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Part 1: Agricultural Extension Research

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Pre-extension demonstration of maize forage intercropping practice at Adami Tulu Jiddo Kombolcha district, Central rift valley of Oromia, Ethiopia

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Abstract

An intercropping practice of maize with forages were demonstrated at Adami Tulu Jiddo kombolcha district of East shoa zone with the participation of farmers in collaboration with district office of agriculture. The objectives were to create awareness on maize forage intercropping, to evaluate grain and biomass yield of the intercropped maize and forage varieties under farmers condition, to analyze the cost-benefit of the demonstrated practices and to assess farmers' and other stakeholders' feedbacks for further technology development/improvement. The activity was implemented on 13 trial farmers land used as demonstration plots or replications. On one trial farmer all the three treatments were sown side by side. The treatments were maize intercropped with lablab, maize intercropped with cowpea and sole maize. The results indicated that the forage intercropping practice have no significant effect on maize yield. Numerically better yield was obtained from sole maize (62.23qt/ha) followed by Maize intercropped with lablab (61.45qt/ha). Maize intercropped with cowpea gave the least maize grain yield (55.2qt/ha). However, the forage intercropping practices gave more than 4 ton/ha of forge biomass yield without significantly affecting the yield of Maize crop. Furthermore, intercropping maize with Lablab weighed better than intercropping maize with cowpea in terms of its grain yield, dry matter yield as well as financial performance. Therefore, further wider scaling up works on Maize lablab intercropping is recommended.

Key Words: Intercropping, Pre-extension Demonstration, forages, rift valley

Background and Justification

Continuous increase in the world population, particularly in the eastern Africa region has increased the demand for food significantly. As a result arable land is mainly devoted for food crops production. Even though animals are very important in agricultural production in the tropics, limited land is given for forage production (Whiteman, 1980). Thus, natural pasture has been the main livestock feed source. Furthermore, grazing lands are under cultivation to satisfy the need of increasing human population.

In view of this, the present system of sole cropping practice cannot meet the diversified needs of the small scale farmers. In addition, due to the limited land available for food crop production sole forage production is not feasible in mixed crop livestock production system whereby food crop production is given high priority. Therefore it is very important to seek alternative forage production strategies for different areas. This is where intercropping comes handy. Intercropping is the agricultural practice of cultivating two or more crops/forages in the same space at the same time which aims to match efficiently crop demands to the available growth resources and labor. The most common advantage of intercropping is the production of greater yield on a given piece of land by making more efficient use of the available growth resources using a mixture of crops of different rooting ability, canopy structure, height, and nutrient requirements based on the complementary utilization of growth resources by the component crops.

In central rift valley areas, in general and in Adami Tulu Jiddo Kombolcha district in particular food crop production is given high priority and the farming system is mixed crop livestock production system. In the district maize is the dominant crop under production. Farmer practice intercropping of maize and haricoat been but intercropping maize with forages is not yet practiced. Yet feed shortage is a critical problem in livestock farming in the study area and crop productivity is low compared to other areas. Thus, to improve crop productivity aw well as to increase feed in quality and quantity, efforts must be done by introducing best combining forage legumes species into existing cropping systems through intercropping (Daniel, 1996).

To this end, experiments emphasizing on intercropping of maize with forages have been conducted and promising results have been found (Diriba Geleti and Lemma Gizachew 2003, Gbaraneh et al., 2004). According to the studies, intercropping maize with forages there had no significance yield reduction. Rather producers can obtain additional forage biomass. Therefore, in the areas where maize is major crop and animal feed shortage is critical, intercropping forage legumes with maize will produce additional biomass and contributes to improving livestock feed availability.Therefore, this activity was proposed with the following objectives

Objectives

- To create awareness on maize forage intercropping
- To evaluate grain and biomass yield of the intercropped maize and forage varieties under farmers condition
- To analyze the cost-benefit of the demonstrated practices
- To assess farmers' and other stakeholders' feedbacks for further technology development/improvement

Methodology

Description of the study areas:

The study was conducted in selected district of East Shewa zone. East Shewa zone is one the administrative zones of Oromia regional state, Ethiopia. The zone has an area of 10241km^{2}and Adama town is serving as the capital town of the zone. There are 10districts within the zone among which Dugda and Lume districts are the study districts where this demonstration activity took place

Adami Tulu Jido Kombolcha district is located at 160 km from the capital city of Ethiopia, Addis Ababa and 115 km from Oromia region's and East Shewa's zonal capital Adama. The district lies at latitude of 7.58ºN and 38.43ºE longitudes. Its altitude ranges from 1500 to 2300 meters above sea level. The mean annual rainfall ranges from 750- 1000mm and the distribution is highly variable between and within years. The mean annual temperature ranges from 22-280C. Mixed crop livestock farming system characterizes the agriculture of the district. The major crop produced under rain fed agriculture is maize.

Site and farmers selection

The study was conducted for two consecutive years at Adami Tulu Jido kombolcha district on two selected kebele's (Dodicha and Haleku). Thirteen trial farmers were selected from each kebele based on their willingness to be involved in the study and who engaged on both crop and livestock production. In each Kebele one group was organized using FREG (Farmers Research and Extension Group) approach having a total of 21 members considering the

participation of women. Thus a total of two groups having 42 members was organized. The selection of sites, FREG organization and trial farmers' selection was done in collaboration with experts from district office of agriculture and natural resource and development agents residing at Kebele level.

Awareness creation events

Training has been provided for all FREG group members, development agents and Experts on forage production, management and cattle feeding. Furthermore, field days were organized to create awareness on the intercropping practice to involved stakeholders.

Planting materials used

One locally adapted variety of maize BH-540, one variety of Cowpea (Black Eye Bean (BEB)), and one lablab variety were used. The forage varieties are adapted varieties to the study location.

Field design and treatments

The demonstration fields used was a total of 0.25ha per trial farmer. Land preparation was done by ox power. A spacing of 7cm between rows and 25cm between plants was used to plant the maize. The forages were sown 15 days after maize was planted as intercropping in between the maize row with 20cm between plants. Other agronomic practices were applied as per recommendations.

Treatments:

The crops were planted on each farmers land for comparisons as

T1: farmers practice: sole maize
T2: intercropped maize and cowpea
T3: Intercropped maize lablab

Data to be collected

- Grain yield, biomass yield, costs involved and benefits gained and farmers feedbacks were collected

Data analysis

The collected yield data was analyzed using SPSS Version 20 software. Descriptive statistics mainly mean was used to analyze the grain and biomass yield. Other quantitative gender disaggregated data were described using tables. Farmer feed backs were summarized qualitatively and described using tabular presentations.

Result and Discussion

FREG formation and training

Before planting training was provided for all participating farmers including host and non-host/ follower farmers, DA's (Development Agents) and district experts. A total of 42 farmers, 6DA's, 2 Experts and 16 other stakeholders including researchers were participants of the training

Table 1: Number of groups formed and farmers and other participants trained

No of Groups	Total no of farmers	No of training participants									
		Farmers		DA's		SMS		Others		Total	
		M	F	M	F	M	F	M	F	M	F
2	42	34	8	4	2	2	0	14	2	54	12

Grain and Biomass yield Performances

The intercropping practices were compared in terms of their maize grain yield and dry matter biomass performances. Accordingly no significantly differing yield and Dry matter performances were gained. The following table describes the result.

Table 2. Yield performance comparison of maize forage intercropping practices

Practices	Maize Grain Yield (Qt/ha)			Forage DM yield (t/ha)		Sig. level ($p<0.05$)
	N	GY	Std. Deviation	DM yield	Std. Deviation	
Maize only	13	62.23 ± 3.97503	14.33217			
Maize Cowpea	13	55.2 ± 4.47862	16.14790	4.1977 ± .76	2.72140	Ns
Maize lablab	13	61.45 ± 5.22463	18.83768	4.4346 ± .97	3.48835	

N.S: Non significant

According to the result presented on the table above, numerically better yield was obtained from sole maize (62.23qt/ha) followed by Maize intercropped with lablab (61.45qt/ha). Maize intercropped with cowpea gave the least maize grain yield (55.2qt/ha). However, both intercropping practices gave more than 4 ton/ha of forge biomass yield without significantly affecting the yield of Maize crop. The findings of this demonstration activity are in line with the findings of (Dawit and Nebi 2017), Getachew et.,al 2013, Diriba Geleti and Lema Gizachew 2003, Gbarneh et,al. 2004) where compatible species of forages intercropped with maize can give better biomass without significantly affecting the yield of the maize crop.

Financial analysis

To estimate the income gained through the intercropping practice a simple financial analysis has been done. The calculations were done on hectare bases taking the market price at harvesting time. The variable costs of the input purchase were the prices during at the early production (rainy) seasons. The calculations also considered price of land (4000 ETB/season) as a fixed cost considering the practice of renting land in the study area. Accordingly, the results indicate that a farmer can get an income of 68,150 through producing sole maize, while for intercropping maize with cowpea an income of 59,750 was gained by allocating a hectare (ha) of land. According to the calculations the highest income can be gained through intercropping maize with cowpea; which is 68,996 Ethiopian birr.

Table 3. Financial analysis on maize forage production 2013 rainy season, Adami Tulu Jiddo Kombolcha

Location: Adami Tulu Jiddo Kombolcha district, Oromia, Ethiopia				
Parameters (on hectare bases)		Intercropping practice		
		Sole maize	Maize cowpea	Maize lablab
Grain Yield (maize (Y) qt/ha		62.23	55.2	61.45
Price (P) per quintal (Birr)		1500	1500	1500
Total Revenue maize (TR= YxP)		93,345	82,800	92,175
Forage biomass yield (t/ha)		0	41.2	44.3
Price for forage biomass(P) per quintal (Birr)		160	160	160
Total Revenue forage biomass (TR= YxP)		0	6592	7088
Total revenue of the practice (TR= YxP)		93,345	89,392	99,263
Variable costs	*Seed cost*	836	5786	5786
	Fertilizer cost	3425	3425	3425
	Chemicals	3511	3511	3511
	labor cost	3000	3000	3000
	Threshing cost	6223	5520	6145
	Transportation cost	200	400	400
Total variable costs (TVC)		17,195	21,642	22,267
Fixed costs	Cost of land (If rented)	4000	4000	4000
Total fixed costs (TFC)		4000	4000	4000
Total Cost (TC) = TVC+TFC		21,195	25,642	26,267
Gross Margin (GM) = TR-TVC		72,150	63,750	72,996
Profit= GM-TFC		**68,150**	**59,750**	**68,996**

Field day

Field days are means of communicating out-put and creating awareness about improved technologies or practices leaving participants specially farmers with new interests and new concepts of what is possible after seeing what their FREG members have been able to accomplish in their line of work. To this end, in this large-scale demonstration activity field day was used as a means to create awareness about the intercropping practice. , method of production as well as the forage production. Thus, a total of 96 Participants attended field day in the course of implementing the activity.

Table: number of field day participants and their role

No of field days conducted	No of participants									
	Farmers		DA's		SMS		Others		Total	
	M	F	M	F	M	F	M	F	M	F
2	58	14	4	2	2	0	14	2	78	18

Farmers' feedback

The FREG member farmers were let to observe the performance of the three practices at different growth phases through different visits. The practices demonstrated were compared based on farmers' preferences, qualities and their drawbacks raised by farmers and presented in the following table. The participant farmers preferred maize lablab intercropping as their first choice when compared to other practices.

Table: Farmers feedback on good qualities and drawbacks observed during the scaling up phase

Practices	Rank	Reasons
Maize-lablab intercropping	1	Very good grain as well as biomass yield without affecting yield, Good plant height and biomass, covers the space very well
Maize-cowpea intercropping	2	Lower grain and biomass yield, lower plant height and biomass cover

Conclusion and recommendations

The demonstration activity created an opportunity for farmers to evaluate the performance of intercropping forages with maize.

Furthermore, through the trainings and field days, awareness has been created to the participating farmers on how to produce and feed forages for their cattle's without affecting their main crop. The results of the study also indicated that the intercropping practice tried had no significant effect on maize yield. Consequently, the intercropping practice of forages with maize was found to be important in enhancing the participating farmers forage productivity.

Yet, intercropping maize with Lablab weighs better than intercropping maize with cowpea in terms of its grain yield, dry matter yield as well as financial performance. Therefore, further wider scaling up works on Maize lablab intercropping is recommended.

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Pre-extension demonstration and evaluation of engine driven Soya bean thresher in East Wallaga Zone of Oromia, Ethiopia

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Abstract

With the aim of circumventing challenges faced farmers in soya bean threshing operation a demonstration of new soya bean thresher was conducted in Guto Gida and Gida Ayana woredas in a total of four kebeles. The thresher was demonstrated at farmer training center as well as on farmers' field and evaluated for its performance against existing farmers practices by sixty participating farmers of both gender who were members of four farmer's research groups. All valuable data were collected through survey, measurement, count and FGDs and were analyzed in descriptive statistics. From the analysis, demonstrated soya bean thresher observed to have a capacity of about five and half quintals per hour and a threshing efficiency of 85 percent with the safer limit of breakage percent ranges from 2 to 3. This result could support the conclusion that adoption and use of demonstrated machine. Therefore, it was recommended that the office of agriculture and natural resource development of the districts to further scaling up the technology to other areas to benefit quite significant number of farmers.

Key words: DA, Demonstration and evaluation, Soya bean, Soya bean thresher,

Introduction

Soya bean (UK) or soybean (U.S.) is a leguminous herbaceous annual plant that the Food and Agriculture Organization (FAO) classified it yet as oil crop rather than pulse. The scientific term associated with it, is Glycine max. Anthropologists, archaeologists, historians, and other scholars believe that soya bean was first domesticated in East Asia with Chinese farmers reportedly the first people to grow the crop some five thousand years ago (Boerma and Specht, 2004). From there, it extended into neighboring regions such as the Russian Far East, Korean peninsula, Japan and later widespread to North America, Europe then to South and Central America. Over time, in the mid-19th century, the crop was introduced to Africa from china along the east coast of Africa (CGIAR, 2005). Over a period of 19th century, the crop was introduced to Africa from china along the east coast of Africa

The first effort to establish soya bean in Africa was made in Algeria when it was grown at a government botanical station in 1896. The next record of soybean cultivation in the continent was in 1903 when they were grown in South Africa at Cedara in Natal and in the Transvaal. In about 1907 soya beans were introduced to Mauritius Island and Tanzania by German agriculturalists. Since then a dramatic and tremendous interest in growing this crop in Africa was raised (Shurtleff & Aoyagi, 2009). Currently South Africa is the largest producer of soybean in African continent, followed by Nigeria, Zambia and Uganda. Distantly followed Benin, Malawi, Zimbabwe and Sudan, Ethiopia has also experienced sizable soy bean production expansion, according to data recorded in the world soya bean production statistics compiled by FAO (2016)

According to Bukill (1935), soya bean (Glycine Max) cultivation reached Ethiopia in the early 1950s although it is not known with certainty who introduced the crop to the country. But attempts to grow the crop at that time failed owing to the low yields obtained. In late 1960s trials re-started and with the introduction of new high-yielding cultivars in the 1970s, new interest was generated. Most importantly, soybean production on a relatively large scale was undertaken in 1980s when the country's socialist regime looked to develop certain state farms in Wallaga, Gojjam, Kaffa, Awassa, Shashemene and Awash. From then on the soybean does very well in Ethiopia. Over the seasons from 2014/15 to 2019/20 soya bean production posted a remarkable surge instigated by the government's quest to improve production of the crop through the second five-year Growth and Transformation Plan for example. The rapid increase in soya bean production in Ethiopia is also attributed to the country's strategic location closer to the world's largest consumers of soybean and soybean products that appealed the nation greatly to target soya bean production as potential export commodity (Birhanu et al., 2018)

Ethiopian government, via GTP II, program targeted to increase the average productivity of soya bean by 49% between 2015 and 2020 and volume of production from 0.72 million quintals to 1.2 million over the same period to meet the demand of the market by creating a linkage with the industry and export market (GTP II, 2015). Records obtained from CSA for the period mentioned above revealed that area under soya bean and its production exceeded the figures envisaged by twofold. During this period, the area cultivated under soya bean increased from 35,259.76 hectare to 163 629 as more farmers were venturing into its farming. The corresponding annual production quantities in that time span have ranged from 721, 837.45 to 3,768,690 quintals (CSA, 20015-2019). The same records reveal that there were closer to 123 farmers grow the crop in 2019/20 for a raft of uses range from human food, to animal feed and to industrial raw materials. Exports jumped from 30,000 metric tons in 2015/16 to around 80,000 metric tons in 2019/20 in large part because of increased demand.

Regionally, Amhara Oromia, Beneshangul Gumuz and Gambela are at the moment, the largest producer while Oromia is by far in the forefront constituting 51% share of the total national production (MoARD, 2010, as cited in Mideksa, 2020). Oromia agricultural office put 2019/20 soya bean production of the region at 232,037 quintals, noting that output has risen from 1200 quintal in 2014/15. The acreage ploughed for the crop and number of farmers engaged in soya bean production was growing year after year. Despite the high level of production of soya bean in Ethiopia, its harvesting and threshing operation remains among the major challenges to holders most notably in western part of the country.

