ➢ Jointly organize and participate on field days
Farmers (wheat growers) Cost sharing	➢ Allocate land and perform required agronomic practices ➢ Actively participate in the training for capacity building (on knowledge, skill and attitude) ➢ Jointly organize and participate on field days ➢ Share skills and experiences to neighboring farmers ➢ Transfer produced seed to surrounding farmers and ➢ Finally, supply excess produced seed to cooperatives
Cooperatives/Unions	➢ Agricultural input supply ➢ Facilitate seed marketing

Approaches followed to disseminate the technology

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.

Field Day and field visit

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

Communication methods Used

Appropriate extension approaches (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 activity. Print Media in Afan Oromo (leaflets, pamphlets, flyers, posters, etc) was used for creating awareness, enhancing user knowledge and skill, changing attitude on using fully recommended packages of improved bread wheat technologies.

Exit Strategy

In order to maintain the seed locally the selected varieties (Ogolcho and Bika) were multiplied at least on one hectare (each) by trial/hosting farmers who already obtained the seed in clustering approach by integrating different technologies and other commodities (pulses and oil crops). Popularization of the variety was made on different extension/promotional events and during Field Day that was organized by ANR Offices in the main cropping season. Furthermore, this report was presented on Bale Zone ADPLAC annual meeting and tried to link relevant stakeholders (SARC, ANRO, Farmers, Cooperatives, Unions, OSE-Bale Branch, Private Dealers, NGOs and others) for sustainable seed supply.

Data type, method of data collection and analysis

Amount of input distributed, harvested yield, total number of farmers participated on training, field visits and field days were recorded by gender composition. Farmers' feed-back (likes and dislikes, which is the base for plant breeding process and perceptions towards the performance of the technologies) was identified. The data collection method employed were field observation and focus group discussion with experts, hosting and other farmers. Descriptive statistics was used to calculate the mean yield harvested.

Results and Discussion

Input distribution

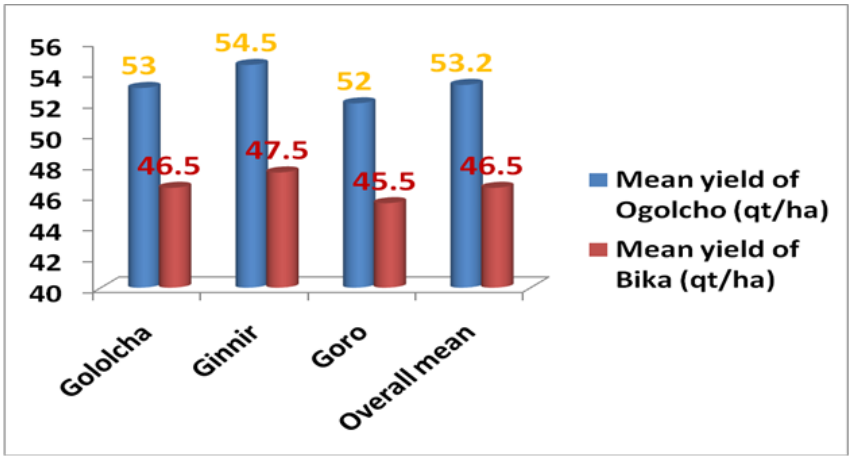
The amount of input distributed and total yield harvested in two years of project duration was summarized in the following table. During implementation a total of 1.6qt of seed was distributed. Farmer-to-farmers seed exchange mechanisms were designed to access seed of Bika and Ogolcho varieties for interested farmers in the mid altitude area.. The distributed initial seed was used as revolving seed to reach other farmers in the area. 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.

Table 2: Implementation of the activity in 2016/17

Year	Cropping season	Locations	No. of trial farmer	Total seed distribute (qt)	Total Area (ha)	Harvested seed (qt)
1	Ogolcho in 2016/17 (2009 E.C)	Gololcha Ginnir Goro	6	0.96	0.64	34
2	Bika in 2016/17 (2009 E.C.)	Gololcha Ginnir Goro	4	0.64	0.43	20
Total			10	1.6	1.07	54

Yield performance across districts

The pre- scaled up varieties Oglcho and Bika have shown a mean yield of 53.2 qt/ha and 46.5 qt/ha respectively. As shown on the graph below the yield gained ranged from 52-54.5qt/ha for Ogolcho and 45.5 to 47.5qt/ha across the four study districts, The highest yield of 54.5qt/ha for Ogolcho and 47.5qt/ha for Bika respectively was recorded at Ginnir distrct.



Training on capacity building

Participatory training was given by SARC multidisciplinary team at Gololcha, Ginnir and Goro districts (Bale zone) from. The training was given at Ginnir towns. The title of the trainingwas on available improved wheat technologies for mid altitude areas of Bale zone and utilization, bread wheat (both in quantity and quality) production and management packages, major wheat diseases and their control measures, agro-chemicals utilizations and safety precautions, the importance of crop rotation to break cereal based mono-cropping practices in mid altitude areas of Bale zone through pulse crops (commodity) integration and on creating strong linkage among relevant actors through multi-stakeholder approach to tackle the problem in joint action through taking emergent, medium and long term actions/measures.

A total of 176 participants (120 farmers, 24 DAs and Supervisors, 20 agricultural experts and 12 researchers) were participated on this training as mentioned in table below.

Table 3: Participants of training for capacity building

Participants	Districts			Total
	Gassara	Goba	Dinsho	
Experts	4	4	4	16
DAs and supervisors	8	8	8	24
Farmers	40	45	35	120
Bale zone ANRDO (Head/Vice Head, Agronomy, Protection and Extension)	-	-	-	4
Researchers	-	-	-	12
Total	52	57	47	176

Field day organized

Field days were organized at each district at physiological maturity stage of the crop in which a total of 185 participants (144 farmers from all category, 18 DAs and 6 Supervisors, 15 agricultural experts and cooperative leaders and 2 researchers) were participated on this extension/promotional event. Participants shared their best experiences especially how to preserve the quality seeds of bread wheat varieties (by cleaning combiner during harvesting or manual harvesting of the plot and other seed cleaning and preservation mechanisms). In addition, participant farmers were shared information on the local seed exchange system (informal) and the types of available improved bread wheat varieties (for mid altitude area) at their hand and ways to exchange and preserve them. Finally, fruit-full discussion were undertaken among farmers and researchers especially on cereal crops based mono-cropping practices and wheat diseases problems in the sustainable production of wheat in the farming system.

Table 4: Participants of Field days in 2016/17

Year	Cropping season	Locations	Total participant	Farmers	DAs	Supervisors	Experts	Researchers
1	2016/17 (2009 E.C)	Goro Ginnir Gololcha	185	144	18	6	15	2
Total			185	144	18	6	**15**	2

Feed-back obtained from Focused group discussion (FGD)

Bika and Ogolcho needs early planting using the first rain shower to overcome the moisture stress problem in the mid land area. All participant farmers were very interested with the stands of Bika and Ogolcho especially (tillering, disease tolerance, spike length, seeds per spike, early maturity, drought tolerance, adaptability, uniformity, crop stand, seed quality and overall yield). Good awareness and confidence were created among stakeholders about bread wheat technologies meant for mid altitude area (demand pull)

Conclusion and Recommendations

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.

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 promotion of newly released/registered wheat technologies under farmers' condition is important to make research demand-driven and enhance wheat production and productivity. Farmers' feed-back assessment 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.

Thus, in order to reach the target community in wider scale with the selected varieties (Ogolcho and Bika), the task of wider scaling up should be handled by extension organisations in collaboration with other stakeholders by integrating different technologies and other commodities (pulses and spice crops).

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Pre-scaling up of Improved Food Barley Technologies in Bale and West Arsi zones, Oromia National Regional State, Ethiopia

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Abstract

Pre-scaling up of improved food barley technologies was conducted at Sinana, Goba, Dinsho, Agarfa and Gassara districts of Bale zone and Adaba and Dodola districts of West Arsi zone during 2015/16 and 2016/17 cropping season. The main objective of the study was to popularize and promote improved food barley technologies by strengthening on-farm seed production scheme and farmer- to-farmer seed dissemination system. An improved food barley variety (Abdanne) was planted on the plot size of 32m x 32m. The variety was treated with full recommended production and management packages. A multi-stage purposive sampling technique was employed to select potential districts, Kebeles and hosting farmers. Stakeholder analysis was made to select potential stakeholders to implement the activity. Field days and field visits were organized to share the experience, evaluate the performance and to communicate the progress of the activity. A total of 466 individuals were participated on these promotional events during the project period. Yield data was recorded and analyzed using mean while farmers' feedback about the technology was assessed and interpreted using simple narration. The yield performance result shows as the overall mean yield of Abdanne was 36 qtha^{-1}. Consequently, the variety has got acceptance from the participant stakeholders in terms of its tillering capacity, resistant to lodging, shoot fly and disease tolerance, spike length, seeds per spike, adaptability, seed plumpness, crop stand and yield. Since, the variety was accepted by the target community, extension organizations and seed multipliers should focus on the extension and popularization of the variety in West Arsi and Bale zones in order to improve the income of the farmers.

Key Words*: Pre-scaling up, Barley variety, Stakeholder analysis, promotional events, Farmers' feedback, Bale zone*

Introduction

Barley is the most important cereal crops cultivated in Ethiopia. Suitable barley growing regions in the country are the highlands ranging from 2300 to 3000masl (Bayeh and Birhane, 2011). 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. Barely productivity in Ethiopia (1.965 t/ha) is low compared to world average of 3.095 t/ha (Barley commodity strategic plan document, 2016). Yield potential assessment showed that grain yield of food barley has increased from 3314.8 to 5088.6 kg ha^{-1} during the period from 1970 to 2006. From 9,974,316.28 hectares of land allocated for cereals in 2015/16 production season, barley (food and malt) covered 944,401.34 ha of land from which 18,567,042.76 quintals of grain was produced with the average productivity of 19.66 qt/ha (CSA, 2016), while most model farmers obtain

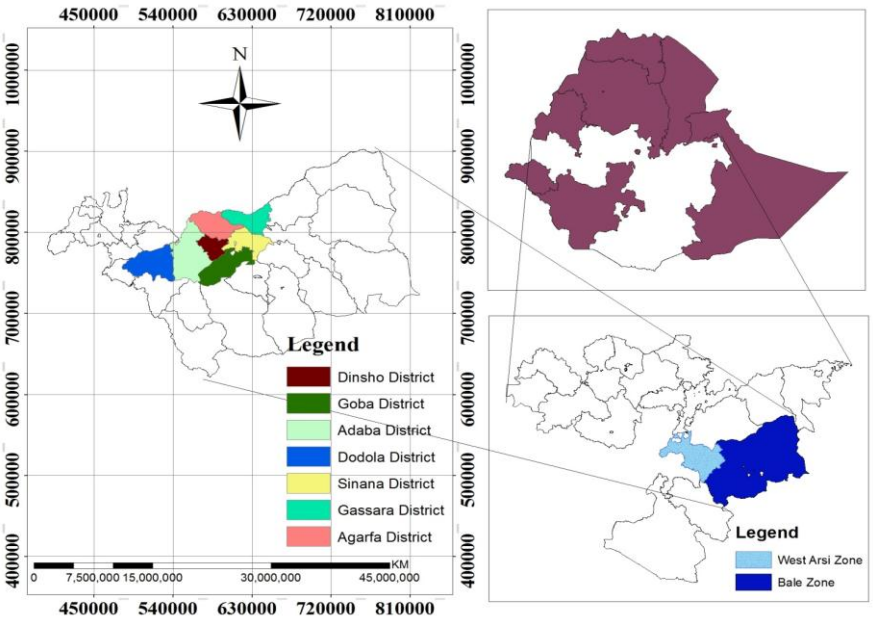
3500 - 4000 kg ha-1 on average. In Bale, 42,368.67 ha of land was covered by barley and 839,875.10 quintals of grain was produced with the productivity of 19.82 qt/ha (CSA, 2016).

Barley crop area is less covered by improved seeds and adoption of fertilizer recommendations is also found comparatively low. Grain yields and malting quality are still not of the desired level even in areas of adequate rainfall due to susceptibility to diseases, insect pests, inappropriate agronomic practices and low crop management practices. Besides, its potential productivity is limited by lack of sufficient improved food barley varieties. Moreover, low use of recommended full packages is also another yield limiting factor. Developing high yielding, disease tolerant and stable varieties that can meet increasing food demand of the growing human population, improve the income and livelihood of farmers are very important. Consequently, participatory on farm demonstration and evaluation of improved food barley technologies were carried out in recent years. At the end of the demonstration process participant farmers selected Abdanne variety among the demonstrated improved food barley varieties. Since, Abdanne variety was selected by the participant farmers the task of pre-scaling up was initiated to address the variety for wider farming community. The aim of the pre-scaling up activity were to promote improved food barley technologies, increase production and productivity and income of farmers in the study zones, to create awareness, improve farmers' knowledge, skill and attitude (KSA) through multidisciplinary participatory training on food barley production and management packages and To strengthen stakeholders' participation, linkage and collaboration.

Methodology

Description of the study area

The research was carried out in Adaba and Dodola districts of West Arsi zone and Sinana, Agarfa, Gassara, Goba and Dinsho districts of Bale zone, Oromia National Regional State (ONRS), Ethiopia. The districts were selected purposively based on their potential to barley production.



Site and Farmers Selection

The study districts were selected based on their potential for barley production. From each district two representative kebeles were selected purposively based on thier potential for barley production.

Subsequently, two to three representative farmers per kebele were selected. The selection of farmers was carried out in collaboration with crop extension experts from district Agriculture and natural resource office and development agents (DAs). Farmers were selected 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. The selection of farmers considered gender composition and other important socio economic variables.

Material used and Field design

One recently released improved food barley variety (Abdanne) was planted on the plot size of 32mx32m *(''1 midde'')*. The variety was treated with full recommended food barley production and management packages. Hosting farmers were used as replication across the districts. All farm operations land preparation, planting, first and second weeding, agro-chemical spray, harvesting, threshing were carried out by hosting farmers with close supervision of researchers and Agricultural experts with practical orientation provided prior to planting. Source of the seed was SARC at the inception of the activity, later on, farmer-to-farmers seed exchange mechanisms were designed to access seed of Abdanne variety locally for interested farmers in the area.

Stakeholder analysis (SA) and roles and responsibility sharing among actors

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? Finally the roles, duties and responsibilities of each actor were clearly stated and shared in implementing the activity.

Table 1: Stakeholder roles and responsibilities in implementing the activity (2015/16)

Stakeholders	Roles and responsibilities
Sinana Agricultural Research Center (SARC)	➢ Coordination and facilitation ➢ Provision of food barley (Abdanne) technologies
Agriculture Development Office (at Zone, district and kebele level)	➢ Assist in site and participant farmers' selection ➢ Follow up day to day activities from zone to kebele level ➢ Assist in providing training ➢ Facilitate seed distribution ➢ Jointly organize and participate on field days

Farmers (wheat growers) Cost sharing	➢ Allocate land and perform required agronomic practices ➢ Actively participate in the training for capacity building (on knowledge, skill and attitude) ➢ Jointly organize and participate on field days ➢ Share skills and experiences to neighboring farmers ➢ Transfer produced seed to surrounding farmers and ➢ Finally, supply excess produced seed to cooperatives
Cooperatives/Unions	➢ Agricultural input supply ➢ Facilitate seed marketing

Approaches followed to disseminate the technology

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). Consequently, training was provided to farmers, DAs, and agricultural experts on food barley 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 the training.