Harvesting and threshing operations are known as crucial and influential processes on quantity, quality and production cost of soybean (Manuwa, 2011). A report by Alemu and Tesema (2010) identified inadequate appropriate harvesting technology as a major problem that may constrain soya bean production in Ethiopia. This made it difficult for area expansion as far as production is concerned. Khan (1971) and IDRC (1976) added that the problem of harvesting and threshing is worsened with the introduction of more productive rice varieties because of the greater amount of crop that has to be handled.

In Ethiopia, soya bean is threshed by stick beating and by being trodden under hooves of animals as no proper mechanical thresher was available. There is little doubt that these processes are tedious and labor intensive. In Ethiopia, It was found that the operation might pull children out of school since processing food for survival takes priority over education in subsistence farming households

The practice require smeared floor and transportation of materials from harvested field to threshing floor especially if the floor was prepared at home garden, leading to involvement of man power, time, and hence cost of operation. If threshing is not done within the stipulated time, all efforts made by farmers and inputs given to crop go wasted. Added to that, traditional method of threshing by animal and humans results in huge losses (Asfaw et.al, 2011) due to the grain being broken or buried in the earth. Hence an efficient cheap mechanical thresher would definitely be a welcome relief

In response to these challenges, several efforts have been made, and are still being made by the research institutes and other organizations. Very recently Bako agricultural engineering research center has adapted and evaluated IITA engine operated Multi-crop thresher for soya bean threshing with a particular focus on transforming the arduous, tediousness, unsanitary and inefficiency attributes associated with traditional threshing methods. The machine was tested in the center and the following optimum performance indices were obtained when soya bean panicles were processed at the best combination of 13% moisture content 5 kg/min feeding rate and 700 rpm cylinder speed: threshing capacity 603.63kg/hr., threshing efficiency 100%, mechanical grain damage 4.38% and cleaning efficiency 82.24%. This indicates that the machine has the advantage of high removal rate and low breakage, which would cut down the threshing time and save labor cost at a time.

In the study area, promotion of this kind of technology is rationalized due to the need to increased soya bean production, inefficiency of manual threshing, seasonal drudgeries of women and children and subsequent losses. Therefore, demonstration and promotion of adapted soya bean thresher is recommended in East wallaga with the specific objectives of creating awareness among farmers about the availability of the technology and its multifarious uses; evaluating field performance of the machine in comparison with that of traditional practices and collecting feedbacks from participants to further improve the technology.

Research Methods

Description of study area

The present demonstration activity was conducted for a two consecutive years in East Wallaga zone, Ethiopia's Oromia region. With 10% share, East Wallaga is a second leading zone in Akuri Atar (Ethiopian soya bean) production in the region after Illu-ababor zone (Hailegiorgis, 2010). Estimation indicates the area harvested in 2019 season was at a record of 98.2 million ha, up 4.2% from 2015/16 season, with cultivation mainly concentrated in the Gida Ayana, Guto Gida, Diga, Sasiga and Limu (WoANR), 2019); Following their standing out in intensity of soya bean production, the first two districts were purposively selected for the current research. Descriptions of each area were given below:

Gida Ayana

Gida Ayana is a district located 444 km far away from Addis Ababa and 112 km north of Nekemte, the capital of East wallaga zone. It is bordered by Guto-wayu district in the south direction, Amhara region in the north, Limu in the west and Kiramu and Abe-Dongoro districts in the east direction. Administratively, the district is subdivided into 19 rural kebeles (sub-districts) and 6 towns that agro-climatically categorized as 50% Kola, 48% Woina Dega, and 2% Dega. The average yearly rainfall is 1739.15 mm, with a rainy season during May to September and a relatively dry period from December to March. There is no high variation of temperature throughout the year but the maximum temperature is in February and March. The district is known for its production of soybeans and other leguminous, Cereals, vegetables and some important fruit crops like mango, avocado, banana etc. (Ethiopian Central Statistical Agency (CSA), 2014). Available soybean production data from unpublished report of the districts shows that the Gida ayana district recorded a total production figure of 5 tons,6 tons and 8 tons from a total of 5ha 6ha and 8ha in 2017,2018 and 2019 respectively with little scientific input. In Gida Ayana, the entire operations in crop production and animal husbandry were still performing with bare hands or using very rudimentary farm tools powered with human and animals, like many of their counterparts across Ethiopia. As concerned to soya bean threshing, here farmers commonly use conventional method involves animal hoofing and beating with sticks depending upon capacity, lot size and situation.

Guto Gida

It is found in the Oromia region towards west direction at a distance of 331 km far from Addis Ababa, the capital city of Ethiopia. The district's climate is sub-tropical type with an annual mean temperature oscillates between 15-24 degree Celsius and receives uni-modal rainfall ranging from 700 to 900mm per annum. Livelihood of people in this area is farming which done on subsistence basis with many small land size holdings and poor mechanization. However, some farmers are engaged in commercial farming cultivating large areas of maize, soybean and groundnut. Staple food crops include maize, sorghum finger-millet. Legumes such as groundnuts, soybean and vegetables like cabbage, spinach and onion constitute the main cash crops. Annual crops are predominant and rain-fed agriculture is mainly practiced using draught power. As far as livestock is concerned, cattle, sheep and horses are the major types of livestock kept by the different households.

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Site and farmer selection and FRG establishment

By holding meeting for experts from District Agriculture and Natural Resource Development office, DAs and local leaders, multi-disciplinary researchers from the Bako Agricultural Engineering Research Centre explained the role of the farmers in the research and development process, the current agriculture extension program and inherent problems, the need to make research and extension more client oriented. This meeting has culminated in the purposive selection of four research sites namely Uke Badiya, Tulu Lencha, Warabo, and Andode Dicho kebeles depending on their greatest potential and access to road.

Table 1. Research sites and participants

Intervention District	Number of kebeles	No of participant		
		Male	Female	Total
Gida Ayana	3	33	12	45
Guto Gida	1	11	4	15
Total	4	44	16	60

From those kebeles a selection of 60 households were carried out focusing soya bean production capacity, willingness of farmer to participate in the research, interest to work in group and share experience to other farmers. In the selection of participants there was consideration for gender justice. The farmers selected for the research were finally encouraged to teamed up together to establish four farmer research groups with a membership of 15 households each. Four arbitrary farmers from each group and three farmers' training center (FTCs) were selected to host the demonstration. Subsequently extension activities like training and demonstration were held to create awareness among those selected farmers, DAs and agricultural extension and mechanization experts about the technology and its various uses. Researchers and Technician staff from the Bako Agricultural Engineering research center (BAERC) served as the resource persons and facilitators of the events.

Types and method of data collection

Sorts of methods of data collection were used. A rapid survey was conducted to capture data on traditional threshing methods time and number of laborers and oxen required in that methods whereas measurements were carried out to gather data related to mass of whole soybean panicle feed in to the machine, grain threshed, Quantity of grain broken in threshing course, un-threshed soybean crop, the time spent in threshing to gauge machine's threshing efficiency, output capacity and the percentage of soya bean grain breakage by formula 1, 2 and 3. Number of farmers who participated in training and demonstration organized gathered through count. On the other hand what participants thought and how they felt about the technology demonstrated as compared with the traditional practices were probed through FGDs. With regard to tools the research was conducted employing checklist and field notebook which were used as interview guide and data recording sheet for the researcher.

$$\textbf{Threshing}\ \text{efficiency}\ (\%) = \frac{Q_T}{Q_T + Q_{US}} \times 100 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 1$$

$$\text{Threshing capacity}(\text{kg/h}) = \frac{Q_T}{T_U} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 2$$

$$\text{Percentage of breakage}\ (\%) = \frac{Q_B}{Q_T} \times 100 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 3$$

where:

Q_T = Quantity of threshed grain (kg)

Q_B = Quantity of broken grain(g)

Q_B = Quantity of unthreshed grain remain in pods(kg)

T_U = time utlized in threshing operation(min)

Data Analysis tools

The collected data were statistically analyzed using descriptive statistics such as percentages, means, and standard deviations. Excel spread sheet was used to compute raw data. Concomitantly the data collected from focus group discussion and personal interview were transcribed verbatim.

Result and Discussion

Conventional methods of threshing prevailing in the study area

Farmers of the study area practice different methods of soya bean threshing. A separated rapid survey conducted identified animal trampling and stick beating in the localities and these methods included in this research to evaluate the comparative advantage of the introduced thresher against both.

Animal trampling

A crew of animals is allowed to treadle on the soya bean stalk spread on threshing ground, often coating with a thin layer of cattle dung and sometimes covering with mats or plastic sheets. According to participant farmers saying, this method takes on average ten oxen-cum-five persons a day to produce one ton output of soya bean grain. Threshing of soya bean undertaking with oxen is less burdensome and safer for seed purpose point of view. Nonetheless it employs huge loss due to mixes with dung, urine and the amount eaten by livestock when they thresh the crop. Absence of sufficient livestock for trampling forces prolonging threshing period thereby increasing loss due to shattering, pests and rotting of grains. If threshing animals are not available, the farmers will thresh by stick beating little by little thereby exaggerating the loss.

Beating by stick

Beating involves pounding panicles of soya bean crop with wooden stick on the ground. Some other growers thresh soya bean by putting the whole soya bean plant inside jute bags and beat open their pods which are usually already dry with a hard stick. This work requires enormous labor than others and damages grain. In a survey, farmers presumed that with this method of threshing 10-12 persons are required for 8 hours-day length. However, farmers claimed that it threshes more grain from the same quantity of soya bean, speedier than other conventional methods, and that more cleanly than the animal trampling. Most threshing jobs take several days, so they assist each other by forming a small farmers' group in their farms. In return for help threshing, they offered payment to each other in the form of a day's worth of food or liquor. In this operation participants are mostly males youth as it demands more energy

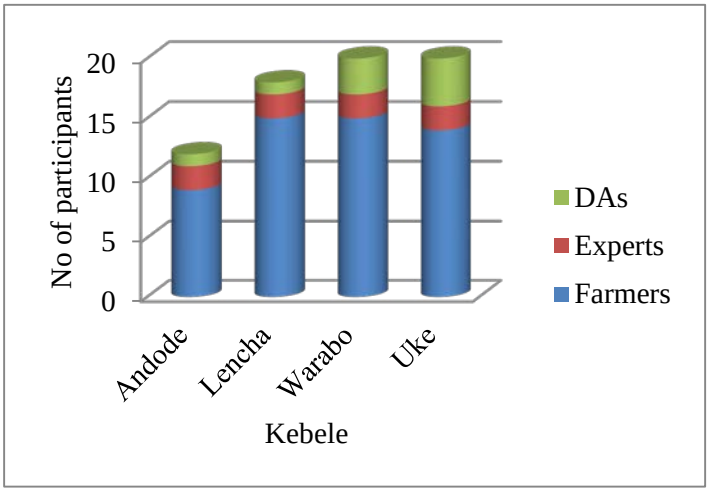
Farmers' Awareness Creation

The means used to create awareness among farmers was training sessions and technology demonstration in the form of field days. The intension is to make the technology better known and more widely accepted by potential users since they are not versed in how to use and maintain the machine

Training of farmers and agricultural extension workers

About 70 people participated in the training program conducted for 4 days. Among the key topics discussed were the overview of the farm mechanization program, proper management practices in soybean farming, the tedious nature of traditional threshing, and basic operation involved in using the technology, which process soya beans in a fraction of the time it takes to do it by hand

Figure 2. Type and number of trainees



The training also touched the safety practices and procedures in machine operation. After the indoor lecture, trainees have proceeded to small field demonstration to complement the training with a practical exercise. During this session farmers were provided an opportunity to learn and operate soya bean thresher having guided by technician. Information on different components of the thresher, its general working principle and proper usage, precautionary

measures, engine ignition and fuel supply system, installation, repair and maintenance schedule of thresher, have been shared

Demonstration of soya bean thresher

The thresher was carried from the workshop to the place where threshing would be performed and was installed on stable level ground in such a way that the wind was blow the straw and other impurities away from the clean grain. Before the start of the test, the thresher and engine was undergone a running for five minute without load to ensure whether all components functioned properly. The thresher was operated with the participation of members of the farmer research group, as well as other interested parties of the community. The occasion was attended by 60 farmers, 16 extension workers and 40 neighboring farmer. Participants were able to see engine driven soya bean thresher in action in a live demonstration and comparatively evaluated the machine against animal trampling and stick beating threshing system. This was the first time, where a thresher has been used for threshing of soya bean in these sites. Time savings, labor savings and grain quality (purity) were thresher's key characteristics collected from farmers and extensions agents at the end of the demonstration holding four FGDs under shaded areas of the field. Views and perception of participants on demonstrated thresher are included in sub title 3.4.

Experimental result

Table 2. Experimental result

Farm	Whole crop input in kg	Mass of threshed grain kg (Q_T)	Time of threshing (min) (T_U)	Quantity of un threshed grain (g) (Q_{US})	Mass of Broken grain (g) (Q_B)	Recommended drum speed (rpm)
1	200	155	17	7.30	3.30	700
2	110	105	13	5.71	2.71	700
3	120	100	10	4.98	2.20	700
4	70	65	8	4.10	1.78	700
Mean	125	106.25	12	5.5	2.5	700
SD	54.46	37.05	3.92	1.33	0.66	

Threshing capacity	550.5 kg/h
Threshing efficiency	85%
Mechanical damage	2.35%

Source: Author's field work computation (2020)

Table 2 shows observations recorded to compute threshing efficiency, output capacity and breakage percentage of soybean thresher. Computation was made employing the index included in section 2.3. It is clear from the table that soya bean thresher has a capacity of about half quintals per hour and a threshing efficiency of 85 percent with the safer limit of breakage percent ranges 2 to 3. This finding is a bit less than the machine potential performance due to operator's skill.

Time and labor cost saving effect of the soya thresher

In order to make rough economic considerations based on farmers' perspective, the added value related to labor cost and time saving in machine threshing was compared relative to stick beating and animal hoofing. During computation the achieved threshing time of experiment was extrapolated to man-hour required per metric ton of soya bean grain. Data for this estimation was collected with three methods included individual survey, FGD, and measurement (Table 3) on the basis of custom hiring

Table 3. Labor cost and time consumed in threshing a ton of soybean grain by different methods

Data source	Threshing capacity			Time needed to thresh 1ton with			Cost of labor to thresh 1 ton with		
	Animal tramplin g	Stick beatin g	Thresh er	Animal tramplin g	Stick beatin g	Thresh er	Animal tramplin g	Stick beatin g	Thresh er
	Kg/h	Kg/h	Kg/h	Hr.	Hr	Hr	birr	birr	birr
Measureme nt	-	-	550.5	-		1.82	-	-	1051.5
Survey	13.74	12.5	-	72.8	80	-	1870	2400	-
FGD	10.99	10.42	-	91	96	-	1965	2650	-

Remark: To calculate the above figure, the following information/assumptions were used;

The national average household size 4.8 persons,
National average of oxen holding 1.8
Assume 10-12 man-days /ton by stick beating
4-5 man-day-cum-8-9 oxen/ton for 8hour
Labor cost =75/day, Oxen rent =30
The farmer (service receiver) is expected to pay 75 Birr per hour as service fee
Meal= 50birr
Estimated threshing loss=2.35% for thresher,5% for traditional
Current price of soybean/quintal =2300

Time required for threshing one ton of soya bean with demonstrated soybean thresher was 1.82 hours whereas 88 and 82 hours on average with stick beating and animal based threshing carried out by 10 oxen-days and 4-5 man-days. This was only about 10 and 12 % of the time that farmers reported spending on oxen trampling and stick beating respectively. That is in agreement with various researches that reported significant time is reduced on the process of threshing when mechanical means are employed. For using the demonstrated soya bean thresher, labor cost due to stick beating and animal trampling could also be saved by 60.3 and 46.5% respectively. The net labor cost saved per ton due to mechanical thresher was birr 913.5 and 1598.5 over beating and animal based threshing method correspondingly

Perception and suggestion of farmers and extension workers on the threshers

In pursuance of the third objective of this research work, elicitation of feedback from farmers, and agricultural extension agents on salient feature of soya bean thresher was carried out. Participant farmers considered themselves as lucky for getting the technology. They started over the machine with feeling of awe highlighting its intrinsic characteristics include speed of threshing which save time, the absence of animals in the threshing process, its ability to lower labor demand and crop loss which not capable of being accomplished by traditional methods. Many farmers were willing to purchase the threshing machine, from having seen or heard of it. Participant Extension workers and officials were also eminently satisfied with the function of the thresher and recognized the effort and cooperation of BAERC in the introduction of new technology.

However, the participant raised and discussed issues related to the access and the possibility of getting the technology. They called government to come to their aid by facilitating micro loan that help them purchase a technology provided that it would otherwise be unavailable. In fact, the farmer does not have to use the machine as a sole proprietor, since farmers can work in groups and use the thresher to generate income. The only two comments from farmers were in the area of mobility and safety. Farmers need the thresher in such a way that it is easily maneuverable because they can be used in any part of their field. It was propounded that the standard car wheels be used at its legs for easy transportation by donkeys. Elaborating further, they proposed to build a safety lever to prevent entrapping of hands by feed roller. A much more convincing remark was which suggests extra fan as they perceived that the machine mixes grain with straw.

Conclusion and Recommendation

In conclusion the technology demonstrated has observed to have an edge over conventional methods and thus very compelling to adopt by farmers. Besides, the feedback from farmers was unanimously affirmative. Hence based on the findings of this analysis and in particular the perception of farmers it was recommended that MoA should take the lead to further popularization of this threshing machine in the districts or outside that scope by providing soft loans for this purpose.

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Participatory On-farm Demonstration and Evaluation of Portable Enset Fermenting Implement in West Shawa Zone of Oromia Region, Ethiopia

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Abstract

The prime objective of the current demonstration activity was to demonstrate farmers, development agents and agricultural extension experts improved enset fermenter then to collect feedback on the performance of the technology showcased. The research was undertaken in Toke Kutaye and Dire Enchini districts involving 45 farmers in the two districts with 98 percent women participation. The study used both quantitative and qualitative methods of analysis in which narration, explanation and simple descriptive statistics were applied. The result revealed that the variation in duration of fermentation was not statistically significant between the kocho fermentation methods of local and improved device. In the contrary the mean difference of kocho yield using fermentation methods of local and demonstrated device is significant at 5% significant level Furthermore FGDs were held among farmers, development agents, and woreda experts. They positively rated the device as compared to the traditional enset fermenting method and some farmers wondered if they could access the device. On the basis of the results, then it was concluded that the technology demonstrated was of improvement that can render a viable solution to an unaddressed problem faced by women farmers for years. Therefore, the technology would be recommended for wider promotion in pre scaling up/out form in other enset culture areas of Ethiopia.

Key words: *enset, fermentation, kocho, pit, traditional processing*

Introduction

Enset is a perennial monocarpic herbaceous plant taxonomically belongs to the order Zingiberales, family Musaceae and genus Ensete. Morphologically it resembles a banana plant and is thus named ‘false banana’. As a common feature, both enset and banana have an underground corm, a stout pseudo-stem of overlapping leaf sheath, large paddle-shaped fronds and produce a massive pendulous inflorescence with big orange fruit. But Enset differs from common bananas in that the edible part of it is not the seedy rubbery fruits it bears, instead the single corm underground and the pseudo-stem above the ground. Enset is a classic multipurpose crop whose domestication, cultivation and farming system exclusively occur in Ethiopia though its wild relatives are known to exist in much of tropical East and Southern Africa and the genus extends across Asia to china (Borrell *et al*., 2020). Enset is dubbed the tree against hunger as it has exceptionally high productivity and the ability to cushion seasonal food deficit.

Enset plantation in Ethiopia as a food crop has long history. Many scientists of different disciplines have developed theories that assume enset domestication in Ethiopia to 10, 000 years (Jacob, 2004). The southern Nations, Nationalities and peoples and part of the Oromia national regional states form the geographical center of enset cultivation (Temesgen *et al*., 2014), and the various ethnic groups in these regions recognize and exploit many enset landraces. Here enset is a crop up on which around 20 million of people rely as a staple and co-staple source of food (Borrell *et al*., 2019). Enset agriculture gives foodstuffs locally named as Kocho, Bulla and Amicho. Kocho is the bulk of the fermented starchy food obtained from the mixture of the scraped leaf sheaths and grated corm whereas Bulla is the sediment of insoluble starchy product separated from processed enset portion by squeezing and decanting the liquid. It is consumed mainly as porridge, in gruel and as crumbled forms. Amicho is boiled corm of enset that cooked and consumed immediately in a similar manner to roots and tubers of other crops.

Moreover, enset is known to have several uses including non-food applications and highly integrated with the economic, social and cultural life of enset growing societies (Admasu and Struik, 2001). It provides a good quality fiber, livestock feed, construction materials and means of earning cash income (Funte *et al*., 2010). Local people also believe that particular enset landraces have various medicinal properties (Nyunja *et al*., 2009). In addition, enset plant help to prevent soil erosion and conserves soil, which contributes to the sustainability of the farming system particularly in steep land (Mohammed *et al*., 2013).

Kocho is the most prevalent product obtained by anaerobic fermentation. Fermentation is the most crucial stage in making of Enset food product which manually was quite dilatory; it is a process introduced by a variable microorganism that turns raw materials into the desired final product. Fermentation has also been identified to improve the nutritional quality, digestibility and safety of enset based foods (Hiwot Bekele, 2015). It also contributes to the development of acceptable texture, flavor and reduces toxicity of plant raw materials. However, harvesting of the enset plant, preparing for fermentation and food preparations follow the traditional route by using the indigenous knowledge and practices. In the first step the leaf sheath of pseudo stem are cut in to a workable size and get decorticated; the corm tissue and stalks of inflorescence are grated and mixed with the pulp decorticated from the leaf sheaths. Afterward the mixed biomass is buried in an earthen pit of about one meter in diameter and one meter deep, wrapped airtight by enset leaves and some heavy stones, and then left to ferment for anywhere between three months and two years, depending on environmental factors.

Fermentation of enset like this in earthen pit can have detrimental effect of the nutrient content of the food. According to Borrell *et al*. (2020) the fermented kocho stored in pit cannot free from microbial contaminators and spoilers. The enset leaves, the soil, air and the handlers of the fermenting kocho contribute to the spectrum of micro-organisms found in it. Of these, some contribute to the rapid spoilage and deterioration of kocho. As stated by Gebreegziabher and & Tsegay (2020), underneath ground generates clostridium bacteria that secret butyric acid giving unpleasant smell to the end products. Loss of kocho due to spoiler organisms is occasionally high in pits where there are air pockets or where anaerobic conditions have not been maintained (Hunduma and Ashenafi, 2010). The other spoilage organisms associated with kocho bring about uncommon inherent sensory attributes characteristics like softness, sliminess and discoloration. Similar data reported by Weldemichael *et al*. (2019), revealed that the enset fermentation approach performed in the

earthen pit is exhausted, labor and time-intensive, considered unsatisfactory with respect to meeting acceptable hygiene, and disproportionally carried out by women.

To overcome the problems in scientific way, a team of researchers, at Bako agricultural engineering research centre have developed improved enset fermenting technology with a capacity of fermenting up to 300 kg of kocho in three weeks or so (Gizachew *et al*., 2019). It is a box like implement contains three compartments totally sealed by polyethylene plastic which was recommended by WHO for food packing. The technology was made out of wood using nails to fix the components as well as fitted with two rubber wheels for easy movement from yard to yard where enset processing often carried out. The above research authors further stated that the implement fabricated is as light as possible, can locally construct, cheap, and easily process and protect kocho from pathogen infestation. Nonetheless Farmers were unaware about availability of this new technology. Hence this research was conducted with an intension to demonstrate the potentiality of the technology to farmers. More specifically the project intended to create awareness of farmers about the availability of the technology; create and strengthen linkage among key actors; evaluate the performance of new technology side by side with the prevailing enset fermentation method, and collect feedback that may highlight some features or problems that engineers can address in their future prototype updating

Materials and Methods

Description of study area

The research areas were Toke Kutaye and Dire Enchini districts, West Shawa of the central Ethiopia highlands. These two districts share boundaries with each other and almost similar in socio-cultural set-up, environmental conditions, farming system and are likely to experience similar challenges. With their capital Toke-kutaye and Dire-Enchini were located at about 135 and 165 km west of Addis Ababa respectively. The major agro-ecological zones of the study area are semi-arid, sub-humid, and humid with uni-modal rain fall characteristics falling from March to mid-October. In normal years, the annual average rain falls ranges from 800 to 1800 mm while the annual average temperature of the districts varies from 13-24 ^{0}c. Agriculture is the primary occupation of inhabitants of these districts. The major annual crops common to both districts include cereals, highland pulse and oil crops, Enset being the dominant perennial crop of the area covering total area of 345 m^2. The latter substantially contributes to both food security, and environmental sustainability as rationalized by farmers. Of cereal crop teff, wheat and burley are the dominant while horse bean and linseed are the major ones from pulse and oil crop. Most of these crops are grown for food and as cash sources as well. Like to many parts of Ethiopia, the study area is endowed with significant number of domestic animals namely cattle, sheep, goats, horses and poultry.

Research site and farmer selection

There are 22 districts in West Shawa Zone, in almost all of which enset plant is being produced. However, due to facilities paucity, only two districts mentioned above were selected grounded the fact that both districts are representative to the rest districts of the zone with regard to enset production, consumption and marketing. From Toke Kutaye Maruf and from Dire Enchini Homi-Anne and Arfanjo-Daga kebeles were chosen depending on their location with respect to the main road. With the full awareness and involvement of district and kebele level agriculture extension personnel, a total of forty five households, fifteen from each kebele, were selected and constituted the participants for this research.

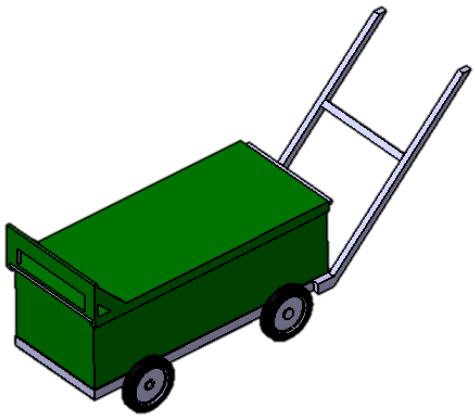
FRG establishment and farmer training

Once the required farmers were selected, meetings on which farmers were presented a detail explanation of FRG and its objectives were held in each and every kebele considered for the study. On this gathering, farmers were briefed on the process of participatory technology demonstration and evaluation as well as group learning and experience sharing. The meeting was also an occasion arranged to establish linkage and define roles and responsibilities of the participating stakeholders at individual and group levels.

Following the completion of discussion, Three FRGs largely made up of women, were established taken neighborhood affinity into account. The project used a household approach; which mean that training and other extension events designed for this research targeted all the members of household as one entity. In the presence of research team, extension personnel, DAs and local leaders, farmers chose four knowledgeable women (in processing enset) among them to host the demonstration. Eventually a three-day training workshop that help farmers understand machine's operating techniques simple maintenance, and possible hazards to themselves and other, were scheduled and given to the farmers and government agricultural extension workers (experts and development agents), ahead of carrying out on farm technology demonstration

Materials

Enset fermentation pit, newly developed box, and matured enset plant were researchable materials. Timber, Angle iron, 4 tires, Polyethylene plastic (recommended by WHO for food packing and processing) were raw materials that required to fabricating the technology. Some of these materials were purchased some were kindly provided by farmers**.** Four implements were multiplied by the center, there were disseminated to the host farmers and one was left for the center as a sample



Data Type and collection Methods
The data for this activity was both quantitative and qualitative in types. The quantitative data were collected on length of fermentation, weight fermented mass (dough weight), number of farmer, extension worker and non-FRG members attended extension promotion activities. Unquantifiable data and feed backs information was amassed through FGD.

Method of Data analysis
The whole data gleaned for the research was subjected to inferential (t-test), descriptive and narrative mechanics of analysis. ‘

Result and Discussion
Farmers’ awareness creation
Having tailed the first objective, the project created knowledge and awareness to farmers and development agents considering that they were not aware of the technology and its uses. This was made possible through farmers’ interaction, field day, training sessions and few technology distributions. Table 1 showed extension activities conducted

Table 1.Summary of extension events during demonstration

Event	Participants									
	Farmer			DAs			SMS			Total
	Male	Female	Total	Male	Female	Total	Male	Female	Total	
Training	11	33	44	7	1	8	3	1	4	56
Demonstration	19	48	67	7	1	8	3	1	4	89
Discussion	10	33	43	7	1	8	3	1	4	55

Three training sessions were organized and catered for farmers, development agents (Ethiopian frontline agricultural extension workers) and SMSes. They become familiar and versed with parts of enset fermenter, its operational detail as well as with the information describe the current method of enset processing.

Upon returning from training, the farmers and agricultural extension agents participated in the organized demonstration exercises along with invited neighbors and evaluated the technology in demonstration concurrently with their prevailing practices 89 Attendees would get a chance to observe, learn first-hand how the device work to help determine which methods might appropriate for enset processing. Three focus group discussions with 55 participants were conducted just on the demonstration site. The results grasped during these discussions were presented in the 3.3 section of this research.

Evaluation of kocho fermenting methods in terms of yield and fermentation time

Table 2. Time and yield obtained

Farm	Underground fermentation			Wooden Box fermenter		
	Buried pulp (kg)	Duration (day)	Output (kg)	Buried pulp (Kg)	Duration (Day)	Output (Kg)
1	54	35	29.7	54	17	39.8
2	59	37	29	59	25	43.4
3	67	32	36.2	67	23	53
Total	180	104	94.9	180	65	136.2
Mean	60	34.67	31.6	60	21.7	45.4
SD	6.56	2.52	3.97	6.56	4.16	6.82

Source: own computation,

Above table showed that fermentation of enset in conventional method took more than 40 days while for the improved technology took only 21.7 days. However, although the means difference were in wide range, the variation in duration of fermentation was not statistical significant between the kocho fermentation methods of local and improved method (t=3.691, P-value 0.066). But for timeliness consideration the investigator felt that it was necessary to completely ferment the kocho placing in the fermenting box.

The kocho yield of enset in terms of weight using wooden box fermenter was investigated and compared with the yield obtained through conventional method. The mean value of kocho output fermented underground was 31.6kg with standard deviation of 3.97. It was measured to be 47% of the original kocho stored (60 kg). In the contrary throughout the site the kocho fermented through demonstrated device was observed to have high weighted mean value than that of pit. The mean score of fresh weight of kocho after fermentation using the device was equal to 45.4 kg from the same pulp buried. the mean difference of kocho yield using fermentation methods of local and demonstrated device is significant (t = 3. 412, p-value 0.0491) at 5% significant level

Farmers Feedback

Farmers who participated in the demonstration were encouraged to give feedbacks from their observation of enset fermenter's performance. By and large almost all women have expressed their fascination and satisfaction with the introduced device innovated to reduce the hardship faced by women in enset processing for food. Time and labor saving benefits of the technology were perceived values of the device by both farmers and their neighbors. Participant stakeholder confirmed that kocho fermenter demonstrated has better relative advantage over tradition practices.

Conclusion and recommendation

The current activity created knowledge and awareness to farmers and development agents considering that they were not aware of the developed enset fermenter and its uses. The yield of kocho obtained from enset fermenting in the introduced device is high weighted than that of pit, so it can be concluded that a technology built and demonstrated is a step in the right direction and a little bit of improvement that can render a viable solution to an unaddressed

problem faced by women farmers for years. Therefore scaling up/out of this technology in the study areas is recommendable

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Pre extension Demonstration of Enset Processing Technologies in Selected Districts of West Shewa and Southwest Shewa Zones

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Abstract

The pre-extension demonstration of engine driven enset processing machine was conducted in 2021 with the objectives of promoting and popularizing engine driven enset processing machine and to create awareness through giving training and enhance stakeholder's participation. Toke Kutaye and Dirre Incenni woreda from West Shewa, one kebele from each woreda, and Waliso from South west Shewa zone, two kebele, were selected purposively based on enset production potential covering a total of four kebele namely: Afinjo, Dega Omi, Anni, Maaruuf, Obi koji and xombe anchebi. 15 farmers per kebele were selected purposively. One host farmer was selected based on their willingness. Trainings and demonstrations were conducted in 2020 and 2021 in selected districts of Toke Kutaye and Dirre Incini districts of west Shewa and Waliso district of South-west Shewa in order to create awareness and understanding among farmers, DAs and SMS on the operation, management and advantage of the engine driven enset processing technologies. Accordingly, Training was given for 60 farmers (45 Females), 6 DAs and 11 SMS. Data was collected through FGD, and observation. The collected data was grouped, summarized, discussed and interpreted. Data was analyzed qualitatively based on the findings. The result showed that using engine operated enset decorticator 5 enset can be decorticated within in 68 min at 790-880 rpm. While traditionally it needs 8 hrs. to 3-4 women to decorticate 5 enset. using engine operated corm grating machine a corm of 5 medium enset can be grated within in 10 min at 2200 rpm. While traditionally it needs 8 hrs. to 3-4 women for grating a corm of 5 enset. Therefore, the technology is highly preferred and thus should be widely manufactured and recommended for further pre-scaling up.

Key words: *Demonstration, Enset processing machines, engine operated, corm grating, decorticating*

Introduction

At present about one-fifth of the Ethiopian population depends on enset as staple or co-staple food (Country STAT Ethiopia, 2016). Processing is very labour intensive, and is usually done by women, although men also help with cutting and harvesting the mature plant.