Field Day

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

Communication methods used

Appropriate extension approaches (participatory) and all extension teaching methods (individual, group and mass contact methods) were employed alone or in a thoughtful combination according to the situations during the implementation of the activity. Print Media in Afan Oromo (leaflets, pamphlets, flyers, posters, etc) was used for creating awareness, enhancing user knowledge and skill, changing attitude on using fully recommended packages of improved food barley technologies.

Exit Strategy

After pre-scaling up, the wider scaling up/out activities will be owned and handled ANRO in collaboration with other key actors in the area and with close supervision by SARC. Thus, in order to access the seed locally the selected variety (Abdanne) was multiplied at least on one hectare by trial/hosting farmers who already obtained the seed in clustering approach by integrating different technologies and other commodities (pulses and oil crops). Popularization of the variety was made on different extension/promotional events and during Field Day that was organized by ANR Offices in the main cropping season. Furthermore, this report was presented on Bale Zone ADPLAC annual meeting (in May 2017) and tried to link relevant stakeholders (SARC, ANRO, Farmers, Cooperatives, Unions, OSE-Bale Branch, Private Dealers, NGOs and others) for sustainable seed supply.

Data type, method of data collection and analysis

Amount of input distributed, harvested yield, total number of farmers participated on training, field visits and field days were recorded by gender composition. Farmers' feed-back (likes and dislikes, which is the base for plant breeding process and perceptions towards the performance of the technologies) was identified. The data collection method employed were field observation and focus group discussion with experts, hosting and other farmers. Descriptive statistics was used to calculate the mean yield harvested.

Results and Discussion

Input distribution

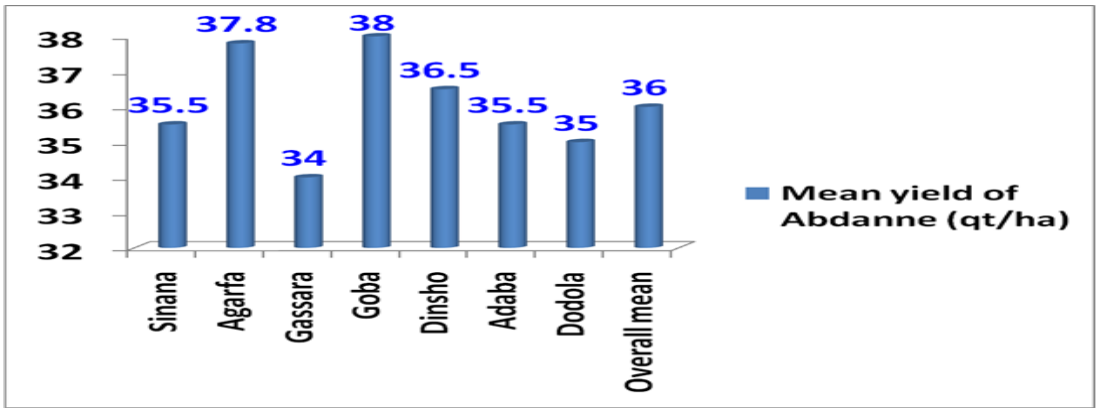
The following table describes the distributed amount of seed and total yield harvested in the study period. The distributed initial seed was used as revolving seed to reach other farmers in the area. This system is a relatively low-cost system that can maintain kind, quantity, quality and access at right time, place and reasonable price. The seed distributed was to a satisfactory level to neighboring farmers locally.

Table 2: distributed amount of seed in the implementation of the activity in the 1st and 2nd years

Year	Cropping season/year	Locations	No. of trial farmer	Total seed distribute (qt)	Total Area (ha)	Harvested seed (qt)
1	2015/16 (2008 E.C)	Sinana Goba Agarfa Gassara	11	1.43	1.19	43
2	2016/17 (2009 E.C.)	Dinsho Adaba Dodola	30	3.9	3.25	117
Total			41	5.33	4.44	160

Yield performance

The yield obtained ranged 34 to 38qt/ha across the study locations. The highest yield was obtained at Goba district.. The following figure describes the yield obtained across all study locations.



Training on capacity building

Participatory training was given by SARC multidisciplinary team in the participant districts of Bale and West Arsi zone. The training was given at Robe and Dodola towns. The title of the training were on available improved barley technologies and utilization, food barley (both in quantity and quality) production and management packages, major barley diseases and their control measures, agro-chemicals utilizations (time, rate, etc.). A total of 435 participants (330 farmers, 56 DAs and Supervisors, 37 agricultural experts and 12 researchers) were participated on this training.

Table 3: Number of training participants

Participants	Districts							Total
	Adaba	Dodola	Sinana	Agarfa	Gassara	Goba	Dinsho	
Experts	5	5	5	5	5	4	4	33
DAs and supervisors	8	8	8	8	8	8	8	56
Farmers	45	50	60	55	45	40	35	330
Bale zone ANRDO	-	-	-	-	-	-	-	4
Researchers	-	-	-	-	-	-	-	12
Total	58	63	73	68	58	52	47	435

Field Day organized

Filed days were organized at each district at physiological maturity stage of the crop in which a total of 466 participants (357 farmers from all category, 58 DAs and Supervisors, 41 agricultural experts and cooperative leaders and 10 researchers) were participated on this extension/promotional event. Participants shared their experiences on how to preserve the quality seeds of food barley varieties (by manual harvesting of the plot and other seed cleaning and preservation mechanisms). In addition,

participant farmers were shared information on the local seed exchange system (informal) and the types of available improved food barley varieties at their hand and ways to exchange and preserve them. Finally, fruit-full discussion was undertaken among farmers and researchers especially on cereal crops based mono-cropping practices and barley diseases problems for the sustainable production of barley in the farming system.

Table 4: Participants of Field days in the two years

Year	Cropping season	Locations	Total participant	Farmers	DAs	Supervisors	Experts	Researchers
1	2015/16 (2008 E.C)	Sinana Goba Agarfa Gassara	168	127	18	6	15	2
2	2016/17 (2009 E.C.)	Goba Dinsho Adaba Dodola	298	230	24	10	26	8
Total			466	357	42	16	41	10

Feed-back of focused group discussion (FGD)

All participant farmers were very interested with the stands of **Abdanne** (tillering capacity, resistant to lodging, shoot fly and disease tolerance, spike length, seeds per spike, adaptability, seed plumpness, crop stand and yield) as compared to the local variety they have at hand. Good awareness and confidence were created among stakeholders about Abdanne variety (demand pull).

Conclusion and Recommendations

Efficient popularization of Agricultural technologies needs FREG approach followed strong promotional events like field days, workshop and participatory training. Effective and efficient delivery of technical advices and support to farmers is highly required to improve barley production and productivity and bring the targeted impact. Farmers' feed-back assessment 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.

Abdanne variety of food barley was obtained wide acceptance from the participant stakeholders, in terms of tillering capacity, resistant to lodging, shoot fly and disease tolerance, spike length, seeds per spike, adaptability, seed plumpness, crop stand and yield. Since, the variety was widely accepted by the target community, the agricultural office extension system, farmers' cooperatives, Unions and seed enterprise organizations should focus on the extension and popularization of the variety in West Arsi and Bale zones in order to improve the income of the farmers.

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Pre-scaling up of Improved Faba Bean Technologies in Bale and West Arsi zones, Southeastern Oromia, Ethiopia

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Abstract

Pre-scaling up activity was initiated with the main objective of disseminating and popularizing proven faba bean technologies. Sinana, Agarfa, Gassara, Goba and Dinsho districts of Bale zone, Adaba and Dodola districts of West Arsi zone were selected purposively based on their potential for faba bean production. Mosisa and Moti were distributed for 45 farmers and planted on the plot size of 32m x 32m ("1 midde"). The spacing of 40cm between rows with the recommended seed rate of 180 kg/ha and fertilizer rate 100kg NPS was applied during row planting time. Field days and field visits were organized to evaluate the performance and to communicate on field progress of the varieties. A total of 466 individuals were participated on these promotional events during the project period. Yield data was recorded and analyzed using mean while farmers' feedback about the technology was assessed and interpreted using simple narration. The result of descriptive statics revealed that the overall mean yield of Mosisa and Moti were 32 and 36 qt ha^{-1} respectively. All participant farmers were interested with the stands of Mosisa and Moti in terms of pods per plant, seeds per pod, seeds per plant, stem strength, good plant height, disease tolerance, relative yield advantage and seed size. Since, the varieties widely accepted by the target community, the Agricultural and Natural Resource office in all levels in collaboration with other stakeholders should focus on the extension and popularization of the varieties with the recommended full packages.

Key Words: *Popularization, Dissemination, Improved Faba Bean Varieties, Promotional Events, Farmers' Feedback, Yield*

Introduction

Faba bean (*Vicia faba* L.), which is one of the most important cool-season food legumes grown in Ethiopia, is originated in the Near East and it is also one of the earliest domesticated legumes after chickpea and pea. Ethiopia is considered as the secondary center of diversity and also one of the nine major agro-geographical production regions of Faba bean. It is grown as field crops throughout the highlands and is most common in mid altitude between the altitudes 1800 m.a.s.l and 3000m.a.s.l (Asfaw *et al*., 1994). According to the United Nations Food and Agriculture Organization (FAO, 2014), China is currently the world's leading producer, accounting for approximately 60% of the total. Other important production regions are northern Europe, the Mediterranean, the Nile Valley, Ethiopia, Central and East Asia, Oceania and the Americas.

Ethiopia ranks 2nd in area coverage in legume production next to china and 4th in productivity in the world. Faba bean production ranks the 1st among pulse crops in area and volume of production in the country. From 1,652,844.19 hectares of land allocated for pulse in 2015/2016 production season, Faba bean covered 443,966.09 hectares of land from which 8,486,545.69 quintals of grain was produced with the productivity of 19.12 qt/ha (CSA, 2016). In Bale, 16,471.36 ha of land was covered by Faba bean and 388,302.53 quintals of grain was produced with the productivity of 23.57 qt/ha (CSA, 2016).

The crop has ecological and economic importance and used for food (rich in protein), income source and foreign currency (attractive market price), soil fertility restoration (NP) and food security. But, its production and productivity is declining through time due to different biotic and abiotic production factors. Of the major production constraints, which contribute for low production and productivity of Faba bean at West Arsi and Bale is lack of improved high yielder, stress and diseases tolerant varieties.

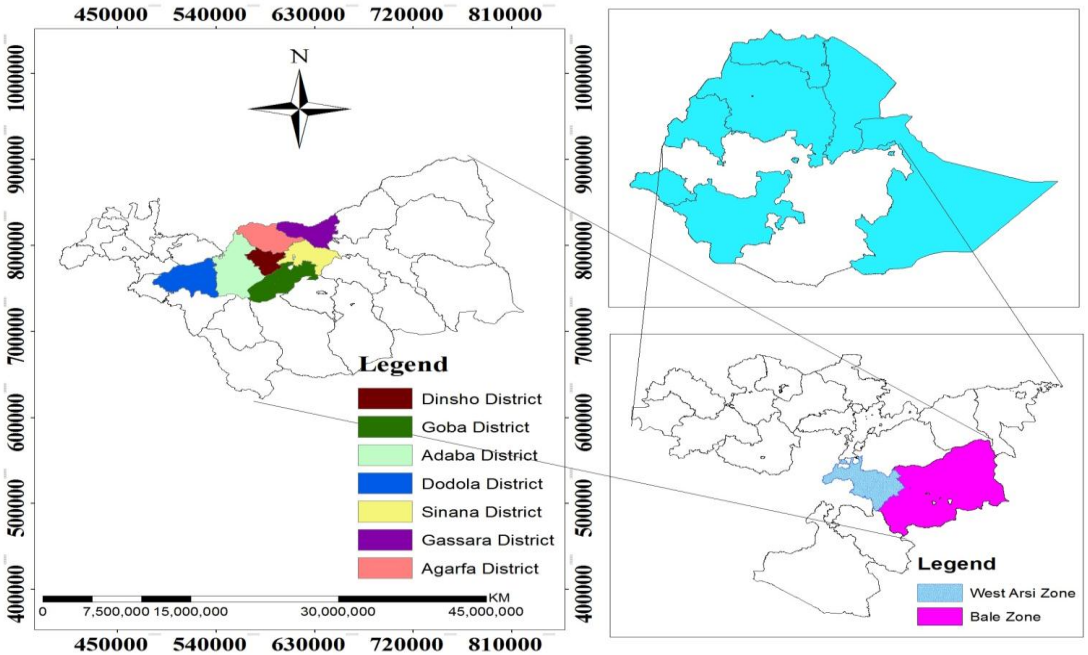
Bale and West Arsi Zones are characterized by integrated (mixed) farming systems in which most of the crop areas were under cereal production. To date, it faced a cereal based mono-cropping threat both at small-scale subsistence farms and the former large-scale state farms (now Oromia Seed Enterprise-Bale Branch). Faba bean are the best break crops for wheat production. Bread wheat grown after these crops gave higher grain yield than after cereal crops with a yield advantage of 15% (Sinana ARC Profile, 2014).

Consequently, participatory on farm demonstration and evaluation of different faba bean technologies was carried out and farmers were enhanced to evaluate the varieties by setting their own selection criteria. Finally, farmers selected Mosisa and Moti varieties of faba bean among demonstrated faba bean varieties. In order to popularize these varieties in areas where demonstration process was carried out and in similar agro-ecologies, pre-scaling up activity was initiated with objectives of promoting improved faba bean technologies to increase production and productivity in the study zones, improving farmers' knowledge, skill and attitude (KSA) through multidisciplinary participatory training on faba bean production and management packages and strengthening stakeholders' participation, linkage and collaboration.

Methodology

Description of the study area

The research was carried out in Adaba and Dodola districts of West Arsi zone and Sinana, Agarfa, Gassara, Goba and Dinsho districts of Bale zone, Oromia National Regional State (ONRS), Ethiopia. The districts were selected purposively based on their potentiality to faba bean production.



Site and Farmers Selection

Pre-scaling up of improved faba bean technologies were undertaken in the main season (Bona) for consecutive two years (2015/16 and 2016/17). Sinana, Agarfa, Gassara, Goba and Dinsho districts of Bale zone and Adaba and Dodola districts of West Arsi zone were selected purposively as study sites based on their potential for faba bean production. The activity was also conducted by selecting two potential faba bean growing kebeles in each district.

Before starting the field work, selection of farmers were carried out in collaboration with crop extension experts from woreda Agriculture and natural resource office and Development agents (DAs). Farmers were selected by considering 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 disaggregation and other important socio economic variables.

Material used and Field design

Two recently released improved faba bean varieties **Mosisa** and **Moti** were selected by participant farmers during demonstration phase. The varieties were planted on the plot size of 32mx32m (*"1 midde"*).The variety was treated with full recommended production and management packages. Row

planting method and other crop management practices were employed during the research work. The spacing of 40cm between rows was used. The recommended seed rate of 180 kg/ha was used by drilling in the prepared rows.The recommended inorganic fertilizer rate 100kg NPS was applied during planting time. 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 variety. All farm operations land preparation, planting, first and second weeding, agro-chemical spray, harvesting, threshing were carried out by hosting farmers with close supervision of researchers and Agricultural experts with practical orientation prior to planting until harvesting of the crop.

Stakeholder analysis (SA) and roles and responsibility sharing among actors

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? Finally the roles, duties and responsibilities of each actor were clearly stated and shared for implementing the activity.