Enset in West and Southwest Shoa zones is cultivated for a range of services. Every part of the plant is useful for something; Products viz. Kocho, Bulla and Amicho are three popular enset derived foods. 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 age-old traditional tools and techniques (Hunduma and Ashenafi, 2011).

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 F., 2009). This exercise is cumbersome; labor intensive, unhygienic, impose a lot of inconvenience to the women workers, and associated with great yield lose. The technologies that farmers used for

corm grating still are also traditional. Traditional tools used in grating processing was indigenously crafted tools of wood serrated at one end to chip the corm. Traditionally 2-3 hours per tuber require to grating. The tubers of enset cannot be stored longer after harvest before decaying, and so processing follows immediately after harvesting.

To address the abovementioned problems and to reduce the burden on women farmers and increase labor efficiency, research has been initiated aimed at mechanizing Enset processing. Engine driven enset decorticator and corm grating machines has been developed and evaluated by BAERC.

The corm grating machine has the optimum grating capacity when the drum was operated at velocity of 2200rpm for Sharte variety was 1277Kg/hr Whereas the minimum grating capacity of 604.0Kg/hr was observed when the drum speed was 2000 rpm at Baladati variety. Fuel consumption of 1.32 lit/hr was recorded (Gelgelo K., 2018)**.** Th engine driven enset decorticator is powered by a 10-horsepower diesel engine and has the decorticating capacity of 255.38 kg/hr. with the highest decorticating efficiency of 98.97 %, Lowest loss of 1.03 % were obtained at 850 rpm, 1 mm and 0.074 kg/s of drum speed, concave clearance and feeding rate respectively (Workesa et al., 2021). It is easily portable, by just two people.

OBJECTIVES

- To create awareness and demand on availability and importance of engine driven enset processing machines
- To evaluate the capacity of the machines under farmers' condition
- To assess farmers' feedback for further improvement of enset decorticator and corm grater machines

Materials & Methods

Description of the study area

The on-farm demonstration of the machines was conducted in Toke Kutaye and Dire enchini *woredas* of West Shewa and Waliso district of south west Shewa zone, Oromia Region. The selected sites/ districts were known for enset production which helps to improve their livelihood strategies for consumption for food to income markets of enset producers.

Toke Kutaye *woreda* is located 132 kilometers west of Addis Abeba. At an elevation of 2390 m.asl, the area is located between 09^0 04'N latitude and 38^0 38'E longitude. It has an average annual rainfall of 1100 mm and average maximum and minimum air temperatures of 22.20C and 6.130C, respectively. Vertisols and Nitosols are the soil types. Toke Kutaye is one of the zone's potential enset growing areas, according to documents from the West Shewa Zone, and has good future potential. There is a total area of 44,012ha farm land in the district, of which 37,192ha are productive.

Dire Enchini *woreda* is located 40 kilometers south-west of Ambo. The district is located between latitudes 8^0 1'N and 8^0 46'N and longitudes 37^0 35'E and 37^0 38'E. The study area, Dire Enchini District, was chosen on purpose because of the potential for enset production, and no previous research on the subject has been conducted. The total area under cultivation for enset was 3,610 hectares.

Woliso *woreda* is located in the Southern West of the country along the Finfinne to Jimma main road, 90-140 kilometers from the country's capital city, Finfinne, at latitude and longitude of 8^0 32′ 23.0″ N and 37^0 58′ 16.3″ E. The district is bounded on the south by the Regional State of Southern Peoples' Nations and Nationalities and Goro district, on the north by West Shoa's Dendi district and Dawo district, on the east by Becho district, on the west by Amaya district, on the north west by Wonchi district, and on the east by Saden Sodo of the South West Shoa Zone. It is classified agro-ecologically into

Materials

The enset processing technologies that were used for pre-extension demonstration are enset processing technologies that are engine driven enset decorticator which helps to decorticate leaf sheath and engine driven corm grater machines which used to grate enset corm.

Site and Farmers Selection

Toke Kutaye and Dirre Incenni *woreda* (sub-regional administrative divisions): from West Shewa, one *kebele* (smallest administrative division) from each woreda, and Waliso from South west Shewa zone, two kebele, covering a total of five *kebeles* namely: *Afinjo Dega, Omi Anni, Maaruuf, Obi koji and xombe anchebi* (Table 1) were selected purposively based on enset production potential in collaboration with Development agents and woreda experts. Fifteen (15) farmers, one host farmer, were selected purposively based on their willingness from each kebele.

Table 1
Summary of Selected Sites

Activity	Zones	District	*Kebele*
Pre-extension demonstration of Enset Processing Technologies in West and South West Shewa Zones	West Shewa	Dirree incinnii	Afinjoo Dagaa
			Omi Anni
		T/Kuttaye	Maaruuf
	South-West Shewa	Waliso	Obi Koji
			Xombe Ancabbi

Technology evaluation and demonstration methods

On farm demonstrations were organized in each kebele, and farmers came to learn about and evaluate the demonstrated improved enset processing machines and farmers were able to compare with their traditional enset processing methods. Method demonstration was used to show the farmers how the machines decorticate leaf sheath and grate corm of enset. The result demonstration was used to show the final products of the decorticated and grated enset products comparing with products from traditional enset processing methods.

Trainings of farmers and other stakeholders

Training was organized for farmers, DAs, SMS to upgrade their skills on importance, operation, management, and handling of engine driven enset decorticator and corm grating machine.

Method of data collection

Both secondary and primary data were used. Primary data was collected through observation during demonstration and FGD (Focus Group Discussions) after demonstration. The capacity, time and labor required for the machines were collected during demonstration while for traditional processing the labor, time required and the capacity was agreed during FGD among the participant.

Method of data analysis

The quantitative data was analyzed using descriptive statistics, mean, and through clustering the qualitative data. The result was interpreted and discussed in comparison with other findings. The data collected through of focus group discussions were transcribed and translated. The results were organized using Microsoft Excel to combine and compare the results from the four focus group discussions. Analysis considered for enset decorticator and enset squeezer separately.

Results and Discussions

Creating awareness and capacity building on engine driven Enset Processing technologies

Trainings and demonstrations were conducted in 2020 and 2021 in selected districts of Toke Kutaye and Dirre Incini districts of west Shewa and Waliso district of South-west Shewa in order to create awareness and understanding among farmers, DAs and SMS on the operation, management and advantage of the enset processing technologies. Accordingly, Training was given 60 farmers (45 Female and 15 male), 6 DAs and 11 SMS (Table 2)

Table 2

*Number of farmers, DAs and SMS participated on training and demonstration by gende*r

Title of Training	Location	Farmers			DAs			SMS		
		M	F	Total	M	F	Total	M	F	Total
Advantage, operation and handling of Enset decorticator and corm grating machines	West Shewa	8	22	30	2	1	3	5	-	5
	South West Shewa	7	23	30	3	-	3	6	-	6
Total		15	45	60	5	1	6	11	-	11

Note: M-male, F-female, DAs-development agents, SMS -subject matter specialists

On farm Demonstration of enset processing technologies

Demonstration used to showcase the appropriate use of the machines, to improve the flow of information between farmers and researchers about technology performance and appropriateness under farmers' conditions (Snapp, 1999). The training sessions are complemented by demonstration, to ensure comprehensive knowledge transfer. On farm demonstration were conducted in the kebele so that farmers could learn about and evaluate enset processing machines. During on farm demonstration, comparisons were made between the machines and traditional processing methods to show how the machine operated and to get feedback on performances of the machines. A total of 216 farmers made aware of the potential benefits of enset processing machines across the six kebeles of the three districts. The highest number of farmers reached was in Waliso district (120) where the demonstration was conducted around FTC near to road on a market day, while the fewest number of farmers reached was in Toke kutaye district.

Capacity of enset processing technologies demonstration

The decorticated leaf sheath and corm grated are from small, medium and large enset according to farmers' categorization. The capacity of the machines are presented separately as follows.

Capacity of Enset decorticator during on farm demonstration

Tables 3 shows comparison of the enset decorticator and traditional methods with regard to average labor required & time spent in decorticating. Accordingly, using engine operated enset decorticator 5 enset can be decorticated in 68 min at 790- 880 rpm. While traditionally it took 8 hrs. by 3-4 women to decorticate 5 enset (Table 3). Although the number of enset and labor participated are different, (Tiruneh A.Z., 2020) reported that the average time required to scrape leaf sheath of a single plant using traditional tools needs 2 hrs.

Table 3:

Comparison of traditional processing and engine operated enset decorticator

Treatments	Criterions of comparison		
	No. of enset	**Labor required**	**Time Required**
Traditional tools	5 enset	3-4 women	8 hrs.
Engine driven Enset decorticator	5 enset	2 persons	68 min

Capacity of enset corm grating machine during on farm demonstration

Tables 4 shows comparison of the enset corm grating machine and traditional processing method with regard to average labor required & time spent in grating corm. Accordingly, using engine operated corm grating machine a corm of 5 medium enset can be decorticated in 10 min at 2200 rpm. While traditionally it needs 8 hrs. by 3-4 women for grating a corm of 5 enset (Table 4). This finding supports the finding of (Kibi, 2018) traditionally 2-3 hours per tuber required for grating corm and 26 enset corm per hr. using the machine.

Table 4: *Comparison of traditional processing and engine operated corm grating*

Treatments	Criterions of comparison		
	No. of enset	**Labor required**	**Time Required**
Traditional tools	5 enset	3-4 women	8 hrs.
Enset corm grating machine	5 enset	2 persons	1 0 min

Farmers' opinion and feedback on the demonstrated enset processing technologies

Four FGDs, two in Waliso, one Dirre Incinni and the other one in Toke Kutaye were carried out in each kebele with a mixture of men and majority of women to ensure the knowledge of both women and men was well represented in the demonstration (Table 5). Holding a focus group discussion is a good way to learn about people's interests, perspectives, opinions and knowledge about different topics. Knowing the perspectives, attitudes and desires of your target audience is essential to know support services, and dissemination approaches.

Table 5

Summary of participants in the focus group discussion

Site	Districts	kebele	# Participants			Date
			Female	Male	Total	
West Shewa	T/Kuttaye	Maaruuf	11	4	15	Jan 30, 2020
	Dirree incinnii	Omi Ani & Afinjoo Dagaa	11	4	15	Jan 31, 2020
South-West Shewa	Waliso	Obi Koji	12	3	15	March 16, 2021
		Xombe Ancabbi	11	4	15	March 16, 2021

Feedback was collected on performances of the machines, their perception in terms of time and labor saving, product quality during Focus Group Discussion. The women found the demonstrated enset processing technologies was better in terms of capacity, labor and time saving, easiness to process, hygiene, inclusion of other member of the family to participate in the processing, and reducing health risk (Box 1). The participant provide suggestion to modify certain parts of the introduced technologies, the modification suggested by them were integrating the two machines into one, tires needed for enset corm grating machine for easiness of transportation. Enset decorticator needs adjustment on inlet.

Excerpts from one of FGD member at *Xombe Anchabi of Waliso district*

'utuu hin du'in baga kana argine, ijaan arginee deebinee hin arginuu laata? , fiixaan nuuf baasaa' meaning ' Happy to see these machines before my death. Can't we see it again? Take it to success.'

Box 1: *Farmers' opinion on demonstrated enset processing technologies*

This indicates the farmer satisfaction to the machine and the interest to use the machine and worry of supply to get the machine in their village and giving assignment to BAERC for further continuity of the intervention.

Conclusion and Recommendations

The demonstrated enset processing machines were better than traditional processing in terms of capacity, labor and time required. Although the machine is not affordable at individual level, the strategy should be designed in a way that farmers access and use the machines through group approach. It is better to integrate the two machines in to one. Based on the finding above and feedback engine operated enset decorticator and corm grating machines are recommended for further pre scaling up.

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Pre-Extension Demonstration of Sorghum Thresher in Diga and Guto Gidda *Woreda*, Western Oromia

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Abstract

The pre-extension demonstration of engine driven sorghum thresher was conducted in 2021 with the objectives of promoting and popularize improved engine driven sorghum thresher, creating awareness through giving training and enhance stakeholder's participation. A total of 30 farmers were selected from two potential sorghum growing kebeles; Lalisa Dimtu kebele of Digga and Meti kebele of Guto Gidda woredas of East Wollega zone. Two FRGs having 30 farmers (24 male and 6 female) were established. Training on the subject matter was given to (24 male and 6 female), 6(1 female) and 3 SMS at Llisa dimtu and Meti. Data was collected through FGD and observation. Data was analyzed qualitatively through narration. The collected data was grouped, summarized, discussed and interpreted. The machines were demonstrated and found to be about 95.88-97.2% efficient with output capacity of about 500-600 kg hr^{-1} at with no grain breakage at 520 rpm. The traditional practices are inefficient; requiring a lot of labor and time and also it is one of the major problems which facilitate physical damage. Hence farmers preferred an engine driven sorghum thresher to alleviate sorghum post-harvest loss, save labor and time, minimize seeds wastage. Therefore, the thresher is highly preferred from every angle and thus should be widely available and disseminated.

Key words: *Demonstration, sorghum thresher, sorghum, awareness, training*

Introduction

Sorghum (*Sorghum bicolor) is the* third most widely cultivated crop, next to teff (*Eragrotis teff) and maize (Zea mays)* in Ethiopia as well as in Oromia region. Areas of greater concentration of sorghum production include much of north central, northwestern, western and eastern mid-altitude area of Ethiopia (Wortman C.S. et.al, 2009)

In Ethiopia, Men do most of the work for sorghum production, *Women are also* primarily responsible for the field operations and Children account for about 16% of the labor invested in production (Girma Abebe, 2009, Merritt Chesley, 2012).

Among the major sorghum production activities, threshing is one the most difficult post-harvest activity, mainly due to the nature of the seed firm attachment to scaly, inedible chaff that surrounds it and lack (unavailability) of improved threshing technologies. Although the traditional methods of threshing are tedious time consuming and inefficient in operation, But, in most development countries, including Ethiopia, women are primarily responsible for post-harvest handling which generally is understood to include threshing, winnowing, and storage of the sorghum (D.B.Naveen Kumar, 2013).

Fadis Agricultural Research Center (FARC) has developed an engine driven sorghum thresher in its area, the Hararghe major sorghum producer area. Accordingly, the machine has been evaluated and attained the threshing efficiency and output capacities of 88.97-97.08% and 7-12 qt/h respectively, and proven to reduce labor power, cost of threshing, and grain loss in comparison with traditional methods of threshing in the area (Bedada T., 2018 and Teha et al, 2020). The machine is powered by a 5-horsepower petrol engine KAMA and

can process. It is easily portable. In addition to the satisfactory performance capacity, the machine has been also reported as of low in its cost and construction and operation is simple and easily repairable. So that, this activity was aimed at demonstration of the FARC motorized sorghum thresher in Diga and G/Gidda District East Wollega, Western Oromia.

Objectives

- To create awareness and demand on engine driven sorghum thresher
- To evaluate the performance of the machine under farmers' condition
- To get feedback on sorghum thresher

Materials & Methods

Description of the study area

The on-farm demonstration of the machines was conducted in Guto Gida and Diga districts of East Wollega zone. The selected districts were known for sorghum production.

Guto Gida is one of the 18 districts in the east Wollega zone covering an area of 1091.5 square kilometers. Guto Gida district is bordered to the east by Wayu Tuka, to the west by Sasigga and Digga, to the north by Gidda Ayana and Gudaya Bila, and to the south by Leka Dulacha. This district is divided into three distinct geographical areas with varying proportions: the high land (2.8 percent of the district), the midland (57.8 percent), and the low land (39.4 percent).

Diga district is approximately 346 kilometers from Addis Abeba and 15 kilometers from the town of Nekemte to the west. The area is bounded on the west by West Wollega Zone, on the east by Guto Gida district, on the south by Sasiga, and on the north by Leka Dulecha. Based on agro-climatic conditions, the study area is divided into two sections: middle altitude ranges (2100-2342 m.a.s.l.) and low land ranges (1200-2100 m.a.s.l.). Middle altitude accounts for 42 percent of total land area, while low land accounts for 58 percent. The district's total area is estimated to be 40788 hectares. This total land area is divided into arable land, grazing land, forest land, bushes and shrubs, construction, and other uses.

Materials

The engine operated sorghum thresher was used for pre-extension demonstration, KAMA engine with 5 hp.

Site and Farmers Selection

Guto Gidda and Diga districts were selected purposively based on AGP-II target area and one kebeles from each district was selected purposively based on sorghum production potential. Accordingly, Lalisa Dimtu kebele of Digga and Meti kebele of Guto Gidda districts of East Wollega zone were selected. Fifteen (15) farmers per kebele were selected purposively. One host farmer was selected based on their willingness and production of sorghum on his farm. The farmers that hosted the demonstrations were selected in collaboration with Development agents.

Technology evaluation and demonstration methods

Demonstrations of new agricultural technologies, especially when done in farmers' fields, are an effective and commonly used technique for showcasing the potential benefits of good farming practices (AGRA,2016). On farm demonstrations were organized in each kebele, and farmers came to learn about and evaluate the demonstrated engine operated sorghum thresher and were able to compare with their traditional practices. Method and result demonstrations were used. Method demonstration was used to show the farmers how the machine threshes the sorghum. The result demonstration was used to show the capacity of the machine and the threshed sorghum.

Trainings of farmers and other stakeholders

Training was organized for farmers, DAs, SMS to upgrade their skills on importance, operation, management, and handling of Sorghum Thresher

Method of data collection

Both secondary and primary data were used. Primary data was collected through observation and focus group discussions. Data was collected through observation during demonstration and FGD after demonstration. The capacity, time and labor required for the machines was collected during demonstration while for traditional processing the labor and time required and the capacity was agreed during FGD among the participant.

Method of data analysis

The data was analyzed using descriptive statistics, average, for time and labor required for threshing sorghum and through clustering the qualitative data. The result was interpreted and discussed in comparison with other findings. Recordings of focus group discussions were transcribed and translated. The results were organized using Microsoft Excel to combine and compare the results from the two focus group discussions.

Results and Discussions

Awareness created and capacity building on engine operated sorghum thresher

In order to help raise awareness and understanding among farmers, DAs and SMS, demonstrations were conducted and Training was given in 2021. Training was given for 30 farmers, 3 experts working on mechanization at woredas and 6 DAs at Lalisa Dimtu kebele of Digga and Meti kebele of Guto Gidda woredas of East Wollega zone (Table 1).

Table 1: Number of farmers, Das and SMS attended the training on engine driven sorghum thresher

Title of training	Location	Participants								
		Farmers			DAs			SMS		
		M	F	Total	M	F	Total	M	F	Total
Usage, handling and advantage of Sorghum thresher	Digga & Guto Gidda	24	6	30	5	1	6	3	-	3

Note: M-male, F-female, DAs-development agents, SMS -subject matter specialists

These training sessions are complemented by demonstrations, to ensure comprehensive knowledge transfer. Demonstration used to showcase the appropriate use of the machines, to improve the flow of information between farmers and researchers about technology performance and appropriateness under farmers' conditions (Snapp, 1999). On farm demonstration were organized in each kebele so that farmers could learn about and evaluate sorghum thresher. Demonstration of sorghum thresher was conducted to show how the machine operated and to get feedback on performances of the machine. In the demonstration, comparisons were made between: the sorghum thresher and traditional threshing. More than 100 farmers and experts made aware on the availability and importance of sorghum thresher which was new to the demonstration site and the potential benefits of sorghum thresher across the two kebele where demonstrations were carried out.

Capacity of sorghum thresher during on farm demonstration

Traditional sorghum threshing is a laborious, manual and slow exercise which is mainly done by beating the harvested heads with sticks on bare ground. In addition to the torturous exercise which exposes the people threshing to grain dust with skin and respiratory repercussions, it results in losses due to spillage, incomplete removal of grains from the heads, grain damage and contamination with soil, stones and other impurities

Table 2:

Comparison of sorghum thresher and traditional Threshing

Treatments		Criterions of comparison	
	Amount of sorghum threshed(kg)	Labor required	Time Required
Traditional Threshing	500	5-6 persons	8 hrs.
Sorghum thresher	500-600	2 persons	1 hr.

Tables 2 shows comparison of the demonstrated sorghum Thresher and traditional farmers practice with regard to average time spent in sorghum threshing. As estimated by the respondents, the average time required to thresh and winnow one quintal of sorghum is one-man day. Threshing about five quintals of sorghum requires 8 hrs., 5-7 oxen-days and 5-6 man-days are required if it is done traditionally. The thresher can thresh 500-600 kg per hour depending on the dryness of the heads with no grain breakage at 560-570 rpm. This is in line with the findings of (Bedada T., 2018 and Teha et al, 2020). Farmers could save considerable time and labor using sorghum thresher.

Farmers' opinion and feedback on sorghum thresher

The feedback was collected using focus group discussions (FGDs) in the demonstration site. One FGD was conducted in each kebele to learn about farmers' interests, perspectives, opinions and knowledge about sorghum thresher (Table 3). Knowing the perspectives, attitudes and desires is essential to know support services, and dissemination approaches.

Table 3

Summary of participants in the focus group discussion

Site	Districts	kebele	# Participants			Date
			Female	Male	Total	
East Wollega	Guto Gida	Meti	3	12	15	Jan 14, 2021
	Digga	Lalisa Dimtu	3	12	15	Jan 15, 2021

The farmers found the demonstrated engine-driven sorghum thresher outperforms traditional practices such as animal trampling and stick beating in terms of reducing unthreshed head, reducing workload, saving time and labor in sorghum threshing, as well as reducing postharvest losses. The thresher that has been demonstrated is portable and can be transported by one person, making it perfect for smallholder farmers because it can be easily moved from one farmer field to another once the harvested heads are ready for threshing. Machine threshing of sorghum, on the other hand, attracted the interest of the youth and men who attended the demonstration.

Box 1: *Farmers opinion on demonstrated sorghum thresher*

Excerpts from one of FGD member at Meti kebele of Guto Gida

'Hojiin isaa warqeedha. Kun dhibbaaf dhibba ce'eera'. In a farmer's word meaning "Its operation is gold. This is passed 100 percent"

This indicates that farmers preferred the demonstrated sorghum thresher comparing with their practices and recommending for further promotion.

Apart from its good features, the thresher does not combine threshing and winnowing which is technically an area for future improvement. The chaff with sorghum grain needs further sieving and winnowing to get clean sorghum grain. This is done with locally produced winnowing baskets. Two people (usually women) can be employed to do this. The FGD participants suggested that they gave their feedback to modify certain parts of the sorghum thresher; the modification suggested by them included widening of the feeding table and feeding inlet, and adding cleaning unit.

Conclusions and Recommendations

The demonstrated sorghum thresher is better in terms of capacity, time and labor required as compared to farmer's practice. However, the thresher is not affordable at individual farmers. The adoption and use of mechanized threshers will also contribute to employment creation and in entrepreneurship opportunities especially for youth to provide threshing, repair and maintenance services to farmers at a fee. It is suggested to add cleaning unit to the thresher. Based on the findings above the sorghum thresher is recommended for further pre scaling up.

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Pre scaling up of Teff Thresher in Selected districts of West Shewa and East Wollega Zones

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Abstract

The pre-scaling up of engine driven teff thresher was conducted in 2021 with the objectives of promoting and popularize improved engine driven teff thresher and to create wider awareness through giving training and enhance stakeholder's participation. Two districts from each zone, one kebele from each district, were selected purposively from West Shewa and East Wollega zones with the cooperation of woreda BoANR. Accordingly, From East Wollega Leka Dulecha woreda (Hordaa Kawisa) and Digga (Jirata kebele) and From West Shewa Zone Dandi (Loqloqa Abba Kebele), and Liban Jawwii (Munyoo Tuuttoo). Twenty (20) farmers per kebele were selected purposively based teff production potential. Awareness created among more than 200 farmers (Table 2) on the availability and importance of teff thresher. Training was given for 60 farmers, 9 DAs and 11 SMS working West shewa and East Wollega zone. Farmers, experts and DAs feedback were also collected on performances of the machines, their perception in terms of time and labor-saving during Focus Group Discussion. The collected data was grouped, summarized, discussed and interpreted. Data was analyzed qualitatively based on the findings. Postharvest losses during traditional threshing were quite significant but were considerably reduced if the teff thresher will be employed. Farmers emphasized the need for the abundant availability of the machines. Building capacity among local manufacturers for teff thresher would increase their accessibility and get repair and maintenance for service providers. Non-availability of maintenance service at the nearby villages are major problems faced by farmers. Machine breakdowns and subsequent absence of maintenance and service providers led to low adoption.

Key words: *Demonstration, Teff thresher, thresher, teff, trainig*

Introduction

The cereal grain teff (Eragrostis teff [Zucc.] Trotter) is one of the major cereal crops of Ethiopia, where it is believed to be native to Ethiopia Teff Vavilov (1951) cited in Ketema (1997). Teff is Ethiopian's most important crop by area covered (23.85% of all land under cereal cultivation) and volume of production (52.8 million quintals), and the second most important cash crop after coffee (CSA,2018).

Some reports indicated that Teff is getting wider acceptance in international market, too. As gluten-free cereal, it is getting global attention and becoming one of the healthy grains (The Guardian, 2014). Therefore, there is potential for Teff to be the second gift of Ethiopia to the world after coffee.

Crop production in Ethiopia is small-scale. It is non-mechanized and well known for its large amount of human and animal power requirements. Traditional animal threshing in Ethiopia remains to be a major component of postharvest activities. Traditional methods of threshing by live animals and humans result not only in significant quantity and quality losses but are also time consuming and arduous (Asfaw et.al, 2011). Despite the important benefits of improved technologies to farmers, their use is limited in the Ethiopian agriculture. This imply a need for an improved technology to curtail this practice.

Regardless of its economic contribution and potential, Teff is a very tiny cereal, which is produced in a very drudgery system and has a number of problems in production and postharvest management. In production, the system is very drudgery and the yield was one of the lowest compared to other world cereals (Assefa et al., 2013). On the other hand, Teff is also a cereal that was subject to loss particularly during the harvesting and threshing processes.

The Teff threshing process is arduous, time intensive, and often keeps children out of school during harvest. In addition, grain is mixed with dirt, stones, and animal feces, making it unsanitary and unhealthy, and much grain is left on the stalk. Threshing is one of the postharvest operations that is mainly done in a traditional way in Ethiopia. Harvested teff, for example, is threshed using oxen or by beating the crop with a stick. This way of processing results in high losses and low-quality produce as grains get mixed with sand and other impurities (Dejene and Wondwossen, 2008). Moreover, time and labor required to thresh teff are high and farmers regard this activity as arduous but yet unavoidable. Threshing is accomplished by trampling a number of oxen or donkeys, treading around on a pile of the materials, or it requires four to six oxen working for three to four days to thresh crop harvested from a hectare. These are some of the bottlenecks during the harvesting season as human and animal labors are not easily available. Improved threshing techniques are required to minimize the loss.

According to the information obtained from the farmers, pre- and post- harvest losses account for more than 40% of yield loss in Teff. As the saying of Oromo people goes “Hamma ani badu otuu beekanii nan facaasani” jette xaafiini”. Meaning “Had they known how much of me is lost, they would not have grown me” said Teff (ATA; Teff Diagnostic Report; No, 2011). From this proverb, one can understand two important things: loss is serious problem of Teff farming system and knowing the exact loss amount is difficult. Therefore, there is clear call for the stakeholders to continue both in yield increasing efforts on one hand and reducing losses on the other hand.

To overcome the above-mentioned problem Bako Agricultural Engineering Research Center (BAERC) developed teff threshing machine to overcome teff threshing and cleaning challenges, thereby decreasing tremendous teff grain post-harvest loss because of traditional method of threshing and cleaning, due to lack of solely threshing machine of this Ethiopian golden crop.

The teff thresher is an engine-powered and portable mechanical “throw-in type” crop thresher equipment developed and modified by BAERC. Most of its parts are locally fabricated except for its power drive, diesel engine. The thresher can be loaded on donkey carts and can move from farm to farm. Outside a village, it can be transported from place to place in trucks and pick-up cars. It is, nevertheless, difficult to transport threshers to remote areas where the roads are not accessible to trucks or carts. The thresher machine has two outlets: the outlet for

teff straw and the outlet for grain. The threshing capacity of the machine is highly significant with both drum speed and feeding rate and not significant replication and any combination of the independent variables. As the feeding rate increased from 23 to 28 kg/min at constant drum speed of 700 rpm the threshing capacity increased from 314.1 to 366.9 kg/hr. respectively. The total grand mean of threshing capacity of the machine is 428.9 kg/hr. As drum speed increased from 700 to 800 rpm at constant feeding rate of 23 kg/min the threshing capacity of the machine increased from 314.1 to 448.2 kg/hr respectively. Increasing drum speed is attributed to the high threshing or beating force applied during threshing operation, that tend to consume more fuel and increase energy required (Merga W.,2016).

Pre extension demonstration of this teff thresher was conducted in West Shewa zone. The demonstration result shows that the thresher has the capacity to thresh 200 kg/hr. on average. The capacity of the machine depends on teff/grain straw ratio, feeding rate and teff variety. The maximum threshing capacity of the machine is 400 kg/hr. The thresher was recommended for pre scaling up based on farmers' feedback. Many demands are coming after the demonstration of the thresher. Therefore, this activity is aimed at pre scaling up of teff thresher.

Objectives

- ✓ To create wider awareness and demand on Bako model teff thresher
- ✓ To strengthen stakeholders' linkage and collaborations
- ✓ To identify bottlenecks for scaling up of teff thresher
- ✓ To collect feedback for further improvement of the teff thresher

Material & Methods

Description of the study area

The on-farm demonstration of the machines was conducted in Leka Dulecha and Diga districts of East Wollega zone and Dandi and Liban Jawi districts of West Shewa.

Diga district is approximately 346 kilometers from Addis Abeba and 15 kilometers from the town of Nekemte to the west. The area is bounded on the west by West Wollega Zone, on the east by Guto Gida district, on the south by Sasiga, and on the north by Leka Dulecha. Based on agro-climatic conditions, the study area is divided into two sections: middle altitude ranges (2100-2342 m.a.s.l.) and low land ranges (1200-2100 m.a.s.l.). Middle altitude accounts for 42 percent of total land area, while low land accounts for 58 percent. The district's total area is estimated to be 40788 hectares. This total land area is divided into arable land, grazing land, forest land, bushes and shrubs, construction, and other uses.

Leka Dulecha is one of the woredas in the Oromia Region of Ethiopia. It is part of the Misraq Welega Zone and it was part of former Diga Leka woreda. It's bounded by Nunu Kumba and Guto Gida in the east, Illubabor Zone in the west, Diga in the north, and Jimma Arjo to the south.

Dandi district is one of the West Shewa zone of Oromia regional state located about 80 kilometer away from Addis Ababa west side. The capital of the district is known as Ginchi. The altitude of the area ranges between 1200-3288 above sea levels and the average temperature is 16.55 degree centigrade with an annual average precipitation of 700-2300 mm per year. The major livelihood of the area is mixed farming which includes both cultivation of various crops and animal husbandry. However, crop cultivation is the major source of income for most farmers. The major crops grown in the area are cereals, pulses and root crops.

Liban Jawi district is One of the West Shewa Zone Oromia Regional State located to West. The farming system the district is mixed farming. Teff is one of the major crops grown in the district and threshing of the teff is traditional by animal trampling.

Material

The technology that was used for pre scaling up is teff thresher that was manufactured by BAERC. One teff thresher that was multiplied by the support of AGP II was delivered to an unemployed youth group.

Site and Farmers Selection

Two districts from each zone, one kebele from each district, were selected purposively from West Shewa and East Wollega zones with the cooperation of woreda BoANR. Accordingly, From East Wollega Leka Dulecha woreda (Hordaa Kawisa) and Digga (Jirata kebele) and From West Shewa Zone Dandi (Loqloqa Abba Kebele), and Liban Jawwii (Munyoo Tuuttoo). Twenty (20) farmers per kebele were selected purposively. One host farmer was selected based on their willingness, accessibility of their field. One group of unemployed youth was established to deliver a teff thresher that was multiplied by the support of AGP II.

Capacity building and wider dissemination methods

On farm demonstrations were organized in each *kebele*, and farmers came to learn about and evaluate the demonstrated engine operated teff thresher and farmers were able to compare with their traditional practices.

Approach in delivery of the thresher for the youth

Youth was selected with the cooperation of development agent and *kebele* representative in Lokloka abba, Dandi district. practical training was given for the youth on operation of the the machine for four consecutive days, memorandum of understanding was signed and the machine was handover to the youth.

Trainings of farmers and other stakeholders

Training was organized for farmers, DAs, SMS to upgrade their skills on importance, operation, management, and handling of teff thresher

Method of data collection

Both secondary and primary data were used. Primary data was collected through observation during demonstration and FGD after demonstration**.** The feedback was collected using focus group discussions (FGDs) in the demonstration site. One FGD was conducted in each kebele to learn about farmers' interests, perspectives, opinions and knowledge about teff thresher.

Knowing the perspectives, attitudes and desires is essential to know support services, and dissemination approaches.

Method of data analysis

The data was analyzed using descriptive statistics and through clustering the qualitative data. The result was interpreted and discussed in comparison with other findings. The data collected through focus group discussions were transcribed and translated. The results were organized using Microsoft Excel to combine and compare the results from the two focus group discussions.

Results and Discussions

Wider awareness and capacity building on teff thresher

Awareness created among more than 200 farmers (Table 2) on the availability and importance of teff thresher. Training was given for 60 farmers, 9 DAs and 11 SMS working West shewa and East Wollega zone. Farmers, experts and DAs feedback were also collected on performances of the machines, their perception in terms of time and labor-saving during Focus Group Discussion.