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Table 1: Stakeholder roles and responsibilities in implementing the activity (2015/16)

Stakeholders	Roles and responsibilities
Sinana Agricultural Research Center (SARC)	➢ Coordination and facilitation ➢ Provision of faba bean (Moti and Mosisa) technologies ➢ Provision of training ➢ Technical backstopping ➢ Organize field days and ➢ Supervision and joint monitoring and evaluation with zone and district agricultural development office ➢ Follow up the revolving seed
Agriculture Development Office (at Zone, district and kebele level)	➢ Assist in site and participant farmers' selection ➢ Follow up day to day activities from zone to kebele level ➢ Assist in providing training ➢ Facilitate seed distribution ➢ Jointly organize and participate on field days
Farmers (wheat growers) Cost sharing	➢ Allocate land and perform required agronomic practices ➢ Actively participate in the training for capacity building (on knowledge, skill and attitude) ➢ Jointly organize and participate on field days ➢ Share skills and experiences to neighboring farmers ➢ Transfer produced seed to surrounding farmers and ➢ Finally, supply excess produced seed to cooperatives
Cooperatives/Unions	➢ Agricultural input supply ➢ Facilitate seed marketing

Approaches followed to disseminate the technology

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 faba bean 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.

Field Day

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

Communication methods used

Appropriate extension approaches (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 activity. Print Media in Afan Oromo (leaflets, pamphlets, flyers, posters, etc) was used for creating awareness, enhancing user knowledge and skill, changing attitude on using fully recommended packages of improved faba bean technologies.

Exit Strategy

After pre-scaling up, the wider scaling up/out activities will be owned and handled ANRO in collaboration with other key actors in the area and with close supervision by SARC. Thus, in order to access the seed locally the selected varieties (Mosisa and Moti) was multiplied at least on one hectare by trial/hosting farmers who already obtained the seed in clustering approach by integrating different technologies and other commodities (cereal crops). Popularization of the varieties was made on different extension/promotional events and during Field Day that was organized by ANR Offices in the main cropping season. Furthermore, this report was presented on Bale Zone ADPLAC annual meeting (in May 2017) and tried to link relevant stakeholders (SARC, ANRO, Farmers, Cooperatives, Unions, OSE-Bale Branch, Private Dealers, NGOs and others) for sustainable seed supply.

Data type, method of data collection and analysis

Amount of input distributed, harvested yield, total number of farmers participated on training, field visits and field days were recorded by gender composition. Farmers' feed-back (likes and dislikes, which is the base for plant breeding process and perceptions towards the performance of the technologies) was identified. The data collection method employed were field observation and focus group discussion with experts, hosting and other farmers. Descriptive statistics was used to calculate the mean yield harvested.

Results and Discussion

Input distribution

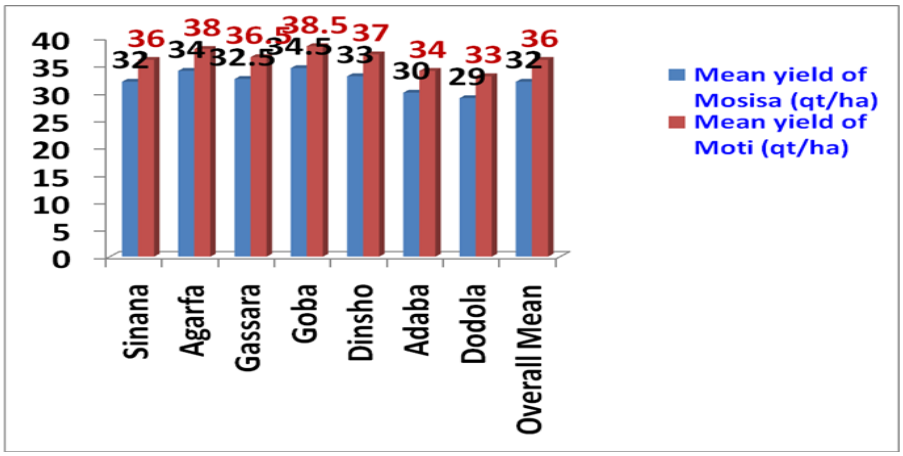
The following table describes the amount of seed distributed to farmers in the study areas. The distributed initial seed was used as revolving seed to reach other farmers in the area. This system is a relatively good low-cost system that can maintain kind, quantity, quality and access (at right time, place and reasonable price) of the seed to a level satisfactory to neighboring farmers locally. The amount of input distributed and total yield harvested in two years of project duration was summarized in the following table.

Table 2: Amount of seed distributed in the implementation of the activity in the 1st and 2nd years

Year	Cropping season	Locations	No. of trial farmer	Total seed distribute (qt)	Total Area (ha)	Harvested seed (qt)
1	2015/16 (2008 E.C)	Sinana Goba Agarfa Gassara	Mosisa 12	2.22	1.24	40
2	2016/17 (2009 E.C.)	Dinsho Adaba Dodola	Mosisa 27	5	2.78	89
			Moti 6	1.11	0.62	22.32
Total			45	8.33	4.64	151.32

Yield performance

The average yield obtained from the two improved varieties of faba bean namely Moti and Mosisa was 36 and 32 quintal per hectare respectively. The yield obtained is found to ber greater than the average yield of the two zones as reported in CSA, 2016 (24 and 23.57 quintal per hectare for West Arsi and Bale zone respectively). Both Mosisa and Moti varieties showed close yields across locations as can be seen from the following figure.



Training on Capacity building

Participatory training was given by SARC multidisciplinary team in the participant districts of Bale and West Arsi zone from 20-28/05/2016. The training was given at Robe and Dodola towns. The title of the training was on available improved pulse crops technologies and utilization, faba bean (both in quantity and quality) production and management packages, major faba bean diseases and their control measures, agro-chemicals utilizations (time, rate, etc.) and safety precautions, the importance of crop rotation to break cereal based mono-cropping practices in Bale and West Arsi zones through pulse crops (commodity) integration and on creating strong linkage among relevant actors through multi-stakeholder approach to tackle the problem in joint action through taking emergent, medium and long term actions/measures. A total of 435 participants (330 farmers, 56 DAs and Supervisors, 37 agricultural experts and 12 researchers) were participated on this training.

Table 3: Participants of training for capacity building

Participants	Districts							Total
	Adaba	Dodola	Sinana	Agarfa	Gasara	Goba	Dinsho	
Experts	5	5	5	5	5	4	4	33
DAs and supervisors	8	8	8	8	8	8	8	56
Farmers	45	50	60	55	45	40	35	330
Bale zone ANRDO	-	-	-	-	-	-	-	4
Researchers	-	-	-	-	-	-	-	12
Total	58	63	73	68	58	52	47	435

Field Day organized

Field days were organized at each district at physiological maturity stage of the crop in which a total of 466 participants (357 farmers from all category, 58 DAs and Supervisors, 41 agricultural experts and cooperative leaders and 10 researchers) were participated on this extension/promotional event. Participants were shared their best experiences especially how to preserve the quality seeds of faba bean varieties (by manual harvesting of the plot and other seed cleaning and preservation mechanisms). In

addition, participant farmers were shared information on the local seed exchange system (informal) and the types of available improved faba bean varieties at their hand and ways to exchange and preserve them. Finally, fruit-full discussion was undertaken among farmers and researchers especially on cereal crops based mono-cropping practices and faba bean diseases problems in the area.

Table 4: Participants of Field days in the two years

Year	Cropping season	Locations	Total participant	Farmers	DAs	Supervisors	Experts	Researchers
1	2015/16 (2008 E.C)	Sinana Goba Agarfa Gassara	168	127	18	6	15	2
2	2016/17 (2009 E.C.)	Sinana Agarfa Gassara Goba Dinsho Adaba Dodola	298	230	24	10	26	8
Total			466	357	42	16	**41**	10

Feedback of focused group discussion (FGD)

Mosisa and Moti needs early planting using the first rain shower since both have more tillers and require enough rain in the season. All participant farmers were very interested with the stands of Mosisa and Moti especially: tillering capacity, pods per plant, seeds per pod, seeds per plant, stem strength - resistant to lodging and good for nutrients translocation, good plant height, disease tolerance, relative yield advantage, seed size and colour for attractive market. Furthermore, faba bean has ecological and economic importance and used for food (rich in protein), soil fertility restoration, income source and foreign currency (attractive market price) and food security. FGD result showed that the problem of pulse crop production in the area is lack of machinery technologies that ease the burden and difficulty of faba bean harvesting and threshing. Good awareness and confidence were created among stakeholders about Mosisa and Moti varieties (demand pull).

Conclusion and Recommendations

Farming system of the two study zones is characterized by cereal based mono-cropping system. High proportion of growing cereal after cereal (cereal monoculture) resulted in: yield reduction, often common incidence of persistent pests (diseases, rust epidemics on wheat, weeds and insect pests) and soil borne diseases like fusarium. The current cereal-based cropping systems puts sustainable crop production system of the zones at risk. To avert such challenges, commodity integration and crop diversification (producing pulse crops) is the best break crops for the prevailing problems in the study zones. One of such crops is faba bean. The result of previous participatory on farm demonstration of faba bean in West Arsi and Bale zone depicts that these areas are the potential areas for faba bean production. The average

yield obtained from this pre-scaling up work showed also the two improved varieties of faba bean namely Moti and Mosisa gaving 36 and 32 quintal per hectare respectively, which is potential and higher when compared with previous works. Thus, their wider scale up should be considered by extension organizations in order to improve the adoption of these varieties. Their wider utilization by farming communities will contribute for effective crop rotation in the process of averting mono cropping in the study areas.

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Pre-scaling up of Improved Linseed Technologies in Bale Highlands, Southeastern Oromia, Ethiopia

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Abstract

The study aimed to pre-scale up improved varieties of linseed, namely, Jitu and Dibanne in Sinana, Dinsho, Goba, Agarfa and Gassara districts of Bale zone during 2015/16 and 2016/17 cropping seasons. Districts and two Kebeles from each district were selected purposively based on their potential for linseed production and the existing priority focus for the crop. The study attempts to promote and popularize the improved linseed technologies in the study areas. FREG approach was followed in which selection of hosting farmers was accompanied in collaboration with DAs, district crop extension experts and farmers. The selected hosting farmers were responsible to provide 32m x 32m area of land where as Sinana agricultural Research Center was responsible to provide seed of Jitu and Dibanne with fertilizer. Accordingly, the seed of Jitu and Dibanne was directly distributed for 32 farmers in which farmer to farmer seed exchange was used to reach large number of famers. Field days and field visits were also

organized to evaluate the performance and to communicate on field progress of the varieties. A total of 410 individuals were participated on these promotional events during the project period. Yield data was recorded and analyzed using mean while farmers' feedback about the technology was assessed and interpreted using simple narration. The result of descriptive statics revealed that the overall mean yield of Jitu and Dibanne were 20.4 and 18.3 qt ha^{-1} respectively. Farmers were interested with Jitu and Dibanne in terms tillering, disease tolerance, relative yield advantage, seed quality, seed size and seed color. Since, farmers were interested to the varieties, it is better to widely scaled out Jitu and Dibanne varieties in small holder farmers field and commercial farms in collaboration with relevant stakeholders.

Key Words: *Popularization, Dissemination, Improved Linseed Varieties, Promotional Events, Farmers' Feedback*

Introduction

Linseed (Linum usitatissimum L.) is one of the oldest oilseeds cultivated for food and fiber (Lay and Dybing, 1989). Linseed has long history of cultivation by smallholder farmers, exclusively for its oil in the traditional agriculture of Ethiopia (Hiruy and Nigussie, 1988). It is a major oilseed and the second most important oil crop after noug (Guizotiaabyssinica Cass.) in Ethiopia. The crop performs best in altitudes ranging from 2200 to 2800 meters above sea level.

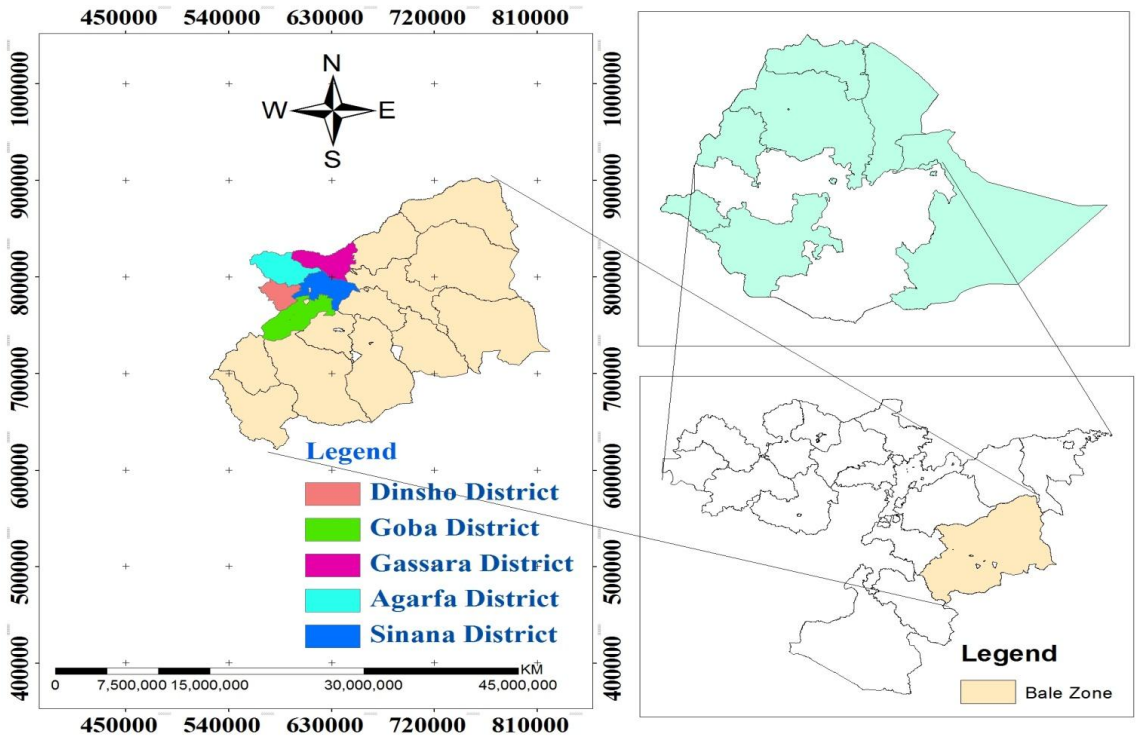
The crop is predominantly self-pollinated, but out crossing (less than 2%) occasionally results from insect activity. On the basis of growth habit, two types (long stemmed and short stemmed) are recognized. Long stem linseed produces a high quality fiber but the oil content of the seed is relatively low. On the other hand, short-stemmed linseed bears larger seeds. Linseed has been a traditional crop in Ethiopia and it is the second most important oil crop in production after noug (Guizotia abyssinica CASS) in the higher altitudes. Ethiopia is also considered to be the secondary center of diversity, and now the 5th major producer of linseed in the world after Canada, China, United States and India (Adugna Wakjira, 2007). It is widely cultivated in the high elevations area of Arsi, Bale, Shewa, Gojam, Gonder, Wollo and Wollega (Getinet and Nigussie, 1997). Linseed oil is suitable for human consumption, and is used as a nutritional supplement. There is also a growing demand in the world market for linseed due to its numerous health benefits, especially in Europe (Wijnands et al., 2007).