Table1:
Number of farmers, DAs and SMS participated on teff thresher training and demonstration by gender

Title of training	Location	Farmers			DAs			SMS		
		M	F	Total	M	F	Total	M	F	Total
Usage, handling and advantage of Sorghum thresher	Leka Dulacha, Digga, Liban Jawi and Dandi	41	9	60	6	2	8	7	2	9

On farm demonstration and promotion

Demonstration used to showcase the appropriate use of the machines, to improve the flow of information between farmers and researchers about technology performance and appropriateness under farmers' conditions (Snapp, 1999). On farm demonstrations were conducted in 2021 to raise the awareness of farmers and other stakeholders. Training was also given for farmers, DAs and SMS to help create awareness and understanding. On farm demonstration were organized in the *kebele* so that farmers could learn about and evaluate sorghum thresher. In the demonstration, comparisons were made between the machines and traditional teff threshing. A total of 200 farmers become aware of the potential benefits of teff thresher.

One group of youth in lokloqa aba kebele get one thresher, which was multiplied by AGP II, the youth were trained on operation and management of machines and engines in 2021, intensive training was given to equip them with basic skills required to operate, maintain and troubleshoot as and when the need arises. The organized youth offer teff-threshing services for farmers, capable of meeting the needs of over 60-90 farmers at harvest time. Facilitates such service provision so that farmers no longer need to carry out inefficient, labor- and time intensive manual threshing. As the machine is movable it reaches many farmers in lokloqa

aba kebele and farmers in the kebele are interested and they take order from the youth to use the machine on hiring bases.

Farmer's feedback

They preferred to buy in groups but lack of supply is a big problem as private manufacturers are not interested in the manufacturing because most of them lacks a machine to manufacture the teff thresher and the other due to its huge size that consume their time and increase the cost of manufacturing of the thresher. Farmers indicated that the teff thresher have advantages over the traditional practice of threshing. But as the machine needs special skill technicians should be trained to repair and maintain machines and engines. The teff thresher will greatly reduce time spent and fatigue to farmers on the same operation. It is simple to use, completely threshes the heads, performs winnowing, and reduces fatigue especially to women. The FGD indicated that as youth, who are productive forces are not engaging in agriculture, this thresher is an opportunity to attract them to agriculture.

Selam type is giving threshing services in the area. However, the farmers preferred BAERC teff thresher as it has a winnowing mechanism. Consumers have developed a preference for machine-threshed teff because it is not contaminated by soil and animal excretions. Farmers indicated that they prefer to use teff thresher instead of the time consuming and labor-intensive traditional method. Saved time will allow them to do other agricultural activities. Many therefore still depend on oxen threshing although readily willing to use the machines. For lokloka aba kebeles that are recently introduced to the machines, there is a growing demand for the service as well as teff thresher.

Farmers realized the fact that teff threshing machine leads to labor and time saving at the same time profitable. The price of oxen was on the rise and many farmers kept their oxen away from threshing so that they gain better fattening and dairy outputs. Speed of threshing which saves time – four hours of threshing that used to take about 3-4 days under traditional methods; Labor cost is significantly reduced – only four persons are required unlike the traditional method which requires a larger number (about 8 persons) for effective threshing of similar amount of cereals. The quality of crop threshed is highly enhanced as there is no mixing with sand, soil, urine and dung of animals as was the case in the traditional method; The crop loss in the threshing process is highly reduced due to effective threshing which reduces un-threshed seeds, produce eaten by animals, losses in earth cracks in the threshing areas and spillovers.

Strengthening linkage

One of the objectives of pre scaling up activity was to create linkage among stakeholders. We attempted to build linkage with farmers and zonal and districts of BoA. The big challenge was to identify local fabricators of the teff thresher who could fabricate the machine, as multiplying is not the mandate of our center. This was planned to tarin local manufacturers so that private service providers could buy the thresher from them. Unfortunately, we didn't get interested manufacturers in the mandate area, their reason not to multiply the thresher is the material cost due to hugeness of the machine, lack of machines and etc. However, we didn't get manufacturers in the mandate area due to different reasons. In order to overcome this challenge local fabricators should be capacitated and supported to get machines at low prices materials such as steel products and machine elements

Challenges and Constraints for wider scaling up of the teff thresher

Some of the constraints identified during FGD are listed below

Susceptible to frequent failures and interruptions during operation. Frequent machine breakdowns especially, Arms of teff threshing machines, due to high vibration of the machine, However, repair and maintenance services are not available near to the farmers. Additionally, CHANFA diesel engine, 6.7 hp, which was used on the machine is low speed and it damaged frequently. The recommended engine ATMA is currently not available on market in Ethiopia. availability of market for spare parts, maintenance and entrepreneurs encourages farmers to invest on the machines.

lack of maintenance and repair services center for the thresher and engines. Lack of skilled individuals to maintain the machines and limited access to spare parts. The presence and active role of private owners and repair and maintenance service providers. Low purchasing power of farmers and non-availability of teff thresher near to farmers; Limited access to agricultural credit for farmers and local fabricators; High local production cost due to imported materials

Conclusions and Recommendations

Postharvest losses during traditional threshing were quite significant but were considerably reduced if the teff thresher will be employed. Farmers emphasized the need for the abundant availability of the machines. Building capacity among local manufacturers for teff thresher would increase their accessibility and get repair and maintenance for service providers. Non-availability of maintenance service at the nearby villages are major problems faced by farmers. Machine breakdowns and subsequent absence of maintenance and service providers led to low adoption. Teff threshing machine, tackles the next stage of the farming economy, introducing better threshing service – so that teff is not eaten by animal – and to save labor and improve post-harvest loss. The teff thresher is powered by petrol engines, and they are mobile, so they can be transported from farm to farm, or village to village. This facilitates the emergence of teff threshing youth, providing service to farmers, while local fabricators are taught how to build and repair the machines. The crop productivity of the area was also very high and hence potentially profitable for private thresher service providers. Farmers should mobilize themselves into groups would help them join effort to purchase one teff thresher that can serve 10-15 people. Promotion of teff threshing machines require joint efforts of researchers, farmers and implement manufacturers and private service providers

Based on the findings of Pre scaling up, the following points are further suggested for further scaling up of the thresher

- Efforts should be made by the BAERC to continue improvement and to popularize good quality threshers among smallholder farmers;
- There should be a continues attempt to improve the overall performance of the machines. (E.g., frequently broken parts).
- Operators of teff thresher and farmers should undergo appropriate trainings in order to gain the required skills, techniques and knowledge of proper operation. Training and support should be focused on capacitating the operators and farmers to maintain minor failures by themselves.

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Pre-extension Demonstration of Improved Teff technologies in potential districts of Western Oromia

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Abstract

The study was conducted in Jimma Arjo, Jimma Geneti, and Chaliya districts of western Oromia, during the 2020 main cropping season. The objective of the study was to demonstrate a recently released teff variety to the farmers in the study areas. A new variety (Jitu) was planted along with a standard check (Dursi) on 100 m^2 adjacent plots, adhering to all agronomic recommendations. Both qualitative and quantitative data were collected and analyzed for this study. At maturity, participatory variety evaluation was done using traits/criteria set by the farmers to select the best variety for future use. Grain yield performance, disease tolerance, lodging tolerance, pest tolerance, and seed color were the first five most important criteria considered by the farmers in their order of importance. The new variety was ranked first on the basis of these criteria and was selected as the first option for future use by the farmers. An independent sample t-test was used to analyze quantitative data, while qualitative data were qualitatively analyzed and described. The mean grain yield performance of the varieties (qt ha^{-1}) was 19.87 ± 0.6 for Jitu and 17.76 ± 1.01 for Dursi variety. The new variety, exhibited a yield advantage of 12.22% over the standard check. The technology gap and technology index for Jitu were 5.43 qt and 21.46 %, respectively while the values for Dursi were 6.24 qt and 26 % witnessing more stability and feasibility of the new variety to the farmers. The financial analysis conducted revealed that the net gain (47833.33 ETB ha^{-1}) was higher for Jitu than for Dursi (40028.33 ETB ha^{-1}) witnessing more profitability of the new variety compared to its counterpart. The new variety, has consequently, met the farmers' demand both in terms of qualitative and quantitative traits including financial benefits than the standard check. Thus, based on these facts, wider dissemination of the variety with its full package to the farmers in the study area and those with similar agro-ecological conditions was recommended.

Key words: Dursi, Jitu, Participatory evaluation; Technology index; technology gap; variety

Introduction

Teff (Eragrostis tef (Zucc.) Trotter) is a warm season annual cereal and the major staple food crop grown in Ethiopia. It is the most important cereal, both in terms of production and consumption in Ethiopia. As the most preferred cereal among better off households, especially urban areas, teff fetches relatively high price in the market, making it attractive cash crop to farmers. It is relatively resistant to many biotic and abiotic stresses and can be grown under different agro-ecological conditions, ranging from lowland to highland areas. It can also be stored for many years without being seriously damaged by common storage insect pests (Bekabil *et al.*, 201; Demeke *et al.*, 2013).

Teff production keeps its first rank in terms of area coverage among the other cereal crops which accounts about 30% of the land allotted to cereal production followed by maize (23%), sorghum (18%), and wheat (17%) (CSA, 2019). However, it is the lowest in its productivity which is only one third of the average wheat productivity of the nation (CSA, 2019). Today, nearly three million hectares of land are covered annually by teff and more than six million small scale farmers are involved in teff cultivation in the country. Teff supports more than 60-75% of Ethiopia's population as staple food and believed as a traditional medicine especially for diabetic people in many areas of the country.

Teff is an economically superior commodity in Ethiopia. It often commands a market price two to three times higher than maize, the commodity with the largest production volume in the country (FAO, 2015); thus making teff an important cash crop for producers (Abraham, 2015). It is an important cereal crop providing the livelihoods for the majority of smallholder farmers and a strategic crop with the potential to enhance commercialization of smallholder agriculture and improve food security in Ethiopia. In Ethiopia, *Teff* is mainly produced in Amhara and Oromia National Regional State (Kebebew et al., 2016; CSA, 2019) and it is estimated to be the most important crop in Ethiopia's agricultural and food economy. Nowadays, with an increasing number of health-conscious consumers across the world, teff has started generating a similar phenomenon with quinoa, the nutritious grains native to South America for global prominence (Cheng et al., 2017). As a result, interests in teff cultivation are spreading to other parts of the world. Those countries include Australia, Cameroon, Canada, China, India, Netherlands, South Africa, the UK, Uganda and the USA (Abraham, 2015). However, comprehensive statistics on the teff production, utilization and trade are little available in those countries.

Outside Ethiopia, global consumers following the super-food wave are willing to pay premiums for teff (Zhu F., 2018). Various teff-based products are developed to capture the premium market in the form of bread, porridge, muffin, biscuit, cake, casserole and pudding. Despite the importance of the crop, productivity is low in Ethiopia. Although the productivity is still regarded as low, grain yield of teff shows an increasing trend during the past decades mainly due to wide dissemination and adoption of improved cultivars (Assefa et al., 2015, Chaniyalew et al., 2019). For instance, in Ethiopia teff productivity, which was only 0.7 t/ha in 1995, when the seed supply of the improved cultivars was limited, reached 1.76 tone/ha in 2018 (CSA, 2019). This success is initiating more researchers to work on improvement of the crop across the country.

Accordingly, the National Agricultural Research System (NARS) has been making tremendous efforts over last ten years to develop and release large numbers of improved tef varieties and associated production technologies for diversified agro ecology of Ethiopia. More specifically, Bako Agricultural Research Center (BARC) has been endeavoring to release improved teff varieties to agro-ecologies under its mandates. As part of this effort, Bako Agricultural Research Center (BARC) released an improved teff variety known as Jitu, having 10 % yield advantage over its predecessor, and exhibiting better agronomic characteristics. Given the potentiality of western Oromia for teff production, increased demand for improved varieties and availability of the options, it is due time to demonstrate these varieties to farmers in potential agro ecologies of teff production under BARC's mandate. This, activity, therefore was initiated with objectives of demonstrating improved tef technologies so as familiarize the farming communities with the new tef varieties which in turn will facilitate the adoption process and bridge the productivity gap.

Objectives of the study

The demonstration work was conducted to address the following objectives.

- To demonstrate and evaluate improved tef technologies;
- To evaluate the productivity and profitability of the technology under farmers' condition;
- To create awareness on the importance of the improved tef technologies;
- To collect feedback from the participants for further research design and the way for ward.

Methodology

Site and farmer selection

A three-stage sampling was used to undertake the activity. In the first stage, three districts (one from East Wollega, one from Horro Guduru Wollega and one from west Shawa zones) were purposively selected based on their accessibility and potentiality for teff production. On the second stage, one potential and representative farmers' Association (FA) was selected in each of the identified districts. Finally four hosting farmers were selected with the help of Development Agents (DAs) of the respective FAs selected earlier. Accordingly, Jimma Arjo, Jimma Geneti and Chaliya districts were used for the activity. In each district one FRG unit comprising of 15 farmers was established Out of the FRG members, 4 of them were hosting farmers whereas 11 were follower farmers. Accordingly, a total of 12 hosting farmers were selected and participated on the activity.

Stakeholders training

Following the establishment of FRGs and identification of hosting farmers, both theoretical and practical training was given to farmers, Development Agents and experts of the respective districts. The training provided covers areas such as teff production, management, and post harvest procedures including seed quality maintenance. The aim of training was to enhance awareness of farmers, Development Agent and district experts on improved teff technologies.

Stakeholders responsibility share

The success of the current work and the guarantee for the successive works ahead cannot be exclusively handled by the researchers alone. Consequently, identification of key stakeholders and making agreement on roles and responsibilities was an essential part of the activity. On this basis, the following four stakeholders, FRG member farmers, researchers, Development Agents and district agricultural experts were identified and shared roles and responsibilities. List of the stakeholders, their roles and responsibilities is depicted in Table 1

Table 1. Stakeholders' roles and responsibilities

Actors	Their role and responsibility
Farmers	• Providing land free of rents • Provide Labor for all field activities(land preparation, planting, weeding, harvesting and threshing) • Follow up of the activities • Evaluate and select the best variety/ies
Researchers	• 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 • Farmer selection and group (FRG) formation. • Writing useful information produced from the technology demonstration
District experts	• Organizing farmers in group with cooperative office • Organizing training for farmers • Organizing field days and experience sharing forum among the GRGs and other farmers • Coordinating all the field activities
Development Agents	• Select appropriate field • Select appropriate farmers • Collaborate in FRG formation • Follow up the FRGs and the fields • Communicate with researchers about status of the field • Collaborate organizing field visits/ field days

Treatments

One newly released improved teff variety (**Jitu**) was planted along with a standard check (Dursi) each on 100 m^2 adjacent plots. A seed rate of 10 kg ha^{-1} was used while fertilizer was applied at the rate of 100 kg ha^{-1} NPS, and 50 kg ha^{-1} urea. Urea was applied in a split form i.e. 25 kg at planting and the rest 25 kg at 25 days after planting. An inter-row spacing of 20 cm was used, and planting was done by drilling. The fields were periodically supervised to check the status and identify gaps.

Data collection

Both qualitative and quantitative data were collected for this activity. The quantitative data collected includes yield data, total number of farmers participated on training, total number of farmers, DAs and district experts participated on field visits, costs of production and income accrued to the farmers. Farmers' perception on the attribute of the technology was the qualitative data collected for the study.

Data analysis

The quantitative data were subjected to SPSS software and were analyzed using simple descriptive statistics such as mean and standard deviation (SD). An independent sample t- test was used to analyze mean, to check if there is significant yield difference between the two varieties. Qualitative data were analyzed and described qualitatively. Besides; score ranking technique was used to evaluate and select best variety/ies and /or technology/gies and to rank their criteria and parameters according to real situation of the area. Finally, gross margin analysis was done to calculate cost of production and income accrued to the farmers. Gross margin analysis is very useful in a situation where fixed capital forms a negligible portion of production. Thus; it is the difference between gross income and the total variable cost (Mohammed *et.al,* 2016). Furthermore; technology gap and technology index were calculated using the following formula.

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

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

Results and Discussion

Results of participatory variety evaluation

Despite many informal evaluations made at different plant growth stages, final joint evaluation was done when the crop was at its maturity stage. Accordingly, mini field day was arranged in which FRG member farmers, neighboring farmers, researchers, DAs and district experts participated. This was a special platform for participatory variety evaluation and selection accompanied by acquainting other farmers with the technologies. At this platform, farmers and researchers listed evaluation criteria at random, which was then ordered using pair-wise technique. The evaluation criteria were ordered in such a way that the trait with highest score was ranked 1st, and was considered as the most important criteria, while the lowest score denotes criteria of lower importance in the order. Each variety was evaluated against the ordered criteria.

To this end, FRG members scored each variety for individual traits they considered important. For each measurable traits grading was again done on a scale of 1-5 units, 1 being very poor and 5 being the highest score representing superiority. At the end of the evaluation process, result of the evaluation was displayed to the evaluators, and discussion was made on the way ahead. The variety/ies selected, accordingly, were proposed for further scaling up.

The evaluation criteria suggested by the participating farmers at random were yield, early maturity, lodging tolerance, insect-pest tolerance, seed color, seed size, tillering capacity, spike length and disease tolerance. On this basis, one can learn from the data in (Table 2) that grain yield performance, disease tolerance, lodging tolerance, pest tolerance, and seed color were the first five most important criteria considered by farmers in their order of importance. This indicates that these criteria are the traits that researchers should seriously consider for future breeding design and way forward to develop farmer preferred variety/ ies. Of the listed criteria/ traits, early maturity received less attention for selection of varieties. This is mainly because in Western Oromia the intensity and distribution of rain fall and early termination of precipitation is not be a problem. During the course what have been learnt was that the farmers' selection criteria are beyond yield and most of the farmers gave priority for qualitative traits such as resistance to disease- pest, lodging tolerance and seed color

(marketability) in addition to grain yield performance. Based on overall mean score and rank, Jitu was selected first where Dursi was selected on the second position.

Table 2: Pair-wise matrix ranking format for the varieties

Crit.	1	2	3	4	5	6	7	8	9	Freq.	Rank
1		1	1	1	1	1	1	1	1	8	1st
2			3	4	5	6	7	8	9	0	-
3				4	5	3	3	3	9	5	4th
4					4	4	4	4	9	6	3rd
5						5	5	5	9	4	5th
6							6	8	9	2	6th
7								7	9	2	6th
8									9	2	6th
9										7	2nd

Criteria: 1= yield, 2=early maturity, 3= lodging tolerance, 4= Insect-pest 5=seed color, 6=seed size, 7=Tillering capacity, 8=spike length, 9= disease tolerance

Varietal score ranking

Varietal score ranking across locations is depicted in (Table 3). According to the collective ranking, the highest score was recorded for Jitu variety, (4.41), followed by Dursi (3.74).Consequently, Jitu variety was ranked as the first option in all of the locations followed by Dursi. However, farmers were highly attracted to the straw biomass mass of Dursi variety which is expressed in two major ways. This trait is important to farmers as they can use it for dry season feed for animals, and plastering of walls mixed with mud. On the other hand the new variety, Jitu was better than Dursi in maturing earlier and tolerating lodging, despite the fact that less attention was given to the former trait as early termination of precipitation is not problem in most of the high land areas of western Oromia. However, comparable yield could be obtained from the two varieties except the non significant yield advantage the new variety(Jitu) showed over the standard check (Dursi) but their major differences mainly stems from the other traits discussed above for selection of the best variety that suits the need of the farmers and most preferred by the farmers' at large.

Table 3: Varietal score ranking in the respective locations

variety	Jimma Arjo			Jimma Geneti			Chaliya		Overall mean	Overall rank
	Total score	Mean score	Rank	Total score	Mean score	Rank	Total score	Mean score		
Jitu	38	4.22	1st	38	4.22	1st	43	4.78	4.41	1st
Dursi	29	3.22	2nd	35	3.89	2nd	37	4.11	3.74	2nd

Table 4: Varietal ranking based on farmers' selection criteria

No	Varieties	Rank	Reasons
1	Jitu	**1st**	Higher yielder, Higher disease tolerance, higher pest tolerance, higher lodging tolerance, best seed color
2	Dursi	**2nd**	Relatively high yielder, Disese tolerant, moderate pest tolerance, moderate lodging tolerance, good color

Grain yield performance of the varieties

The grain yield performance of the varieties is depicted in (Table 5). In spite of the inevitable variability in performance between and even within locations, a yield performance of the varieties was promising. The variability in yield performance might have stemmed from difference in the status of soil fertility, and prior cultivation history that might impose difference between fields and locations. The combined grain yield performance (qt ha^{-1}) of the varieties demonstrated is summarized in (Table 5) below. Accordingly; a mean grain yield of 19.87 ±0.6 and 17.76 ±1.01, respectively was recorded for Jitu and Dursi varieties. The mean grain yield difference between the two varieties, however, was not statistically significant. From the above result one can deduce that almost on farm mean yield performances for the varieties is almost similar.

Table 5: Mean yield of the varieties across the districts

Variety	N	Mean	SD	Min	Max
Jitu	9	19.87 ±0.6	3.03	16.86	22.140
Dursi	9	17.76 ±1.01	1.9	13.46	23.5

Yield Advantage

Calculating yield advantage of the varieties helps to show the extra benefit in percentage that the farmers obtain from producing improved variety. Besides, it is used to recommend based on the relative yield advantage over other varieties. Accordingly, Jitu had yield advantage of 12.22 % over Dursi. Yield advantage is calculated using the following formula:

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

$$= \frac{19.87 \text{ qt ha}^{-1} - 17.76 \text{ qt ha}^{-1}}{17.76 \text{ qt ha}^{-1}} * 100 = 12.22\%$$

Technology gap and Technology index

Technology gap indicates the gap in the demonstration yield over potential yield. The observed technology gap is attributed to dissimilarities in fertility, acidity, rainfall and other natural calamities. The yield gaps can further be categorized into technology index which is used to show the feasibility of the variety at the farmer's field. The lower the values of technology index the more the feasibility of the varieties. Accordingly, the technology gap and index of demonstrated varieties were calculated using the underlying formulas and presented in below table.

Technology gap = Potential yield (qt ha^{-1}) - Demonstration yield (qt ha^{-1})

$$\text{Technology index} = \frac{\text{Potential yield (qt ha}^{-1}\text{) - Demonstration yield (qt ha}^{-1}\text{)}}{\text{Potential yield}} * 100.$$

Technology index can also be expressed as (Technology gap/potential yield/ Potential yield)*100

Technology gap:

The technology gap for the two varieties was calculated as shown below and was summarized in (Table 6). As can be seen in the table, the technology gap for the varieties was 5.43 qt and 6.24 qt, respectively. Comparing the two varieties for this parameter, the gap is a bit higher for Dursi as compared to the new variety (Jitu), though the gap is not significantly wider. This indicates that the relatively lower gap was observed on Jitu variety which in turn shows the demonstration yield is very close to the potential yield. This might be due to the fact that the standard check was under production and the consequential contamination (impurity) which is one factor, among others, that contribute to yield reduction.

Technology gap for: Jitu= 25.3(qt ha^{-1}) -19.87(qt ha^{-1}) = 5.43 qt

Dursi= 24 (qt ha^{-1}) -17.76 (qt ha^{-1}) = 6.24 qt

Technology index:

The demonstrated grain yield performance of the two varieties and their respective potential yield were compared to estimate the yield gaps which were further categorized in to technology index. The technology index for the two varieties was calculated as indicated below and was summarized in (Table 6). The result shows that the value was 21.46 for Jitu (the new variety) while it were 26 for the standard check (Dursi). The average value of the index (23.73 %) reveals that the varieties are feasible to the farmers in the study area and other similar agro-ecologies. However, as lower value of the index denotes more feasibility of the technology to farmers, it can be learned that it is more feasible to produce Jitu variety than to produce Dursi variety under farmers' condition.

Technology index for: Jitu= $\frac{5.43\text{qt}}{25.3\text{ qt}}$*100=21.46

Dursi= $\frac{6.24\text{ qt}}{24\text{ qt}}$ *100=26

Table 6. Yield advantage, technology gap and technology index of the varieties

Variety	Potential yield (qt ha^{-1})	Demo yield (qt ha^{-1})	Technology gap (qt)	Technology index	Yield advantage (%) of the
Jitu	25.3	19.87	5.43	21.46	
Dursi	24	17.76	6.24	26	17.76

Financial analysis

In terms of profitability and returns that could be gained from each of the varieties, financial analysis result of the study was summarized and presented in (Table 7). On average a net profit of 47833.33 ETB ha^{-1} and 40028.33 ETB ha^{-1} were gained from Jitu and Dursi varieties, respectively. As can be seen from (Table 7), variety wise analysis reveals that the highest profit was gained from producing Jitu variety as compared to producing Dursi variety.

Consequently, the return on investment (ROI) was higher (2.73) for Jitu variety compared to that of standard check (2.23). The result from the financial analysis as depicted in (Table 8) reveals that farmers could gain an additional 7805 ETB ha^{-1} while they produced Jitu variety. On the other hand, location wise analysis indicates that the highest average net gain per hectare (49787. 5 ETB) was accrued to the farmers at Chaliya, while the least average gain per hectare was accrued to the farmers at Jimma Geneti (36855 ETB).

The lowest gain for the farmers at this site was due to the relatively low performance of the variety exhibited at this specific location that lowered the total revenue accrued from sale of the variety. At Chaliya, both the varieties performed almost similarly resulting in a very low gain difference (875 birr) between producing Jitu and the standard check (Dursi), while the gain difference for the two varieties was the highest (13440 ETB ha^{-1}) for Jimma Geneti. One can learn from the financial that the demonstrated variety (Jitu) exhibited better yield performance, hence greater net gain for the producers. Table 7: Financial analysis for the varieties across the districts

	Jimma Arjo		Jimma Geneti		Chaliya	
	Jitu	Dursi	Jitu	Dursi	Jitu	Dursi
Yield qt/ha (Y)	20.2	17.6	18.45	14.61	20.35	20.1
Price(P) per	3500	3500	3500	3500	3500	3500
Total Revenue (TR) = TR = Y*P	70700	61600	64575	51135	71225	70350
Variable costs						
Seed cost	4000	4000	4000	4000	4000	4000
Fertilizer cost	4000	4000	4000	4000	4000	4000
Labor cost	6000	6000	6000	6000	6000	6000
Total Variable costs (TVC)	14000	14000	14000	14000	14000	14000
Fixed costs						
Cost of land	3500	3500	3500	3500	3500	3500
Total fixed costs (TFC)	3500	3500	3500	3500	3500	3500
Total cost (TC) = TVC+TFC	17500	17500	17500	17500	17500	17500
Gross Margin (GM)=TR-TVC	53200	44100	47075	33635	53725	52850
Profit=GM-TFC	49700	40600	43575	30135	50225	49350
Return on investment (RIO) =(TR/TC)*100	2.84	2.32	2.49	1.72	2.87	2.82

NB: all costs and incomes were calculated in ETB (Ethiopian Birr); 1 ETB=0.021USD

Table 8: Comparison of net gain from Jitu and Dursi varieties across locations (birr)

Jimma Arjo			Jimma Genet			Chaliya		
Gain(J)	Gain(D)	Diff.	Gain(J)	Gain(D)	Diff.	Gain(J)	Gain(D)	Diff.
49700	40600	9100	43575	30135	13440	50225	49350	875

Gain (D) = net gain from Dursi; Gain (J) = net gain from Jitu; Diff. = gain difference

Training of farmers, Experts and DAs

Stakeholders participated on teff production and management across the districts is depicted in (Table 6). As indicated in the table, a total of 84 participants from the four districts have taken part in the training. Accordingly, 9 district experts, 12 DAs, 3 supervisors, and 80 farmers took the training.

Table 9: Stakeholders training participants by district and gender

Participants	Jimma Arjo	Jimma Geneti	Chaliya	Total
Experts	3	3	3	9
DAs	4	4	4	12
Supervisors	1	1	1	3
Farmers	20	20	20	60
Total	28	28	28	84

Field Visit/Mini field days

Field visit was also arranged across the districts so as to evaluate/select best performing varieties, to enhance farmers' knowledge on teff production and management and to collect feedback from all relevant stakeholders' for further way forward. On the field visit event organized a total of 120 participants; 92 (75 M and 17 F) farmers, 16 (14 M and 2 F) DAs and Supervisors and 12 (11 M and 1 F) agricultural experts participated across the districts.

Table 10. Participants of mini field day by district and gender

Participants' category	Number of participants		
	Male	Female	Total
Experts	6	3	9
DAs	8	4	12
Farmers	75	17	92
Total	89	24	113

Farmers' perception of the technology

The farmers' have appreciated the selected teff variety for the following merits; perceived better yielder than the commercial varieties, perceived better resistance to disease, perceived better Seed color, tillering capacity and marketability. Apart from these traits the farmers liked the higher biomass and leaf to stem ratio of the improved variety (Jitu) that is an important characteristic as a dry season animal feed and other benefits like thatching roof

making and plastering materials. Moreover, teff straw is an important cash source in addition to the importance mentioned earlier.

Conclusion and recommendations

The current study aimed at demonstrating a recently released improved teff variety, Jitu to farmers in selected districts of western Oromia region. The variety was planted along with a standard check, Dursi, on plot size of 100m^2 each on 12 famers plots following recommended agronomic practices. The result of participatory evaluation conducted at maturity reveals that the new variety excelled the standard check in terms of both qualitative and quantitative parameters/criteria used to evaluate and select the varieties. Furthermore, the financial analysis revealed the highest net return from the new variety as compared to the standard check planted along with it. The farmers appreciated the new variety and showed keen interest for future large scale dissemination. Based on these facts, Jitu variety was recommended for further scale up and scale out of demo districts to other similar agro ecologies within the districts and beyond.

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Pre-extension Demonstration of Improved Finger millet Technology in selected Districts of East Wallaga and Buno Badalle Zones

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Abstract

The study was conducted in selected districts of western Oromia, during the 2020 main cropping season. The objective of the study was to demonstrate a recently released finger millet variety to the farmers in the study areas. A new variety (Kumsa) was planted along with a standard check (Bako-09) on 100 m^2 adjacent plots, adhering to all agronomic recommendations. Both qualitative and quantitative data were collected and analyzed for this study. At maturity, participatory variety evaluation was done using traits/criteria set by the farmers to select the best variety for future use. Disease resistance/ tolerance, grain yield performance, tillering capacity, number of fingers per head and seed colour were the first five most important criteria considered by the farmers in their order of importance. The new variety was ranked first on the basis these criteria and was selected as the first option for future use by the farmers. An independent sample t-test was used to analyze quantitative data, while qualitative data were analyzed and described qualitatively. The mean grain yield performance of the varieties (qt ha^{-1}) was 27.45±1.10 for Kumsa and 22.82±1.3 for Bako-09, respectively which is statistically significant ($p<0.01$). The new variety, exhibited a yield advantage of 20.29% over the standard check. The technology gap and technology index, for Kumsa (4.55 qt, 14.22% respectively) and for Bako-09(6.98 qt, 23.42% respectively) revealed more stability and feasibility of the new variety to the farmers. The financial analysis result has also showed that higher net gain (36612.8 ETB ha^{-1}) was recorded for Kumsa than for Bako-09(28.122.5 ETB ha^{-1}) witnessing more profitability of the new variety. The new variety, has consequently, met the farmers demand both in terms of qualitative and quantitative traits including financial benefits than the standard check. Thus, based on these facts, wider dissemination of the variety with its full package to the farmers in the study area and with similar agro-ecologies was recommended

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Key words: Bako-09, Kumsa; Participatory evaluation; Technology index; technology gap; variety

Introduction

Finger millet, (Eleusine coracana L.) Gaertn. ssp. coracana), is the second most widely grown millets on the continent of Africa and it is an important crop grown in low input farming systems by resource poor farmers in eastern and southern Africa (Damar et al., 2016). Being indigenous to the highlands of Uganda and Ethiopia, finger millet is widely produced by small scale landholders and consumed locally (Adugna et al., 2011). It is a climate-resilient crop with highly nutritious and antioxidant properties (Gupta et al., 2017). Finger millet is grown mainly by subsistence farmers in the drier regions of Africa and serves as a food security crop because of its high nutritional value, excellent storage qualities and as a low input-requiring crop (Dida et al., 2008).

It is extensively cultivated in the tropical and sub-tropical regions of Africa and India, and is known to save the lives of poor farmers from starvation at times of extreme drought (Kotschi, 2006). It is adapted to a wide range of environments and grown mainly by subsistence farmers and serves as a food security crop because of its high nutritional value and excellent storage qualities and its importance as a low input crop (Dida et al, 2007). In Ethiopia, finger millet, which is considered as a poor man's crop, is being grown by the rural poor farmers in marginal lands with low yielding potential, mainly in Amhara and Oromia regions (Adugna et al., 2011; Ayalew, 2015). Today, in response to increased drought and soil fertility degradation, a significant number of farmers in Ethiopia are opting for finger millet and, consequently the area under the crop is currently on significant increase.

According to CSA 2018/19, in Ethiopia cereals accounted for the largest share of grains in terms of both area and volume of production. The report of CSA, 2019 reveals that it accounted for 81.4 % of the total area of grain crops and 87.97 % of the total volume of production of the same. Finger millet, one of the cereals grown in the country accounted for 4.31 % and 3.73% of total area and volume of production of cereals for the same production season, respectively (CSA 2019). Its capacity to tolerate acidic soil conditions and thriving on low input has recently made the crop more preferable in mid and low land areas of western Oromia in general, and east Wollega in particular. Low grain yield due to lack of stable and high yielding varieties with disease resistance is a major problem constraining widespread cultivation and use of finger millets in Ethiopia (Dagnachew et al., 2015).