Nationally, the area covered by linseed production, during 2015/16 cropping season was 85,415.67 hectares with the national average yield of 10.37 quintals per hectare. Similarly, in Bale and West Arsi zones, the total area covered by linseed crop in 2015/16 cropping calendar was 18, 250.08 and 4, 135.01 hectares respectively. The average productivity of the crop was also 11.60 and 14.46 quintals per hectare in Bale and West Arsi zone respectively (CSA, 2016). In recent years, participatory on farm demonstration and evaluation of different linseed technologies was carried out and farmers were let to evaluate the varieties by setting their own selection criteria. In order to popularize these varieties in areas where demonstration process was carried out and in similar agro-ecologies, pre-scaling up activity was initiated with objectives of promoting improved linseed technologies to increase production and productivity in the study zones, improving farmers' knowledge, skill and attitude (KSA) through multidisciplinary participatory training on production and management packages and strengthening stakeholders' participation, linkage and collaboration.

Methodology

Description of the study area

The research was carried out in Sinana, Agarfa, Gassara, Goba and Dinsho districts of Bale zone, Oromia National Regional State (ONRS), Ethiopia. The districts were selected purposively based on their potentiality to linseed production.



Site and Farmers Selection

Pre-scaling up of improved linseed technologies were undertaken in the main season (Bona) for consecutive two years (2015/16 and 2016/17) in Sinana, Dinsho, Goba, Agarfa and Gassara, districts of Bale zone. The activity was conducted at two Kebeles per district and on two to three representative farmers per kebele. Before starting the field work, selection of farmers were carried out in collaboration with crop extension experts from district Agriculture and natural resource office and development agents (DAs).

Farmers were selected by considering 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.

Material used and Field design

Two recently released improved linseed varieties Jitu and Dibanne were planted on the plot size of 32m x 32m (*"1 midde").* The variety was treated with full recommended linseed production and management packages. All farm operations land preparation, planting, first and second weeding, agro-chemical spray, harvesting, threshing were carried out by hosting farmers with close supervision of researchers and Agricultural experts with practical orientation prior to planting until harvesting of the crop.

Stakeholder analysis (SA) and roles and responsibility sharing among actors

Pre-scaling up activity should be done by different actors in partnership and collaborative approach. So, SA is highly important for institutional arrangement. 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? Finally the roles, duties and responsibilities of each actor were clearly stated and shared for implementing the activity

Table 1: Stakeholder roles and responsibilities in implementing the activity (2016/17)

Stakeholders	Roles and responsibilities
Sinana Agricultural Research Center (SARC)	➢ Coordination and facilitation ➢ Provision of linseed (Jitu and Dibanne) technologies ➢ Provision of training ➢ Technical backstopping ➢ Organize field days and ➢ Supervision and joint monitoring and evaluation with zone and district agricultural development office ➢ Follow up the revolving seed
Agriculture Development Office (at Zone, district and kebele level)	➢ Assist in site and participant farmers' selection ➢ Follow up day to day activities from zone to kebele level ➢ Assist in providing training ➢ Facilitate seed distribution ➢ Jointly organize and participate on field days
Farmers (wheat growers) Cost sharing	➢ Allocate land and perform required agronomic practices ➢ Actively participate in the training for capacity building (on knowledge, skill and attitude) ➢ Jointly organize and participate on field days ➢ Share skills and experiences to neighboring farmers ➢ Transfer produced seed to surrounding farmers and ➢ Finally, supply excess produced seed to cooperatives
Cooperatives/Unions	➢ Agricultural input supply ➢ Facilitate seed marketing

Approaches followed to disseminate the technology

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 linseed 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.

Field Day

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

Communication methods used

Appropriate extension approaches (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 activity. Print Media in Afan Oromo (leaflets, pamphlets, flyers, posters, etc) was used for creating awareness, enhancing user knowledge and skill, changing attitude on using fully recommended packages of improved linseed technologies.

Exit Strategy

Farmer-to-farmers seed exchange mechanisms were designed to access seed of Jitu and Dibanne for interested farmers in the area. However, after the pre-scaling up, the wider scaling up/out activities will be owned and handled ANRO in collaboration with other key actors in the area and with close supervision by SARC. Thus, in order to access the seed locally the selected varieties (Jitu and Dibanne) were multiplied at least on half (0.5) hectare by trial/hosting farmers who already obtained the seed in clustering approach by integrating different technologies and other commodities (cereal crops). Popularization of the varieties was made on different extension/promotional events and during Field Day that was organized by ANR Offices in the main cropping season. Furthermore, this report was presented

on Bale Zone ADPLAC annual meeting (in May 2017) and tried to link relevant stakeholders (SARC, ANRO, Farmers, Cooperatives, Unions, OSE-Bale Branch, Private Dealers, NGOs and others) for sustainable seed supply.

Data type, method of data collection and analysis

Amount of input distributed, harvested yield, total number of farmers participated on training, field visits and field days were recorded by gender composition. Farmers' feed-back (likes and dislikes, which is the base for plant breeding process and perceptions towards the performance of the technologies) was identified. The data collection method employed were field observation and focus group discussion with experts, hosting and other farmers. Descriptive statistics was used to calculate the mean yield harvested.

Results and Discussion

Input distributed

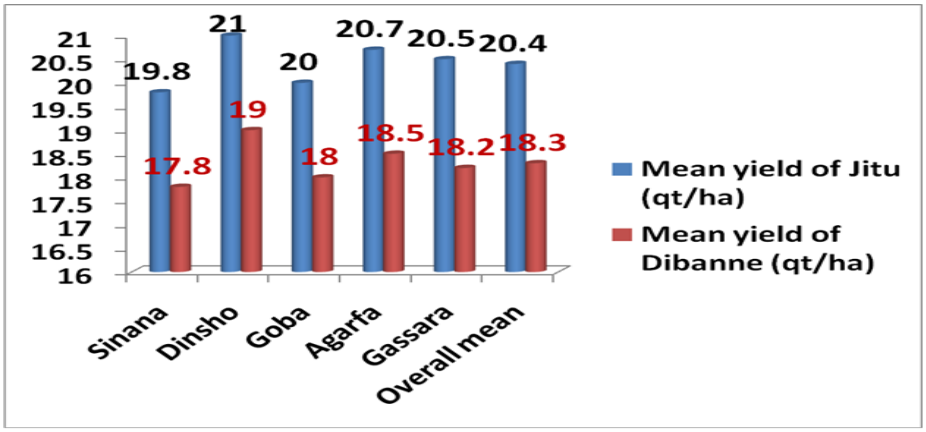
The amount of input distributed and total yield harvested in two years of project duration was summarized in the following table. A total of 0.96qt of seed was distributed to the participating farmers found in all districts in the two years duration of the activity and a total of 64qt was harvested.

Table 2: Implementation of the activity in the 1st and 2nd years.

Year	Cropping season	Locations	No. of trial farmer	Total amount of seed distributed (qt)	Total Area (ha)	Harvested seed (qt)
1	2015/16 (2008 E.C)	Sinana Dinsho Agarfa Gassara	12 Jitu	0.36	1.2	24.5
2	2016/17 (2009 E.C.)	Sinana Dinsho Goba Agarfa Gassara	Jitu 12 Dibane 8	0.36 0.24	1..2 0.8	24.5 15
Total			32	0.96	3.2	64

Yiled performance

As can be seen from the following diagram *Jitu* variety has shown better yield than *Dibane*. The highest yield was obtained at Dinsho district from *Jitu* variety 21 qt/ha while the lowest yield was obtained at Sinana district from *Dibanne* 17.8qt/ha. Across locations the varieties have shown almost similar yield performances.



Training on capacity building

Participatory training was given by SARC multidisciplinary team in the participant districts of Bale zone from 20-28/05/2016. The training was given at Robe, Agarfa and Gassara towns. The title of the trainings were on available improved oil crops technologies and utilization, linseed (both in quantity and quality) production and management packages, major linseed weeds, diseases and their control measures, agro-chemicals utilizations (time, rate, etc.) and safety precautions, the importance of crop rotation to break cereal based mono-cropping practices in Bale and West Arsi zones through pulse crops (commodity) integration and on creating strong linkage among relevant actors through multi-stakeholder approach to tackle the problem in joint action through taking emergent, medium and long term actions/measures.

A total of 299 participants (220 farmers, 39 DAs and Supervisors, 34 agricultural experts and 6 researchers) were participated on this raining.

Table 3: Participants of training for capacity building

Participants	Districts					
	Sinana	Agarfa	Gassara	Goba	Dinsho	Total
Agricultural experts	6	6	6	6	6	30
DAs and supervisors	8	8	8	8	7	39
Farmers	44	44	44	44	44	220
Bale zone (Head/Vice Head)	-	-	-	-	-	4
Researchers	-	-	-	-	-	6
Total	58	58	58	58	57	299

Field Day organized

Field days were organized at each district at physiological maturity stage of the crop in which a total of 410 participants (296 farmers from all category, 64 DAs and Supervisors, 38 agricultural experts and cooperative leaders and 12 researchers) were participated on this extension/promotional event.

Participants were shared their best experiences especially how to preserve the quality seeds of linseed varieties (by manual harvesting of the plot and other seed cleaning and preservation mechanisms). In addition, participant farmers were shared information on the local seed exchange system (informal) and the types of available improved linseed varieties at their hand and ways to exchange and preserve them. Finally, fruit-full discussion was undertaken among farmers and researchers especially on cereal crops based mono-cropping practices, linseed weeds and diseases problems in the area.

Table 4: Participants of Field days in the two years

Year	Cropping season	Locations	Total participant	Farmers	DAs	Supervisors	Experts	Researchers
1	2015/16 (2008 E.C)	Dinsho Agarfa Gassara	118	76	18	6	12	6
2	2016/17 (2009 E.C.)	Sinana Dinsho Goba Agarfa Gassara	292	220	30	10	26	6
Total			410	296	48	16	38	12

Feed-back of focused group discussion (FGD)

All participant farmers were very interested with the stands of Jitu and Dibanne especially: tillering, uniformly reach maturity, crop stand, good plant height disease tolerance, relative yield advantage, seed quality, seed size and seed color for attractive market. Good awareness and confidence were created among stakeholders about linseed technologies (demand pull). The varieties are stable across locations. Farmer-to-farmers seed exchange mechanisms were designed to access seed of Jitu and Dibanne for interested farmers in the area.

Conclusion and Recommendations

Oil crops are mainly produced mainly for marketing purpose as compared to cereal and pulse crop Bale zone. Farmers mainly focused on market attractive varieties of linseed in order to get high market price. This was accompanied with high demand for marketable varieties of linseed like Jitu and Dibanne. The average yield of Jitu and Dibanne varieties was 20.4 and 18.3 quintal per hectare respectively. The feed-back assessed about the varieties revealed that all participant farmers were very interested with the stands of Jitu and Dibanne especially: tillering, uniformly maturing, crop stand, good plant height disease tolerance, relative yield advantage, seed quality, seed size and seed color for attractive market. Therefore, the farmers feed-back about the technology should be given a great emphasis in order to hasten the adoption rate of the technology and to make demand driven. Since, farmers were interested to the varieties pre-scaled out in small scale, it is better to widely scaled out Jitu and Dibanne varieties of linseed in small holder farmers field and commercial farm in collaboration with relevant stake holders.

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Pre-scaling up of Improved Black Cumin Technologies in mid altitude areas of Bale zone, Oromia National Regional State, Ethiopia

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Abstract

Popularization of black cumin technologies (Dirshaye variety with its full packages) was under taken in Goro and Ginnir districts of Bale zone.The objectives were popularizing and creating high demand for improved black cumin technologies in order to improve the income of farmers by increasing production and productivity of black cumin in the study zones. Dirshaye variety was distributed for representative 6 farmers in each district in which each farmer planted on plot size of 32mx32m (1 midde). Row planting method with a spacing of 20cm between rows and other crop management practices were employed during the field work. Participatory training, field visit and field days were used as an approach to disseminate and popularize the technology on which different actors actively participated in partnership and collaborative approach. A total of 152 stakeholders participated on promotional events organized in representative potential kebeles of Goro and Ginnir districts. Yield data and farmers' feed-back about the technology were assessed and interpreted using descriptive statistics and qualitative data analysis methods. The average mean yield of Dirshaye in Goro and Ginnir districts was about 15 quintal per hectare. Farmers were interested to Dirshaye in terms of its fertile tillering, disease tolerance, early maturity, pod per plants, drought tolerance, adaptability to the environment, uniformity, crop stand, seed quality, good for mechanization and grain yield. Thus, the agricultural office extension packages,

farmers' cooperatives, Unions and seed enterprise organizations should focus on the extension and popularization of Dirshaye variety in Goro and Ginnir districts of Bale zone and in other similar agro ecologies to improve the income of the farmers.

Key words: *Popularization, Black cumin, Dirshaye variety, Actors, Farmers' feedback, Bale zone*

Introduction

Ethiopia is a homeland for many spices, such as korerima, long red pepper, black cumin, white cumin, coriander, fenugreek, turmeric, sage, cinnamon, and ginger (ACP, 2010). Ethiopia has become one of the largest consumers of spices in Africa. People use spices to flavor food and use them to make medicines and perfumes. Black cumin is the 3rd most important export spice next to ginger and turmeric. Black cumin covers about 13,672.52ha of land in Ethiopia with a total annual production of 42,012 quintals (Masresha, 2010). Goro and Ginnir districts of Bale zone is known for its production potential of spices. A total of 5,750ha land is covered with Black cumin every year (BZADO, 2015). In spite of its importance and the potential available in the area, the crop was not utilized due to a shortage of improved varieties and crop management packages.

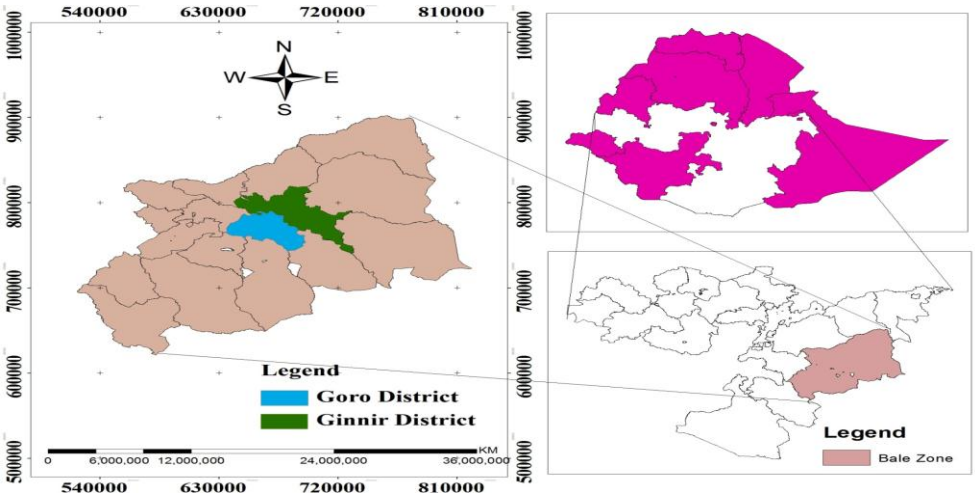
The gap between current production and consumption levels could only be closed by expansion of improved black cumin technologies through institutional innovation, making the research and extension system problem solving, demand-driven and client oriented for efficient distribution of the technologies among the end users. Thus, developing high yielding, disease tolerant/resistant and stable variety/ies that can meet increasing demand of spice market, improve the income and livelihood of farmers are very important. Consequently, the research system have been making continuous 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. Accordingly, promising black cumin varieties, released by SARC were demonstrated and pre-scaled up on farmers' field in recent years

The demonstration and pre-scaling were undertaken at Goro and Ginnir districts for the last years using a variety called Darbera. However, due to its late maturity characteristics of the variety adoption rate was very low. Cnsequently two other varieties namely Eden and Dirshaye were released by the research system and their demonstration and participatory evaluation along with one local check were undertaken at Goro and Ginnir districts of Bale zone in the 2015/16 main season. According to the findings both varieties have shown promising results in both yield and farmers preferences. The farmers' assessment and grain yield data (tillering, pod per plants, early maturity, disease tolerance, adaptability, crop stand and good yield) of both varieties have shown good potential. However dirshaye variety was ranked first then recommended for pre-scaling up activity in the mid-altitude areas of Bale zone. Hence, a pre-scaling up activity of Dirshaye variety with recommended packages was initiated undertaken at Goro and Ginnir districts in 2016/17. The objectives of the activity were to promote improved black cumin technologies, increae production and productivity and improve farmers' income in the study area, to create awareness, improve farmers' knowledge, skill and attitude (KSA) through multidisciplinary participatory training on black cumin production and management packages and to strengthen stakeholders participation linkage and collaboration.

Methodology

Description of the study area

The research was carried out in Goro and Ginnir districts of Bale zone, Oromia National Regional State (ONRS), Ethiopia.



Site and Farmers selection

The activity was undertaken in the main season (Bona) for one year (2016/17) in Goro and Ginnir districts of Bale zone. The districts were selected purposively based on their potential to black cumin production. From each district two kebeles were selected also based on their potential black cumin production. From each Kebele two to three representative farmers farmers were then selected by considering 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.

Material used and Field design

One recently released improved black cumin variety (Dirshaye) was planted on the plot size of 32m x 32m (*"1 midde")*. The variety was treated with full recommended black cumin production and management packages. All farm operations land preparation, planting, first and second weeding, agro-chemical spray, harvesting, threshing were carried out by hosting farmers with close supervision of researchers and Agricultural experts with practical orientation prior to planting until harvesting of the crop.

Stakeholder analysis (SA) and Roles and responsibility sharing among actors

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 before embarking on the pre-scaling up activity. Thus, SA was undertaken to identify potential stakeholders. Finally the roles, duties and responsibilities of each actor were clearly stated and shared for successful implemention of the activity. The following table describes the roles and responsibilities shared for stakeholders participated in the activitiy.

Table 1: Stakeholder roles and responsibilities in implementing the activity (2016/17)

Stakeholders	Roles and responsibilities
Sinana Agricultural Research Center (SARC)	➢ Coordination and facilitation ➢ Provision of black cumin (Dirshaye) technologies ➢ Provision of training ➢ Technical backstopping ➢ Organize field days and ➢ Supervision and joint monitoring and evaluation with zone and district agricultural development office ➢ Follow up the revolving seed
Agriculture Development Office (at Zone, district and kebele level)	➢ Assist in site and participant farmers' selection ➢ Follow up day to day activities from zone to kebele level ➢ Assist in providing training ➢ Facilitate seed distribution ➢ Jointly organize and participate on field days
Farmers (wheat growers) Cost sharing	➢ Allocate land and perform required agronomic practices ➢ Actively participate in the training for capacity building (on knowledge, skill and attitude) ➢ Jointly organize and participate on field days ➢ Share skills and experiences to neighboring farmers ➢ Transfer produced seed to surrounding farmers and ➢ Finally, supply excess produced seed to cooperatives
Cooperatives/Unions	➢ Agricultural input supply ➢ Facilitate seed marketing

Approaches followed to disseminate the technology

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 blackumin 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.

Field Day

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

Communication methods used

Appropriate extension approaches (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 activity. Print Media in Afan Oromo (leaflets, pamphlets, flyers, posters, etc) was used for creating awareness, enhancing user knowledge and skill, changing attitude on using fully recommended packages of improved black cumin technologies.

Exit strategy used

After pre-scaling up, the wider scaling up/out activities will be owned and handled ANRO in collaboration with other key actors in the area and with close supervision by SARC. Thus, in order to access the seed locally the selected variety (Dirshaye) was multiplied at least on half (0.5) hectare by trial/hosting farmers who already obtained the seed in clustering approach by integrating different technologies and other commodities. Popularization of the variety will be made on different extension/promotional events and during Field Day that was organized by ANR Offices in the main cropping season. Furthermore, this report was presented on Bale Zone ADPLAC annual meeting and tried to link relevant stakeholders (SARC, ANRO, Farmers, Cooperatives, Unions, OSE-Bale Branch, Private Dealers, NGOs and others) for sustainable seed supply. Furthermore, farmer-to-farmers seed exchange mechanisms were designed to access seed of Dirshaye for interested farmers in the mid altitude areas of Bale zone.

Data type, method of data collection and analysis

Amount of input distributed, harvested yield, total number of farmers participated on training, field visits and field days were recorded by gender composition. Farmers' feed-back (likes and dislikes, which is the base for plant breeding process and perceptions towards the performance of the technologies) was

identified. The data collection method employed were field observation and focus group discussion with experts, hosting and other farmers. Descriptive statistics was used to calculate the mean yield harvested.

Results and Discussion

Input distributed

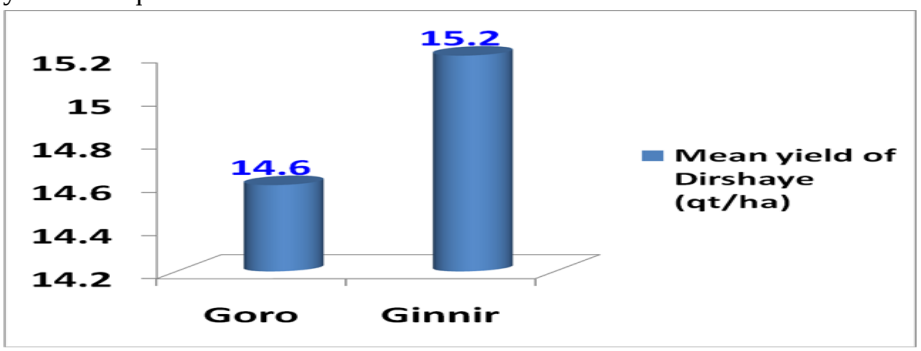
As it is shown in table below, a total of 9 quintal of *Dirshaye* seed was harvested from **0.6** hectare of land allocated for black cumin production by participant farmers. The distributed 0.09qt of initial seed was used as revolving seed to reach other farmers in the area. This system is a relatively 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.

Table 2: Amount of seed distributed, area covered and amount of harvested seed in the activity duration

Year	Cropping season	Locations	No. of trial farmer	Total amount of seed distributed (qt)	Total Area (ha)	Harvested seed (qt)
1	2016/17 (2009 E.C.)	Goro Ginnir	6	0.09	0.6	9
	Total		6	0.09	0.6	9

Yield Performance

Relatively, the maximum yield (15.2 qt ha^{-1}) of Dirshaye was obtained from Ginnir site while minimum yield 14.6 quintal was harvested from Goro site.



Training on capacity building

Participatory training was given by SARC multidisciplinary team in the Goro and Ginnir districts of Bale zone from 20-24/06/2016. The training was given at Goro and Ginnir towns. The title of the training was on available improved spice crops technologies and utilization, black cumin (both in quantity and quality) production and management packages, on the quality of the crop for attractive market, on the importance and the dynamics of spice disease epidemics-major black cumin weeds, diseases and their control measures, agro-chemicals utilizations and safety precautions, the importance of crop rotation to break cereal based mono-cropping practices in mid altitude areas of Bale zone through (commodity) integration

and on creating strong linkage among relevant actors through multi-stakeholder approach to tackle the problem in joint action through taking emergent, medium and long term actions/measures.

A total of 154 participants (120 farmers, 16 DAs and Supervisors, 12 agricultural experts and 6 researchers) were participated on this training.

Table 3: Participants of training for capacity building

Participants	**Districts**		
	Goro	**Ginnir**	**Total**
Agricultural experts	6	6	12
DAs and supervisors	8	8	16
Farmers (resource poor, medium and model)	56	64	120
Bale zone (Head/Vice Head, Agronomy, Protection and Extension)	-	-	-
Researchers			6
Total	**70**	**78**	**154**

Field day organized

Filed days were organized at each district at physiological maturity stage of the crop in collaboration with actors (especially District ANRO) in which a total of 152 participants (120 farmers, 12 DAs, supervisors 4, 12 experts and researchers 4) were participated on the this extension/promotional event. Participants were shared their best experiences especially how to preserve the quality seeds of black cumin varieties (by manual harvesting of the plot and other seed cleaning and preservation mechanisms). In addition, participant farmers were shared information on the local seed exchange system (informal) and the types of available improved black cumin varieties at their hand and ways to exchange and preserve them. Finally, fruit-full discussion was undertaken among farmers and researchers especially on cereal crops based mono-cropping practices and spice diseases problems in the mid altitude areas of the zone.

Table 4: Participants of Field days in the two years

Year	Cropping season	Locations	Total participant	Farmers	DAs	Supervisors	Experts	Researchers
1	2016/17 (2009 E.C.)	Goro Ginnir	152	120	12	4	12	4
Total			152	120	12	4	12	4

Feedback of focused group discussion (FGD)

Dirshaye needs early planting using the first rain shower to overcome the moisture stress problem in the area. All participant farmers were very interested with the stands of Dirshaye especially (tillering, disease tolerance, early maturity, pod per plants, drought tolerance, adaptability to the environment, uniformity,

crop stand, seed quality, good for mechanization and grain yield).Good awareness and confidence were created among stakeholders about Dirshaye variety (demand pull).

Conclusion and Recommendations

Dirshaye variety of black cumin obtained acceptance from the participant farmers and experts invited during field day, in terms of tillering, disease tolerance, early maturity, pod per plants, drought tolerance, adaptability to the environment, uniformity, crop stand, seed quality, good for mechanization and grain yield. Relatively, the maximum yield of 15.2 qt ha^{-1} was obtained from Ginnir site while minimum yield 14.6 quintal was harvested from Goro site. Hence,

Since, the variety was widely accepted by the target community, the agricultural office extension package at zonal and district level, farmers' cooperatives, Unions and seed enterprise organizations should focus on the extension and popularization of the variety in mid altitude areas of Bale zone and similar agro ecologies in order to improve the income of the farmers. Effective and efficient delivery of technical advices and support to farmers is highly required to improve black cumin production and productivity and bring the targeted impact. Farmers' feed-back assessment 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. of Bale zone.

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Participatory Demonstration and Evaluation of 'Chefeka' Hive Technology in Abaya and Yabello Districts of West Guji and Borana Zones of Oromia Regional State, Ethiopia

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Abstract

The active role of pastoralists in developing beekeeping technologies has been largely underestimated and underutilized. In view of this the study was conducted during the 2013/14 and 2014/15 at Abaya and Yabello Districts of West Guji and Borana Zones to evaluate the productivity and profitability of Chefeka hive made from locally available materials under pastoralists' and farmers' circumstances, to create awareness on Chefeka hive made from locally available materials for pastoralist beekeepers, and to improve farmers' and patoralists' knowledge and skill of application/use of the Chefeka hive technology. Generally one demonstration site have been selected from each districts based on the potentiality of the area and participation of pastoralists in beekeeping activities. For evaluation and demonstration of the technology various participatory approaches were employed namely, Pastoralists Research Groups Formation, Training, Client-oriented research approach workshop and exchange visit. At each site three chefeka hives have been constructed and yield comparison was made with traditional beehives and analyzed using descriptive statistics. The result of the demonstration showed that the honey bees have accepted the chefeka hive made from locally available materials. The average honey yield obtained per annum from chefeka hive made from locally available materials and traditional hive is 11kg and 3kg, respectively. Even though chefeka hives' cost of production is different from place to place, it is on average 62.00Birr. At all demonstration sites, the beekeepers have confirmed as the technology fits to their socio-economic situation (affordable & manageable). Hence, the technology is productive, affordable and strongly recommended to be more popularized for maximizing honey production and alleviating the existing problems of traditional beehives.

Key Words: *Chefeka hive, Participatory demonstration, Beekeeping*

Introduction

It is vital to note that no amount of research will lead to sustainable agricultural development if the countries in Africa do not address the constraints to sustainable agriculture (Chambers et al,1989). Most importantly, they have to use an extension strategy that allows the stakeholder to be part of the research agenda. When the stakeholders to agricultural research are part of the planning and implementation, they have the sense of belonging and ownership. The use of Pastoral/Agro-pastoral Research Groups (PAPRG) is one of the approaches, which make the pastoralist/agro-pastoralist to be central to agricultural research and dissemination: to ensure synergies from complementary investments in research and extension resulting in more effective and efficient systems participatory technology beekeeping generation and transfer play great role in changing the livelihood of pastoralist/agro-pastoralist beekeepers. In view of this, participatory demonstration and evaluation of Chefeka hive was conducted. Particularly, it helps beekeepers who have

economic limitation for using other types of hives. As study report of Nuru and Eddesa (2005) it is possible to use hand-made Chefeka hives and frames from locally available materials.

Different beekeeping technologies were adapted by the Pastoral and Dry-land Agriculture Research Center in addressing the technology gap that improves traditional beekeeping practices for improving the livelihood of pastoralists/agro-pastoralists. Nevertheless, those technologies were not sufficiently introduced to all potential production sites. Recently adapted beekeeping technology (Chefeka hive) was also found potential for small scale pastoralist/farmers. The technology was good yielder compared to traditional ones and it poses an opportunity for the farmers and pastoralists who cannot afford for modern beekeeping technologies 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 improved beekeeping technologies.

Therefore, this activity was designed to demonstrate and evaluate the improved beekeeping technologies to farmers and pastoralists in potential honey producing areas in the West Guji and Borana Zones, particularly, in Abaya and Yabello Districts.

Methodology

Description of the study area

Yabello is found in southern Ethiopian rift valley 575km away from Addis Ababa. It has an altitude of 1656masl. The area is characterized by erratic, low and unpredictable seasonal rain fall. Occasionally high temperature during the rainy season exacerbates soil moisture stress. As a result moisture deficit is the most pressing problem causing frequent crop failure in the area. Annual rain fall ranges from 500mm to 700mm. Main season rain fall starts in March and reaches its peak in April. Soil in this area is of diverse type, generally low in organic matter, poor in water holding capacity and electrical conductivity hence drought prone contributing to periodic crop moisture deficit (Habtu, 1995). Abeya (Bunata) is also found in southern Ethiopian rift valley 367km away from Addis Ababa. It has an altitude of 1641 masl, annual rain fall ranging from 900mm to 1400mm and temperature 16-28$^{0}{}_{c}$). It is characterized by black paddy clay soil.

Site and farmers' selection

The activity was carried out for two years (2013/14-2014/15) in two Districts (Abaya and Yabello) of West Guji and Borana Zones of Oromia Region purposively selected based on potential of the area and participation of farmers/pastoralists in beekeeping activities.

There were 20 and 15 participating farmers/pastoralists in Abaya and Yabello, respectively based on their interest towards the technologies, willingness to manage the research activity. Majority of the farmers/pastoralists were male. The number of female farmers/pastoralists ranged from 2 in Abaya to 4 in Yabello. The District agricultural/patoral office experts and Development Agents (DA) had also taken part in the implementation process. Multidisciplinary team composed of an Agriculutural Extensionist, livestock breeder, bee expert, and entomologist were in charge of this activity.

Research design

At each site three Chefeka hives were constructed from the locally available materials and installed side by side with the traditional hives. For comparison purpose, honey yield data of both Chefeka and traditional hives at respective demonstration sites were collected. The cost of Chefeka hive construction was also estimated at each demonstration sites.

Technology evaluation and demonstration methods

The evaluation and demonstration of the trial was implemented on farmers/pastoralists' fields to create awareness about the beekeeping technology. The evaluation and demonstration of the trials was followed process demonstration approach by involving F/PRGs, development agents and experts at different stage of the research work. The activity was jointly monitored by F/PRGs, researchers, experts and development agents.

Data collection

During the study, the data were collected on Chefeka hive acceptance by honeybees, honey yield of two seasons, attitudes of farmers/pastoralists towards Chefeka hives and costs of Chefeka production. For gathering information observation, structured interview schedule, key informant interview and group discussion were used.

Data analysis

The collected data (quantitative data) were analyzed by using descriptive statistics such as average and frequency distribution while qualitative data were analyzed using preference ranking.

Results and Discussion

Training of farmers and other stakeholders

Trainings were given in 2013/14 and 2014/15 (Table 1). This includes both theoretical and practical types of training. The following table illustrates the number of farmers/pastoralists, DAs and experts participated on the training.

Table 1: Training of farmers/pastoralists and other stakeholders

Year	Participants					
	Exper9-+ts (DA + SMS)			Farmers/pastoralists		
	Male	Female	Total	Male	Female	Total
2013/14	6	5	11	29	6	35
2014/15	5	4	9	29	6	35

The contents of the training were: the advantage and disadvantages of traditional, transitional and improved beekeeping, colony organization, honey plant and site selection, honey bee diseases, enemy control and honey bee poising seasonal colony management, hive product handling, processing and marketing, design and construction of Chefeka hives. At phase two, more of practical training was given at each host beekeepers'

apiary site. It consists of construction of Chefeka hive from locally available materials, methods of transferring honeybee colonies from traditional hive to Chefeka hives. Phase three of the training was focused on methods of inspection, feeding, harvesting, and processing of honey and beeswax.

Farmers/pastoralists' and other stakeholders' participation in demonstration

Identification and documentation of major stakeholders in beekeeping technology promotion in the two Districts, and formation of multidisciplinary team from Yabello Pastoral and Dryland Agriculture Research Center and from both Districts were conducted during the initial stage of the research activity. The team consists of Agricultural Extension, Apiculture research teams of YPDARC and beekeepers of potential Districts, District Bee Experts, District Extension team leader, and Development Agents (DAs) from the respective Districts.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/pastoralists DAs and experts right on the apiary sites in order to jointly evaluate the performance of the hives on the field. During the visit both farmer/pastoralists' and DAs' data recording format were checked to observe how they handled the information gathering process.

Yield performance and economic analysis

In all demonstration sites, the honeybees accepted the Chefeka hive made from locally available materials. The comparison of honey yield of Chefeka hive with traditional hive was also done at each demonstration sites. Accordingly, the average yield obtained per annual from Chefeka hive made from locally available materials and traditional hive was 11kg and 3kg, respectively. The price of one kg crude honey on average was 46.25Br. Even though chefeka hives' cost of production is different from place to place, it was on average 62.00 Birr. It is too cheap when compared to machine made top bar hives which was estimated to be 400.00 Birr.

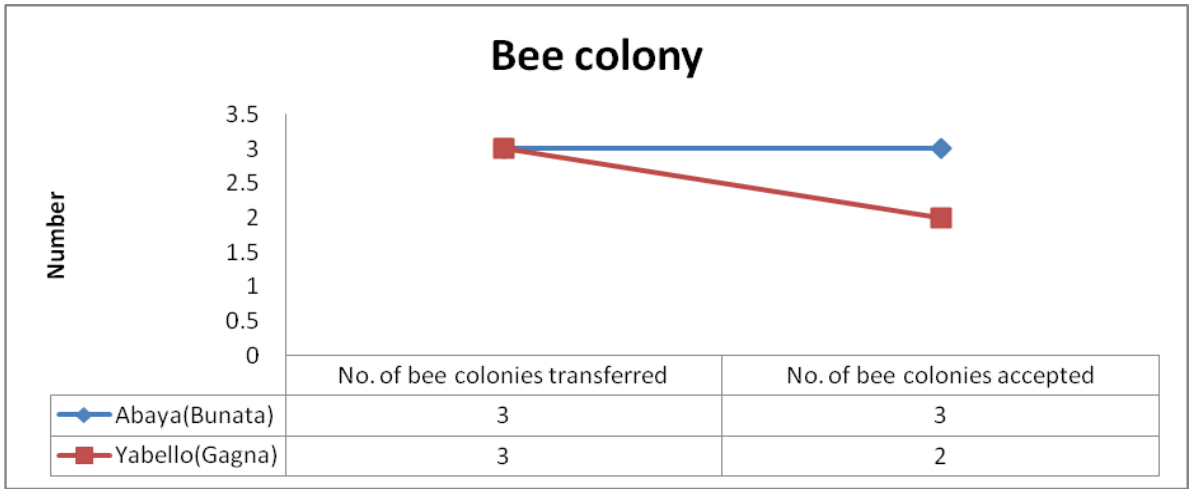

Figure 1: Acceptance of Chefeka hives by honeybees at different demonstration sites

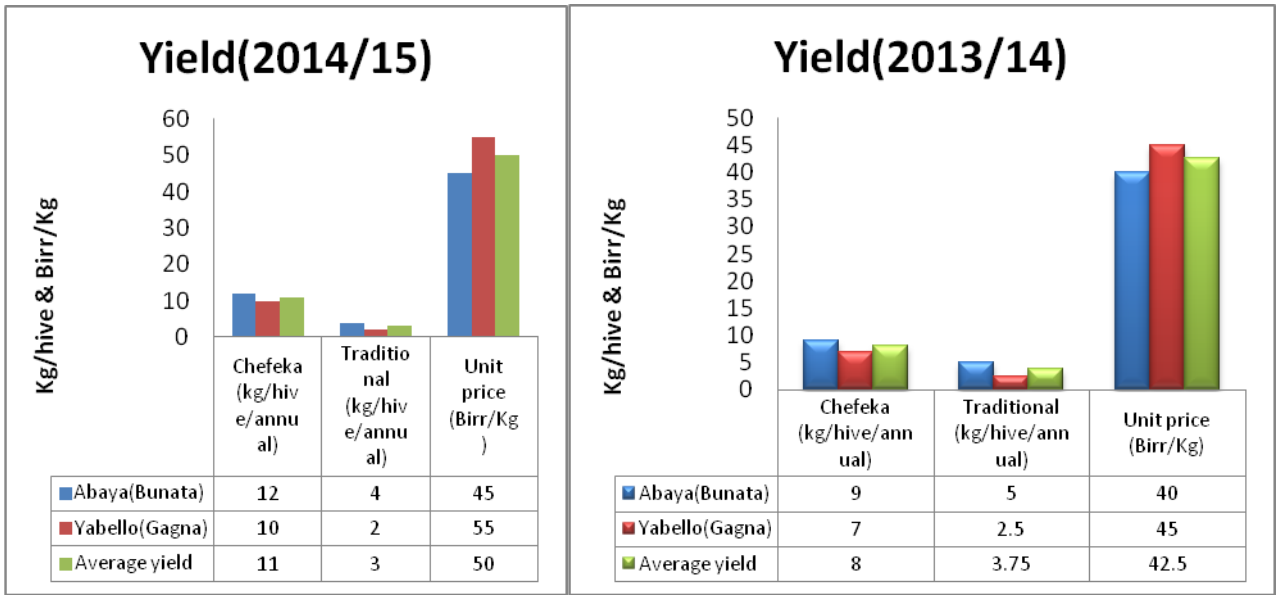

Figure 2. Annual crude honey yield of Chefeka and Traditional hives, and Price of the yield

Average cost of hives as estimated at respective demonstration sites/Districts were 65 and 15Br for Chefeka and Traditional, respectively as illustrated in the next table. This variation was due to availability of locally available materials.

Table 2. Cost of hives (Br) as estimated at respective demonstration sites

No.	District	Cost of hives by types of hives	
		Chefeka	Traditional hive
1	Abaya	56	10
2	Yabello	68	20
Average		62	15

Farmers/pastoralists' opinion/perception

On the exchange visit demonstration site of Abaya district namely: Bunata was visited. The participants exchanged their views, opinions and shared their experience. Above all, it created an opportunity for popularization of the technology. In the same token, on the client-oriented research workshop key problems to beekeeping sector were identified and thorough discussion was made to alleviate the existing problems. It also created a good opportunity for researchers to conduct demand driven beekeeping technology generation and for Pastoral and Rural Development Offices gave lessons on which beekeeping technology popularization work to be done. An assessment on attitude of beekeepers towards the technology was also made; accordingly, in all demonstration sites the beekeepers suggested that the technology is appropriate, productive, and cost effective.

Conclusion and Recommendations

Conclusion

Recently, there has been growing dissatisfaction with the poor rates of adoption of beekeeping technologies, particularly for resource poor farmers/pastoralists. This poor adoption has resulted partly because beekeeping technologies are developed with little input from farmers/pastoralists and other stakeholders.

Cognizant of this fact, Yabello Pastoral and Dryland Agriculture Research Center has tried to adopt various participatory research approaches to improve farmers/pastoralists' involvement in beekeeping technology generation and promotion. Although, it may be too early to talk about the impact of participatory beekeeping technology promotion within this short time, from Chefeka hives with its improved management intervention one can see indications of positive impact of the approaches in terms of providing good lessons for researchers, extension workers and farmers/pastoralists in the study areas.

Recommendation

The technology is feasible and strongly recommended to be popularized for maximizing honey production and alleviating the existing problems of traditional beehives. Hence, the Regional Pastoral and Agricultural Development Offices, NGOs and other concerned bodies may include the technology in their agricultural development program. For effective utilization of the technology, short-term beekeeping training is required. Yabello Pastoral and Dryland Agriculture Research Center may also include the technology in its on spot and on station beekeeping training program.

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Pre-scaling up of Irish Potato (Solanum tuberosum) in Bule Hora District of West Guji Zone,Oromia Region, Ethiopia

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Abstract

This activity was conducted during the 2013 and 2014 main cropping season at Bule Hora District of Borana Zone to improve farmers' income, develop local capacity for future scaling up of potato technology and strengthen stakeholders' linkage and collaboration in the study area. A total of forty (40) farmers in the district were participated for the activity. A multidisciplinary team composed of breeder, pathologist, agronomist and agricultural extensionist were closely working both with the farmers and respective district agricultural experts and DAs. Regular visits, trainings and field days were conducted to provide for interaction among researchers, extension workers and farmers. Generated income and farmers' perception were collected as a data and descriptive statistics was used for data analysis. So, concerning body should scale up further for similar agro ecology to improve potato production and productivity of farming community.

Key Words: Pre-scaling up, Irish Potato, Multidisciplinary

Introduction

An Irish potato is an edible tuber from the *Solanum tuberosum* plant, which is actually native to South America, not Ireland. Irish potatoes are named after Ireland because they are closely associated with the Irish potato famine, a historical famine caused by a mold infestation of the Irish potato crop (Robert and Cartwrite, 2006). Irish potato is the root crop that is widely grown in the world as well as in Ethiopia. It is a short duration crop that can mature within short period of time. Potato production has been considered as the first priority compared to other food crops because of its contribution to food security, income generation and double cropping advantages and its utilization in different forms (Muthoni and Nyamongo, 2009). White potato became an essential staple in the diets of common people throughout Europe. In Ireland, where the crop did extremely well, potato was the only staple food. It is also advantageous in that its consumable part, the tubers, are below the ground that not subjected to some vertebrate pests like birds and to some insect pest attack.

It is the world's fourth-largest food crop, following rice, wheat, and maize. Long-term storage of potatoes requires specialized care in cold warehouses. It is also widely produced in Ethiopia. From vegetable crops it stands second next to enset (*Ensete ventricosum*) in area coverage in Ethiopia and also gives high yield per unit area. Many Irish potato 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. Gudane variety was significantly higher in total and marketable yield than all the varieties. It has got 63.8

marketable yield increments over local variety. On the other side, most of the farming community had little chance to know and use the high yielder Irish potato variety demonstrated.

Therefore, this activity was designed to popularize improved Irish potato variety and seed production techniques to farmers in major Irish potato growing areas of West Guji Zone, particularly, in Bule Hora District.

Methodology

Description of the study area

Bule Hora is found in southern Ethiopian rift valley 475km away from Addis Ababa. It has an altitude of 2244masl. The area is characterized by bi- modal type of rain fall. Annual rain fall ranges from 700mm-900 mm. Main rainfall season starts in March and reaches its peak in November. According to the soil map of Ethiopia (National Atlas), the district has three dominantly occurring soil types. The first two are orthic acrisols, which cover about 65% and orthic luvisols 15% of the total area of the district, while calcaric and eutric fluvisols covers about 10% of the area of the district. Dystric nitosols and chromic eutric and cambisols cover about 10% (each 5%) of the total area of the district.

Technology dissemination/popularization approach followed

Participatory and multidisciplinary approaches were used during the implementation of this research activity. Multidisciplinary team consists of breeder, pathologist, agronomist and agricultural extensionist was established at Yabello Pastoral and Dryland Agriculture Research Center (YPDARC) for the implementation of the activity.

Joint planning, training on capacity building for concerned stakeholders, packaging and distribution of irish potato technologies and other agricultural inputs, organizing farmers into FREGs, joint monitoring and evaluation, and facilitating seed delivery mechanisms were conducted for enhancing efficiency and effectiveness as well as for the sustainability of the research work outputs.

Site and farmers' selection

The activity was carried out in two kebeles (Garba and Hera Liphitu) of Bule Hora District of West Guji Zone of Oromia region purposively selected based on potential in irish potato production. It was implemented for two years (2012/13-2014/15. There were 40 participating farmers based on their interest towards the technologies, willingness to manage and allocate field trial for the activity. Majority of the farmers were male farmers. The district agriculture and natural resource office experts and Development Agents (DA) had also taken part in the implementation process.

A total of 40 farmers were selected and grouped into two FREGs. In each kebele, FREG had 20 members with composition of men, women and youth farmers.

Research Design

YPDARC was the source of all agricultural inputs (seed of improved irish potato variety/'Gudane', fertilizers-DAP and UREA. One best performing improved irish potato variety (Gudane) was planted on selected farmers' plot (20m X 20m) during the main season. The variety was treated with full recommended Irish potato production packages.

Data collection

Both qualitative and quantitative data such as agronomic data, total number of farmers and stakeholders participated on training and field day, number of farmers become aware of the relative advantage of the technology, role and perceptions of farmers and stakeholders on the technology were collected using appropriate data collection methods such as household/participant interview, focus group discussion and field observation.

Method of data analysis

The collected data (quantitative data) were analyzed by using descriptive statistics such as average and frequency distribution while qualitative data were analyzed using idea explanation and preference ranking.

Results and Discussion

Training of farmers and other stakeholders

Training on Irish potato production and management practices were given in 2012/13 and 2014/15 (Table 1). This includes both theoretical and practical types of training. The following table illustrates the number of farmers, DAs and experts participated on the training.

Table 1: Training of farmers and other stakeholders

Year	Participants					
	Experts (DA + SMS)			Farmers		
	Male	Female	Total	Male	Female	Total
2012/13	5	2	7	28	12	40
2014/15	6	2	8	42	12	54
Grand Total	11	4	15	70	24	94

During regular visits, it was recognized that the farmers had hard time identifying one disease from another, there was difference in planting pattern (spacing), weeding and other cultural practices. Accordingly, tailored midterm training was organized for 94 farmers and 15 DAs and 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 FREG activity, problems and weaknesses observed and finally how to handle the task ahead.

Seed and fertilizer distribution

A total of 40 Quintals of Irish potato seeds, 5 Quintals DAP and 3.20 Quintals UREA were distributed to 40 trial farmers participated in the research activity.

Monitoring and evaluation

Regular joint monitoring and evaluation, and provision of technical advice were undertaken at different crop stages based on the practical problem observed on the spot in the implementation areas.

Field days

To show the overall performance of the Irish potato technology, field day was jointly organized in collaboration with other stakeholders (Experts from zone and district level agricultural development offices and participant farmers) at each research sites and 215 participants were participated on this event including FREGs members. Besides, handover strategy of the technology for further scale-out on wider area was also facilitated by dispatching letters to the respective district and zonal bureau of agriculture so as to ensure sustainability.

Yield performance

The variety showed conspicuous field performance which was highly appreciated by the farmers. Presented below are the results from the field trial of respective sites.

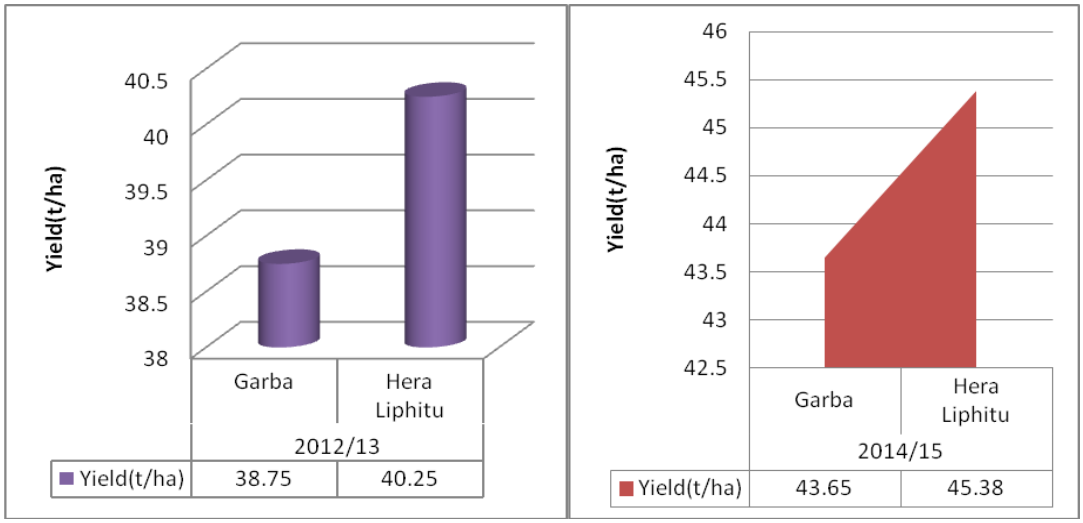

Figure 1: Average yield performance of Gudane variety of irish potato across sites and year.

Farmers' reaction/feedback

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 Gudane variety of Irish potato was liked by farmers as it exhibit healthy and better marketable yield performance.

Table 2: Preference of Gudane variety of Irish potato as evaluated by farmers at the two sites

Variety	Garba farmers (N-20)					
	Size	Early maturity	Disease resistance	Market preference	Sweetness	Yield
	%	%	%	%	%	%
Gudane	20	5	15	20	10	30
	Hera Liphitu farmers (N=20)					
>>	10	10	20	30	5	25

Conclusion and Recommendation

Conclusion

In the effort of bridging knowledge and skill gaps, attitude of the farmers is changed through intensive training especially on the importance of cash crop production and on using full recommended packages. Knowledge and skill of DAs and agricultural experts also enhanced through training and exchange visits.

Besides farmers access to improved Irish potato technologies increased, large number of farmers were persuaded and information was disseminated to several farmers, which might pave the way for the demand driven technology transfer and scaling out. Dissemination of improved Irish potato technologies enhanced through farmer to farmer learning mechanisms using FREGs approach and strong linkage among stakeholders was created for the sustainability and further scaling up of the technology in the similar agro-ecologies.

Recommendation

Strengthening the capacity of farmers or end-users in technology up-take and utilization is the base for technology adoption. Strengthening the pre-scaling up of the best performing Irish potato variety under farmers' condition is important to make our research demand driven. Hence, establishing and strengthening FREGs is one of the approaches for channeling improved agricultural technologies to farmers, which make the farmers to be central to agricultural research and dissemination. During pre-scaling up activity, all types/ categories of farmers should be included by considering all wealth status and gender during site and farmers' selection.

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 pre-scaling-up 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 Irish potato disease and pests as well as on features of the variety. Despite the high yield potential of preferred variety in the District, 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.

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Pre-Extension Demonstration of Enset Decorticator and Squeezer in West and Southwest Shoa Zones of Oromia, Ethiopia

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Abstract

The research was conducted in Dire Enchini, Toke Kutaye, Wanch and Waliso districts of western and south western zones with the prime objective of demonstrating enset decorticator and squeezer technologies to make the community aware of the diversity they possessed and compare the performance of each technology with the existing local technologies in actual farm condition. From the result of the intended demonstration, it was witnessed that the overall performance of the improved enset decorticator and squeezer device was found superior over the existing traditional tools in terms of time saving, income change and role distribution. It was, thus, recommended that further popularizing and scale out of these improved enset processing implements are quite pertinent.

***Key words**: demonstration, enset, enset decorticators and squeezer, kocho*

Introduction

Enset (Ensete ventricosum) is endemic to Ethiopia and cultivated dominantly in the south and southwestern highlands ranging between 1400 and 3200 meters above sea level (Bezuneh, 2012). Most of these areas are part of the Southern Nations, Nationalities and Peoples Region, which can therefore be considered to be the home of enset agriculture (ibid). This does not mean that enset is cultivated and used only in this administrative region. The mid to highlands of Arsi-Bale, South west shewa and adjoining places in west shewa of Oromia regional state are among the rural areas that known in enset production (CSA, 2009). At present about one-fifth of the Ethiopian population depends on it as staple or co-staple food (Country STAT Ethiopia, 2016). Reports have revealed that the area coverage of enset production has increases during last ten years from year to year, for instance, the amount of area allotted to enset production increased from 270,000 hectares in 2011 to 312,171.98 hectares with total production of about 7,288,868.96 quintals in 2013. This took up about 2.30% land area covered by all crops at country level and contributed about 2.68% to the total country-level crop production during the year (CSA, 2013; Bekele and Reddy, 2015).

Enset in West and Southwest Shoa zones is cultivated for a range of services and every part of the plant is useful for something. The root and leaf sheath of the plant provides food in the form of kocho bulla and amicho. Kocho is a bulk of fermented starch made from a mixture of the decorticated leaf sheaths and pulverized corm. The combination of kocho and kitfo is now virtually a common menu at restaurants. The best quality the enset food, bulla, is extracted mainly from fully matured enset plants. It can be prepared as a pan cake, porridge, and dumpling (Agric-service Ethiopia, 2008). Amicho is the non-fermented corm of the enset which is consumed after boiling just like other root and tuber crops. Amicho from younger plants is usually preferred and it is a meal preparing quickly if the amount of enset harvested is insufficient, or for special occasions. But enset's importance extends far beyond human food. Unpublished reports from respective woredas' office of agriculture and natural resources indicate that enset uses as medicine, fiber, feed for cattle and environmental protection. It also serves as a symbol for expressing condolence and other rituals

While the crop has such importance, not much research has been done to improve the processing aspect of the crop and thus in most case farmers are observed to use still age-old traditional tools and techniques (Hunduma and Ashenafi, 2011). Both men and women are involved in growing, processing and managing enset at field level in most cases, however, there are places where enset processing is most commonly regarded as an exclusive responsibility of women that ameliorating gender disparity in access to resources. Traditional enset decorticating and squeezing procedure is an overall abhorrence. It involves placing a leaf sheath on an inclined watani, holding it up with one foot from a sitting position and using both hands to scrape the leaf with a sibisa, hadu, etc (Dereje, 2009).

Figure 12. Traditional way of enset decorticating

This exercise is cumbersome; labor intensive, unhygienic, impose a lot of inconvenience to the working women, and associated with great yield lose.

There is, therefore, a real need to develop and promote appropriate enset processing technologies to help solve such problems of the household and mitigate the burden on women. Recently, Bako Agricultural Engineering Research Centre and other Agriculture Implements Research and Improvement Centers have developed some enset scraping and squeezing devices with proven performance in terms of time saving, income change and role distribution. On-station data indicated that the average time required to scraping and squeezing a single plant using these improved devices is 73 and 66 minute which is a twofold improvement over the traditional methods. Therefore the present research sought to showcase the technologies and its performance to farmers and other stakeholders in the targeted area.

Objectives

- To create awareness among farmers on enset decorticator and squeezer technologies.
- To get farmers feedback for further improvement of the technology

Methodology

Study area

The project was conducted between July 2015/16 and June 2017 in enset growing areas of Dirre enchini, Tokke-kutaye, Waliso and Wanchi districts of west and south west Shewa Zone, Ethiopia (see Fig 2). Eight kebeles namely Arfanjo Daga, Homi Hane, Gimbi Bila, Maruf, Obi Goji, Xombi Anchabi, Fitte Wato and Waldo were purposively selected for the study based on the area under enset cultivation

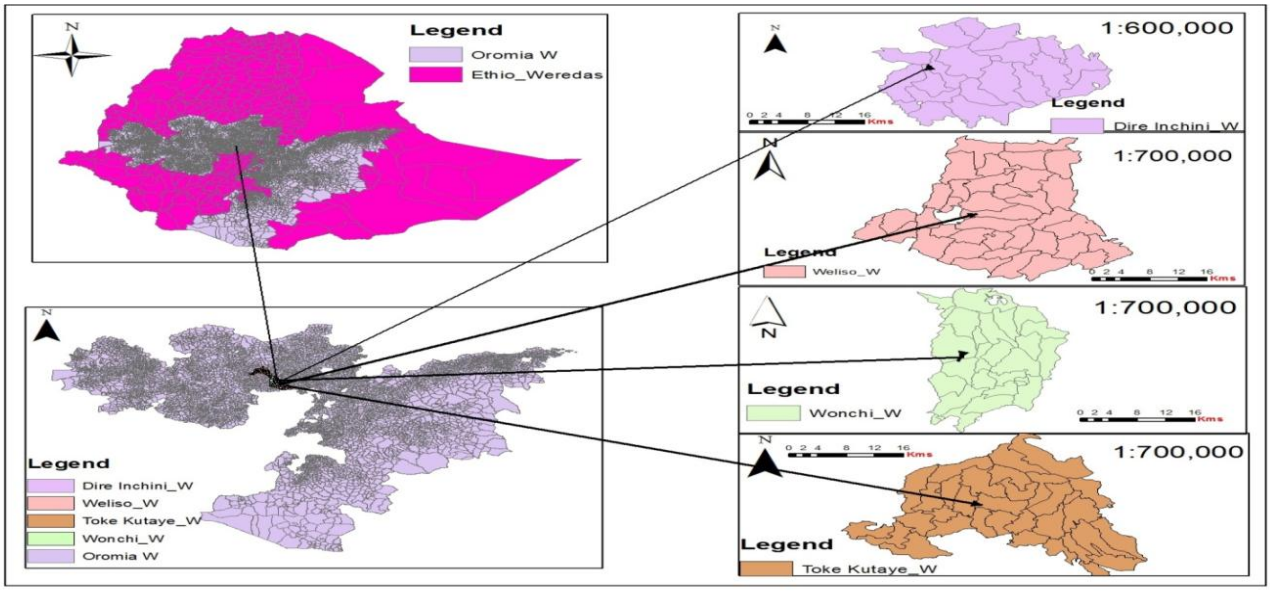

Figure 13. Map of Study Areas

Farmer selection

About 15 households from each kebele and a total of 120 households who were leading their life mainly with enset based farming system, were selected to participate in the current pre extension demonstration research. The Extension Department of the Woreda, a local Development Agents and leaders of respective kebele were involved in this exercise.

Data collection and analysis

Quantitative data on farmer, DAs and experts trained, FRG members and non members attend demonstration, stakeholders engaged, technologies' performance in the sense that they save women's time, and a qualitative data like farmers and other stakeholders' feedback and view toward the introduced enset decorticating and squeezing tools were collected employing checklists and were analyzed by Simple descriptive statistical analysis tools, partial budget analysis were used to do cost-benefit analysis and the result achieved will be communicated to wider beneficiaries via written report

Result and discussion

Training of farmers and extension workers

Farmer training is one of the important components in the technologies pre-extension demonstration. It is meant to introduce a new way of doing things and/or to fill observed gaps in performance or undertaking some research activities. In the course of demonstration, farmer participants, development agents and experts working for the agricultural and natural resource

development offices were given trainings (Table 1) on benefit, utilization and general aspects of managing the technology at different time in FTC.

Table 1. Distribution of Trainees

District	kebele	Participants								
		Farmers			Development agents			SMS		
		Male	Female	Total	Male	Female	Total	Male	Female	Total
D/enchini	Arfajo daga		14	14	1		1	-	1	1
	Homi hane		14	14	2		2			
T/kutaye	Gimbi bila		15	15	3		3	1	1	2
	Maruf		15	15	2	1	3			
Waliso	Obbi goji		15	15	3		3	1	1	2
	Xob anchabi		15	15	3		3			
Wanchi	Fitte Wato		15	15	1		1	1	-	2
	Waldo		15	15	1		1			

Participation of farmers and dissemination of technologies

The task involves illustrating the importance and application of introduced enset scraper and squeezer technologies to participants in following participatory methodology where all the targeted farmers, development agents and SMSs have involved in the process having their roles and responsibilities. BAERC was the source of enset processing technologies delivered. A total of 14 enset scraping and squeezing devices were distributed to eight farmer research groups for demonstration purpose.

Farmers provided enset plant; DAs played important role in mobilizing farmers through meeting them at targeted site; Researcher provided orientation on the objective of demonstration of technologies in collaboration with experts from office of agriculture and natural resources. In the process of demonstration the FRGs farmers and das were actively participated. Accordingly a total of 120 farmers were participated and the researchers have collected the required data there on the spot.

Farmers' perception and feedback on the introduced technology

In order to improve the technologies, there was a need to elicit the perceptions of the farmers and almost all farmers gave their feedback to modify certain functionalities of the delivered technologies. The modification suggested by them included widening of the squeezer's hole, replacement of the clip, and increasing length of the plank. On the other hand, they listed the strong features of the introduced technology. As perceived by farmers, good quality enset product, reduced workload and time, hygienic, and income change due to high unit price are the major good feature of the technologies amongst others. Furthermore, farmers aired out that the introduced technologies produce positive feature of improving gender role distribution among households in a way that more boys, girls, and men are involved in the scraping and squeezing activities.

Conclusion and recommendations

In this pre-extension demonstration of enset decorticating and squeezing devices farmers and DAs of the targeted area got first hand observation and information on the actual performance and benefit of that delivered technologies. Similarly, surrounding non FRG farmers got the opportunity to observe and learn the potential of the demonstrated technologies. Knowledge is gained skill is acquired and attitude of the farmers was changed through training. Furthermore the activity helped extract farmers' opinion idea, perception interest and views that need due consideration to improve the device and upon this improvement then further scaling up activity is recommended.

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Pre-Scaling up of Chefeka Bee Hive Technology Package in Oromia Region, Ethiopia

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Abstract

Pre- scaling of chefeka bee hive technology package was conducted in Ejere and Wolmera Woredas, Oromia region, Ethiopia 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. Farmers research and extension groups (FREG) were used for technology dissemination. One FREG, which contain 15-23 beekeepers established at each pre-scaling up site and there is one site in each selected Village Administration. Accordingly, one site at Ejere and four sites at Wolmera Woreda selected. A total of five FREGs established and 192 beekeepers participated. Communal land of FREG members used as center of learning and technology dissemination. At each site, farmers, development agents and experts trained, a total of 92 chefeka bee hives and 20 hive stand with ant protection constructed, 80 honeybee colony transferred to it and continuous honeybee colony follow up and colony multiplication activities undertaken in partnership with FREG members, development agents and experts. Quantitative data collected for four honey seasons and analyzed using descriptive statics such as 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 9-12.5 kg/hive/season harvested from pre-scaling up colonies and mean honey yield per hive per season 8.9, 9.65, 11.5, 11.88 and 10.21

kg/hive/season harvested at Asgori, Chirri, Goleliban, Sadomo and Wajitu sites, respectively. In addition, 13,16,8 and 10 nuclei colonies formed from these colonies at Goleliban, Sadomo, Sororo and Wajitu sites, respectively. It can be concluded that yield per hive and shortage of honeybee colony can be improved at beekeeper's backyard if locally made chefeka bee hive technology package used. Therefore, livestock office should give attention to build capacity of beekeepers and dissemination of beekeeping technology package.

***Key words**: Pre scaling up, Chefeka bee hive, package, farmers research and extension groups (FREG), improved beekeeping, honeybee, colony multiplication*

Introduction

Agriculture in Ethiopia remains the cornerstone of the economy and the most important source of growth. It accounts for almost 48% of Growth Domestic Product, 85% of export earnings and also main income, livelihood and way-of-living for 85% of Ethiopians living in rural areas (World Bank, 2016). Ethiopia is also the 10th largest producer of livestock in the world with 75 million head of livestock and has the largest concentration of livestock on the African continent (World Bank, 2016). Livestock contribute up to 20% to Ethiopia's GDP and livelihoods of 60 to 70% of the population (Central Statistical Agency [CSA], 2013). 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). Having such large resources, the country has potential of producing over 500,000 tones of honey per year and the annual production of honey and beeswax is low compared to its potential (Ethiopian Apiculture Board [EAB], 2016). 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).

Beekeeping in Ethiopia plays an important role in income generation for farmers. Nationally, an average of 420 million ETB is obtained annually from the sale of honey (Workneh, 2007). Honey production of the country also meets beverage requirements of the urban and rural population. It is also demanded for its nutritional and medicinal values. In Ethiopia, traditional, transitional and frame hives are used in beekeeping. Aabout 5,207,300 hives exist in the country out of which about 95.96% was traditional, 1.06% transitional and 2.98% frame hives (CSA, 2013).

Though the country had large apicultural resource, potential of producing over 500,000 tones of honey per year, the annual production of honey and beeswax is low compared to its potential. This is due to the reason that more than 95% of our beekeepers use traditional hive management practices which affect yield. To improve the traditional production system, improved box hives have been introduced and promoted in the country for the last 40 years but majorities of the beekeepers are still in traditional beekeeping system (Workneh, 2007) due to the reason that this hive requires accessories that are not affordable at small scale level. This result in traditional production system, which results in low

production and productivity, poor pre and post harvest processing and handling techniques and practices combined with poor marketing efforts that kept it part of the subsistent sector (Meaza, 2010).

In most cases, Ethiopian beekeepers are observed to use traditional hives, which are 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 15 kg/hive crude honey can be produced if chefeka hive is used. Chefekabee 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 and can be used for honeybee colony multiplication activity. As study report of Nuru and Edessa (2002) conducted at Holeta bee research center sub-sites indicates, it is possible to use hand- made top-bar hives and frames from locally available materials (bamboo, Arundinaria alpina), shembeko (Arundinaria donax), shimel (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. 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 bee hive technology package, reduce the prevailing shortage of bee colonies through colony multiplication, awareness creation and build beekeepers capacity in applying beekeeping technologies in Ejere and WolmeraWoredas.

Objectives

- To pre-scale up chefeka bee hive technology packagein the study area.
- To reduce the prevailing shortage of bee colonies through colony multiplication
- To build local capacity in applying beekeeping technologies

Materials and methods

Description of the Study Areas and Period

The research was conducted in West Shoa Zone namely Ejere Woreda and Oromia Special Zone Surrounding Finfinne (OSZSF), Wolmera Woreda from 2014 to 2017. Detail description of the study areas presented as follow.

Ejere Woreda

Ejere Woreda is one of the Woredas in Western Shoa Zone of Oromia regional state. It is about 44km West of Addis Ababa. The Woreda is located at 38°-22'E longitude and 9°-2'N latitude (OBoFED, 2014). The Woreda is bordered on the South by the Southwest Shewa Zone, on the West by Dendi, on the Northwest by Jeldu, on the North by Meta Robi, on the Northeast by Adda Berga, and on the East by Walmara (OBoFED, 2014). Altitude ranges from 2060-3085masl. The climate condition of the area is 45% highland and 55% mid altitude (OBoFED, 2014). A total population for this Woreda is 86,934, of

whom 44,222 were men and 42,712 were women; 10,071 or 11.59% of its population were urban dwellers (OBoFED, 2014).

The area receives an average annual rainfall of 1075mm, more than 80% of which falls between May and September (wet season). The average annual temperature ranges between 26°c-27°c, with a mean of 26.5^{o}c(OBoFED,2014). The prevailing farming system in the area is mixed farming system. The total cattle population in the area is 93152(Ejere district Animal production and health main department, 2014).

Wolmera Woreda

Wolmera Woreda is one of the Woredas in Oromia Special Zone Surrounding Finfinne, Oromia region. Wolmera Woreda is about 30 km away in West of Addis Ababa along the Ambo rode at 9^{0}02N and 38^{0}34E. Altitude ranges from 2000-3380 m.a.s.l. (Bureau of Agriculture [BoA], 2013). The Woreda is bounded in the North by Sululta Woreda, in the South by Sebeta Awas Woreda, in the West by Burayu city administration and in the East by Ejere Woreda

The Woreda is classified in to two agro climatic zones namely Dega 61%, Woynadega 39 % (BoA, 2013). The area is characterized by mean annual rainfall of 1067mm and mean temperature of 18 ^{0} c. The main rain season is from the months of June to September which accounts for 70% rainfall while the remained 30% is from February to April (BoA, 2013). The Woreda has a total population of 146,227 of which 72,301(49.4%) are males and 73,926(50.6%) are females. In term of area residence 100,857(68%) population has been living in the rural areas while 45,370(31%) has been living in the urban centers (BoA, 2013).

Crop- livestock mixed farming system characterizes agriculture in the Woreda. The major crops in the farming system are wheat, teff, barley, and faba bean. In the Woreda, about 3,566 hives exist out of which about 1853 was traditional, 870 transitional and 843 box hives (BoA, 2013).

Study Design

To pre-scale up and disseminate chefeka bee hive technology package in both zones, five pre-scaling up sites (one at Ejere and four at Wolmera Woreda) which is apiary of model beekeepers used as center of learning, honeybee colonies (Apis mellifera bandansii) at each sites transferred from traditional hive to chefeka bee hives and Farmers Research Extension Group (FREG) used.

Farmer Selection and Sampling Techniques

For this study, Ejere and Wolmera Woredas were selected purposively for pre-scaling up of chefekabee hive technology package based on the assumption of potentiality of the sites, shortage of honeybee colony, non addressed areas and close follow up. At the beginning of the implementation, memorandum of understanding was signed with respective livestock office and awareness creation workshop was made to introduce the objective of the activity and expected out puts. Five pre-scaling up sites namely Chirri Village Administration[VA] from Ejere ; Asgori, Goleliban, Sadomo and Wajitu VAs from Wolmera Woreda selected purposively based on convenience of the sites to disseminate the technology package. 15-23 beekeepers were selected purposively as members of FREG and one FREG established at each pre-

scaling up sites. A total of five FREG established for this 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

FREGs were used for technology dissemination. At each prescaling up sites one FREG which contain 15-23 beekeepers was established. All 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, selection of mother colonies, techniques of colony strengthening, rearrangement of mother colony, splitting, harvesting queen pupae, nuclei colony formation, nuclei colony management undertaken. After training, chefeka bee hives and hive stands with ant protection constructed, honeybee colonies transferred to them, regular honey follow up activities (inspection, feeding, inserting/removing partition, honey harvesting and processing) and mother colony selection, splitting and nuclei colonies formation activities 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 on average of two chefeka bee 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 numbers of sites and farmers selected; FREGs established; farmers, development agents and experts trained; hives and stands constructed; honeybee colonies transferred from traditional to chefekabee hive; honeybee colonies absconded; frequency of inspection, feeding, inserting and removing partition; number of nuclei hives constructed; queen pupae prepared, hatched and harvested;honey and beeswax harvested; processed honey and beeswax and number of stakeholders involved collected and documented using data collection sheet, personal observation of sites and group discussion. Secondary data also collected from respective Woreda livestock office, literatures, research reports and internet search.

Method of Data Analysis

Quantitative data collected from pre-scaling up colonies analyzed using descriptive statics 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 discussion

Capacity Building

Capacity of the beekeepers, DAs and local experts to apply chefeka hive technology package built through two rounds theoretical and practical training conducted at respective Woreda. Training given

mainly focused on improved beekeeping management practices, hive construction, pre and post-harvest handling of bee products and honeybee colony multiplication technique. Besides the training, FREG members, DAs and experts were participated on regular honeybee colony follow up activities seasonally during the study period. As shown on table 1 below, capacity of 192 beekeepers, 7 DAs and 2experts built basically on practical demonstration of the technology package. In addition, technical staffs of Holeta bee research center took part in pre-scaling up of the activity in monitoring and follow up of hive construction, establishing colony, colony multiplication, feeding, inspection, harvesting and processing of honey from established colonies at pre-scaling up sites during project life span.

Table 1. Number of beekeepers, Development Agents, Experts participated on training and pre scaling up.

No	Sites	Farmers	DAs	Experts
1	Asgori	24	2	2
2	Chirri	104	2	
3	Goleliban	24	2	
4	Sadamo	15	-	
5	Wajitu	25	2	
Total	192	7	2	

Technology Dissemination

Chefeka hive construction and honeybee colony establishment

After practical training given to FREG members, A total of 92 chefeka bee hives (18.4 on average at each pre- scaling site) constructed, 20 hive stands each 4-6 meter length with ant protection constructed, honeybee colonies transferred to 80 of them and regular honey follow up activities (inspection, feeding, inserting/removing partition, honey harvesting and processing) were undertaken (table 2).

Table 2. Number of hives and stand constructed and honey colonies transferred

No.	Sites	Number of hive stands with ant protection constructed	Number of chefeka hives constructed	Number of colonies transferred
1	Asgori	3	24	19
2	Chirri	4	17	13
3.	Goleliban	6	26	23
4	Sadamo	5	19	19
5	Wajitu	2	6	6
Total		20	92	80

Honey yield and economic benefit

In this study, crude honey yield obtained and processed for four active seasons from pre-scaling up colonies established was used to compute the results. Honey yield on average which ranges from 9 to 12.5 kg/hive/season was harvested from pre-scaling up sites. Mean honey yield 8.9, 9.65, 11.5, 11.88 and 10.21 kg/hive/season harvested at Asgori, Chirri, Goleliban, Sadomo and Wajitu, respectively. The

highest Mean honey yield, 11.88 kg/hive/season, was recorded at Sadamo site as compared to other four sites (Table 3). The reason why honey yield at Sadamo site is higher than the other sites could be ample forage for honeybees and seasonal monitoring and follow up of honeybee colonies is also better in this site. Moreover, harvested crude honey processed to pure honey and crude beeswax. Again, crude beeswax processed to pure beeswax. Processing honey yield maximize the income from the hive by adding value by processing to table honey and pure beeswax. The result of this research is in line with finding of Taye et al. (2015) which states the average honey yield from this hive was 13.88 kg/hive crude honey. Regarding the benefit, beekeepers were benefited from honey sold on average of Ethiopian Birr (ETB) 1094.55 (on average of 150 ETB/kg for pure honey and 345 ETB/kg for pure beeswax), 1285.85,1303.35and 1156.5per hive per season at Chirri, Goleliban,Sadamoand Wajitu Woredas, respectively. The finding of this research is in line with similar studies which showed the beekeepers were benefited in using this hive (Melaku, 2005; Workneh, 2007; Wongelu, 2014).

Table 3 Mean honey and beeswax yield at each pre-scaling up sites

No	Sites	Mean crude honey harvested	Mean processed honey	Mean crude wax	Mean processed wax
1	Asgori	8.9	6.27	2.63	0.28
2	Chirri	9.65	6.63	2.73	0.29
3	Goleliban	11.5	7.9	3.34	0.33
4	Sadamo	11.88	8.16	3.5	0.23
5	Wajitu	10.21	7.02	2.89	0.3

Honeybee colony multiplication

Colony strengthening

Honeybee colony multiplication requires strong mother colony to prepare queen cells after splitting. To make this happen the mother colony should be strengthened through intensive feeding of the colony during dry season of the year. Accordingly, all colonies at pre scaling up sites strengthened through feeding of sugar syrup at feeding ratio of 1:1 twice per year. Failure in strengthening the colony might result in no response after splitting. Number of mother colonies strengthened at each pre scaling up sites shown below (table 4).

Colony splitting

After all mother colonies strengthened, colonies to be splitted selected with FREG members mainly based on brood pattern, high honey production and pest rest resistance of the mother colonies. Before splitting, resource in the hive divided on brood and honey chamber equally and queen excluder inserted one day in advance. After queen excluder inserted, the selected mother colonies with queen excluder splitted in to two on the second day. Splitted colony with queen transported to backyard of willing beekeepers at least 500 meter and queen less colony kept in its original place to avoid unit. On average, 14 mother colonies splitted at all pre scaling up sites (table 4).

Table 4. Colony multiplication activities data at pre scaling up sites

No	Sites	Colony strengthened	Colony splitted	Queen pupae prepared	Nuclei colonies formed	Nuclei colonies transferred to standard hive	Success rate in %
1	Goleliban	23	4	19	13	12	92.31
2	Sadamo	19	4	23	16	13	81.25
3	Sororo	13	3	23	8	7	87.5
4	Wajitu	6	3	11	10	8	80
Total		61	14	76	47	40	

Queen pupae prepared and nuclei colonies harvested

Queen less colony prepared queen pupae and hatched after 9 days of splitting. Hatched pupae harvested, fixed on frames and nuclei colonies formed with 3-5 frames. The number of nuclei colonies formed per queen less colony was highest at Sadamo site, which were 4. The probable reason for this response is that strength and resource in the hive of mother colonies was better at this site (table 4).

Role of Colony Multiplication

Managing nuclei colonies formed to with stand dearth period and protection from pests and predators has great impact on significance of colony multiplication. Nuclei colonies formed may abscond or dwindle either due to pest attack or starvation. Success rate in managing and transferring nuclei colonies formed to standard/ 10 frame hive is highest, 92.31 % at Goleliban. FREG members gained on average of 12, 13, 7 and 8 additional colonies yearly at Goleliban, Sadamo, Sororo, and Wajitu sites as a result of honeybee colony multiplication technique, respectively. When converted to monetary value, they gained ETB 9600 (on average of 800 birr/colony), 10400, 5600 and 6400 as additional source of income from sell of multiplied colonies at Goleliben, Sadamo, Sororo, and Wajitu sites, respectively.

Conclusion and recommendations

It can be concluded that yield per hive at beekeeper's backyard with minimum cost can be improved if chefeka bee hive with its package used, knowledge and skill of the beekeeper on the technology upgraded, continuous follow up assured by DAs and experts. 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 further dissemination of technology package and improve delivery of extension service given to the beekeepers.

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