To curb this productivity bottle necks, developing and popularizing adaptable, stable, high yielding and disease resistant varieties is currently gaining due importance. Consequently, during the past two decades, significant effort has been made by the national and regional research programs to develop improved finger millet varieties and promote the technologies to the end users. More specifically, Bako agricultural research center (BARC) has been making tremendous efforts to release improved finger millet varieties to potential production areas under its mandates. Bako-09 variety was among those varieties recently released and recommended to suitable agro ecologies under BARC's mandate. As this variety excels the local variety by more than two-fold, demonstrating it to the farming communities to create awareness and availing options to the farmers is the first step in technology scaling up. This activity was therefore designed with the following objectives:

Objectives of the study

- To demonstrate and evaluate improved finger millet technologies;
- To evaluate the productivity and profitability of the technology under farmers' condition;
- To create awareness on the importance of the improved tef technologies;
- To collect feedback from the participants for further research design and the way for ward.

Methodology

Site and farmers' selection

A three-stage sampling was used to undertake the activity. In the first stage, four districts were purposively selected based on their accessibility and potentiality for finger millet production. On the second stage, one potential and representative farmers' Association (FA) was selected in each of the identified districts. Finally four hosting farmers were selected with the help of Development Agents (DAs) of the respective FAs selected earlier.

Accordingly, Boneya Boshe, Wayu Tuqa, Diga and Ilu Harar districts were used for the activity. In each district one FRG unit comprising of four hosting (experimenting) farmers and 11 follower farmers was established. As a result the activity was conducted on 16 farmers' plots that are willing to handle the activity, possess suitable plots to accommodate the trials, have plots nearer to main roads and willing to explain the activity to other farmers.

Stakeholders training

Following the establishment of FRGs and identification of hosting farmers, both theoretical and practical training was given to farmers, Development Agents and experts of the respective districts. The training covered areas such as finger millet production, management, and post harvest procedures including seed quality maintenance. The aim of training was to enhance awareness of farmers, Development Agent and district experts on improved finger millet production technologies.

Stakeholders Responsibility Sharing

The success of the current work and the guarantee for the successive works ahead cannot be exclusively handled by the researchers alone. Consequently, identification of key stakeholders and making agreement on roles and responsibilities was an essential part of the activity. On this basis, the following four stakeholders, FRG member farmers, researchers, Development Agents and district agricultural experts were identified and shared roles and responsibilities. List of the stakeholders, their roles and responsibilities is depicted in Table 1.

Table 1. Stakeholders' roles and responsibilities

Actors	**Their role and responsibility**
Farmers	• Providing land free of rents • Provide Labor for all field activities(land preparation, planting, weeding, harvesting and threshing) • Follow up of the activities • Evaluate and select the best variety/ies
Researchers	• 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 • Farmer selection and group (FRG) formation. • Writing useful information produced from the technology demonstration
District experts	• Organizing farmers in group with cooperative office • Organizing training for farmers • Organizing field days and experience sharing forum among the GRGs and other farmers • Coordinating all the field activities
Development Agents	• Select appropriate field • Select appropriate farmers • Collaborate in FRG formation • Follow up the FRGs and the fields • Communicate with researchers about status of the field • Collaborate organizing field visits/ field days

Treatments

One newly released improved finger variety (**Kumsa**) was planted along with a standard check (Bako-09) each on 100 m^2 adjacent plots. A seed rate of 15 kg ha^{-1} was used while fertilizer was applied at the rate of 105 kg ha^{-1}, and 65 kg ha^{-1} for NPS and urea, respectively. An inter-row spacing of 40 cm was used and planting was done by drilling. These treatments were replicated by the number of hosting farmers in each district. The fields were periodically supervised to check the status and identify gaps.

Data collection

Both qualitative and quantitative data were collected for this activity. The quantitative data collected includes yield data, total number of farmers participated on training, total number of farmers, DAs and district experts participated on field visits, trainings, costs of production and income accrued to the farmers. Farmers' perception on the attribute of the technology was the qualitative data collected for the study.

Data analysis

Quantitative data were subjected to SPSS software and were analyzed using simple descriptive statistics such as mean and standard deviation (SD). An independent sample t- test was used to analyze mean, to check if there is significant grain yield difference between the two varieties. Qualitative data were analyzed and qualitatively narrated. Besides; score ranking technique was used to evaluate and select best bet variety/ies and /or technology/gies and to rank their criteria and parameters according to real situation of the area. Finally, gross margin analysis was done to identify costs of production and net gain accrued to the farmers under consideration. Gross margin analysis is very useful in a situation where fixed capital forms a negligible portion of production. It is the difference between gross income and the total variable cost (Mohammed *et.al*, 2016). Furthermore; technology gap and technology index were calculated using the following formula.

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

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

Results and Discussions

Training of farmers, Experts and DAs

Stakeholders participated on finger millet production and management across the districts is depicted in (Table 6). As indicated in the table, a total of 112 participants from the four districts have taken part in the training. Accordingly, 12 district experts, 16 DAs, 4 supervisors, and 80 farmers took the training.

Table 9: Stakeholders training participants by district and gender

Participants	Districts				Total
	Boneya Boshe	Wayu Tuqa	Diga	Ilu Harar	
Experts	3	3	3	3	12
DAs	4	4	4	4	16
Supervisors	1	1	1	1	4
Farmers	20	20	20	20	80
Total	27	27	27	27	112

Field Visit/Mini field days

Field visit was also arranged across the districts so as to evaluate/select best performing varieties, to enhance farmers' knowledge on teff production and management and to collect feedback from all relevant stakeholders' for further way forward. On the field visit event organized a total of 120 participants; 92 (75 M and 17 F) farmers, 16 (14 M and 2 F) DAs and Supervisors and 12 (11 M and 1 F) agricultural experts participated across the districts.

Table 10. Participants of mini field day by district and gender

Participants	Number of participants		
	Male	Female	Total
Experts	9	3	12
DAs	12	4	16
Farmers	75	17	92
Total	96	24	120

Results of variety evaluation

Despite many informal evaluations made at different plant growth stages, final joint evaluation was done when the crop was at its maturity stage. Accordingly, mini field day was arranged in which FRG member farmers, neighboring farmers, researchers, DAs and district experts participated. This was a special platform for participatory variety evaluation and selection accompanied by acquainting other farmers with the technologies. At this platform farmers and researchers listed evaluation criteria at random, which was then ordered using pair-wise technique. The evaluation criteria were ordered in an ascending order in which the trait with highest score was ranked 1st, and was considered as the most important criteria, while the least score denotes criteria of lower importance in the order.

Each variety was evaluated against the ordered criteria. Accordingly; FRG members scored each variety for individual traits they considered important. For each measurable traits ranking was done on a scale of 1-5units, 1 being very poor and 5 being the highest score representing superiority. At the end of the evaluation process, result of the evaluation was displayed to the evaluators, and discussion was made on the way ahead. The variety/ies selected, accordingly, were proposed for further scaling up. The evaluation criteria suggested by the participating farmers at random were grain yield performance, disease tolerance; early maturity, lodging tolerance; number of fingers per head; seed color; seed size; tillering capacity and finger length. Based on the overall mean score most preferred variety was evaluated and selected. Accordingly; in all the districts, based on overall mean score and rank, Kumsa was selected first in all of its traits where Bako-09 was selected on the second position.

Pair wise ranking of varietal traits

At maturity farmers were invited to evaluate and rank the varieties on the basis of the most important criteria/traits that enable them to select best variety from all the demonstrated varieties. At outset they were helped to jot down their selection criteria at random. Then the farmers evaluated the varieties' traits against the ordered criteria. Pair-wise ranking technique was used to order the criteria on the basis of the weight attached. Disease tolerance, early maturity, lodging tolerance, number of fingers per head, seed color, seed size, tillering

capacity, finger length and grain yield were the most important criteria considered to select finger millet varieties (Table 2).

As indicated in (Table 2), disease resistance/ tolerance, grain yield performance, tillering capacity, number of fingers per head and seed colour were the first five most important criteria considered by farmers in their order of importance. This indicates that these criteria are the traits that researchers should seriously consider for future breeding design and way forward to develop farmer preferred variety/ ies. Of the listed criteria/ traits, early maturity received less attention for selection of varieties. This is mainly because in Western Oromia the intensity and distribution of rain fall may not be a problem. During the course what have been learnt was that the farmers' selection criteria are beyond yield and most of the farmers gave priority for qualitative traits such as resistance to disease- pest, lodging tolerance and seed color (marketability) of the varieties.

Table 2: Pair-wise matrix ranking format for finger millet varieties

Criteria	1	2	3	4	5	6	7	8	9	Freq.	Rank
1		1	1	1	1	1	1	1	1	8	1st
2			3	4	5	6	7	8	9	0	9
3				4	3	6	7	8	9	2	6th
4					4	4	7	4	9	5	4th
5						5	7	5	9	3	5th
6							7	6	9	3	5th
7								7	9	6	3rd
8									9	2	6th
9										7	2nd

NB: 1-9= Farmers' selection criteria: 1= Disease Tolerance; 2= Early Maturity; 3= Lodging Tolerance; 4= No of fingers per head; 5= Seed color; 6= Seed size; 7= Tillering capacity; 8= finger length; 9= Yield

Varietal score ranking

Varietal score ranking of the varieties across locations is depicted in (Table 3). According to the collective ranking, the highest score was recorded for Kumsa variety, 4.75, followed by Bko-09 (3.8).Consequently, Kumsa variety was ranked as the first option in all of the locations followed by Bko-09. Apart from the aforementioned criteria, farmers were highly attracted to the straw biomass mass and higher leaf to stem ratio of Kumsa variety which are expressed in many ways. This trait is important to farmers as they can use it for dry season feed for animals, as a thatched roof for houses and plastering of walls as an alternative to teff straw. On the contrary, Bako-09 is very stemmy and has low leaf to stem ratio which are not suitable for animal feed and wall plastering. However Bako-09 was found to excel Kumsa in its finger size and early maturity, even though the later criterion was the less considered criteria in this case. Except for finger size and early maturity farmers selected Kumsa variety as a best because of its ability to tolerate major finger millet diseases, desirable seed color, number of fingers per head, finger length, number of tillers per plant and marketability.

Table 3: Varietal score ranking in the respective locations

variety	Bilo Boshe			Wayu Tuqa			Diga			IluHara r		Overall mean	Overall rank
	To tal	M ea	Ra	To tal	M ea	Rank	To tal	M ea	Ra	To tal sc	M ea		
Kumsa	44	4.89	1st	42	4.67	**1st**	43	4.78	**1st**	42	4.67	4.75	**1st**
Bako-09	37	4.11	2nd	36	4	**2nd**	33	3.67	2nd	37	4.11	3.8	**2nd**

Table 4: Varietal ranking based on farmers' selection criteria

No	Varieties	Rank	Reasons for selection
1	Kumsa	**1st**	Higher disease tolerant, Higher yielder, many tillers, many fingers
2	Bko-09	**2nd**	Disese tolerant, Moderate yielder, few tillers, relatively less fingers , good color

Grain yield performance of the varieties

The combined grain yield performance of the varieties demonstrated is summarized in (Table 5). Accordingly; a mean grain yield of 27.45 ±1.90 qt ha^{-1} and 22.82 ±0.94 qt ha^{-1}, respectively was recorded for Kumsa and Bako-09 varieties. The mean grain yield difference between the two varieties (4.64) is statistically significant ($P<0.01$). The variability in yield performance might have stemmed from difference in the status of soil fertility, and variability in rainfall intensity and pattern that slightly differs between locations.

Table 5: Mean yield of teff varieties across the districts

Variety	N	Mean	SD	Min	Max	**P**
Kumsa	11	27.45±1.10	6.3	21	32	0.01
Bako-09	11	22.82±1.3	6.4	20	28	
Difference		4.64				

Yield Advantage

Calculating yield advantage of the varieties helpful to reveal the extra benefit in percentage that the farmers obtained from producing improved variety. Additionally, it is used to make recommendations based on the relative yield advantage of the demonstrated variety/ies over the commercial check. Accordingly, Kumsa variety exhibited a yield advantage of 20.29% over Bako-09. Yield advantage is calculated using the following formula:

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

$$= \frac{27.45 \text{ qt ha}^{-1} - 22.82 \text{ qt ha}^{-1}}{22.82 \text{ qt ha}^{-1}} \times 100 = 20.29\%$$

Technology gap and Technology index

Technology gap indicates the gap in the demonstration yield over potential yield. The observed technology gap is attributed to dissimilarities in fertility, acidity, rainfall and other natural calamities. The yield gaps can be further categorized into technology index which is used to show the feasibility of the variety at the farmer's field. The lower the values of technology index the more the feasibility of the varieties. Accordingly, the technology gap and index of demonstrated varieties were calculated using the underlying formulas and presented in below table.

Technology gap = Potential yield (qt ha^{-1}) - Demonstration yield (qt ha^{-1})

Technology gap for Kumsa= 32-27.45= 4.55 qt

Technology gap for Bako-09= 29.8 qt ha^{-1}-22.82 ha^{-1} = 6.98 qt

Technology gap:

The technology gap for the two varieties was calculated as shown above and was summarized in (Table 6). As can be seen from the table, the technology gap for the varieties was 4.55 qt and 6.98 qt, for Kumsa and Bako-09, respectively. Comparing the two varieties for this parameter, the gap is a bit higher for Bako-09 as compared to the new variety (Kumsa), though the gap is not significantly wider. This indicates that the relatively lower gap was observed on Kumsa variety which in turn shows the demonstration yield is very close to the potential yield. This might be due to the fact that the standard check was under production and the consequential contamination (impurity) which is one factor, among others, that contribute to yield reduction.

Technology index:

The demonstrated grain yield performance of the two varieties and their respective potential yield were compared to estimate the yield gaps which were further categorized in to technology index. The technology index for the two varieties was calculated as indicated below and was summarized in (Table 6). The result shows that the value was 14.22 for Kumsa (the new variety) while it were 23.42 for the standard check (Bako-09). The average value of the index (18.82 %) reveals that the varieties are feasible to the farmers in the study area and other similar agro-ecologies. However, as lower value of the index denotes more feasibility of the technology to farmers, it can be learned that it is more feasible to produce Kumsa variety than to produce Bako-09 under farmers' condition.

$$\text{Technology index} = \frac{\text{Potential yield (qt ha}^{-1}) - \text{Demonstration yield (qt ha}^{-1})}{\text{Potential yield}} * 100$$

$$\text{Technology index for Bako-09} = \frac{(29.8 \text{ qt ha}^{-1} - 22\text{-}82 \text{ qt ha}^{-1})}{29.8 \text{ qt ha}^{-1}} * 100 = 23.42$$

$$\text{Technology index for Kumsa} = \frac{(32 - 27.45)}{32} * 100 = 14.22$$

Table 6. Yield advantage, technology gap and technology index of the varieties

Variety	Potential yield (qt ha^{-1})	Demo yield (qt ha^{-1})	Technology gap (qt)	Technology Index (%)	Yield advantage (%)
Kumsa	32	27.45	4.55	14.22	20.29
Bako-09	29.8	22.82	6.98	23.42	
Average				18.82	

Financial analysis

Here, costs and revenues were calculated using ETB, which is Ethiopian currency named Ethiopian Birr. One ETB, as of 10/28/2021 was 0.021USD. In terms of profitability and returns that could be gained from each of the varieties, financial analysis result of the study was summarized and presented in (Table 7). On average a net gain/profit of 36612.8 ETB ha^{-1} and 28122.5ETB ha^{-1} were gained from Kumsa and Bako-09 varieties, respectively. Consequently, return on investment (RIO) was higher (2.7) compared to that of Bako-09(2.08). As can be seen from (Table 8) variety wise analysis reveals that the highest profit was gained from producing Kumsa variety as compared to producing Bako-09 variety. The result of variety wise financial analysis, as depicted in (Table 8) reveals that farmers could gain an additional 8490.3 ETB while they produced Kumsa variety.

On the basis of the new variety (Kumsa), location wise analysis indicates that the highest average net gain (48970.6 ETB ha^{-1}) was accrued to the farmers at Boneya Boshe, while the least average gain per hectare was accrued to the farmers at Diga (27440 ETB ha^{-1}). The lowest gain for the farmers at this site was due to the relatively low performance the demonstrated variety exhibited at this specific location reducing the total revenue accrued from sale of the variety.

At Wayu Tuqa, both the varieties performed almost similarly, but the productivity of the new variety was relatively lower than the standard check resulting in a lower gain (-1219.4 ETB) between producing Kumsa and the standard check (Bako-09), while the gain difference for the two varieties was the highest (18500.6 ETB) for Boneya Boshe. One can learn from the financial analysis that the demonstrated variety (Kumsa) exhibited better yield performance, hence greater net gain/ better return on investment for the producers, on average.

Table 7: Financial analysis for the varieties across the districts

parameters	**B.Boshe**		**Wayu Tuqa**		**Diga**		**Ilu Harar**	
	Kumsa	**Bako-09**	**Kumsa**	**Bako-09**	**Kumsa**	**Bako-09**	**Kumsa**	**Bako-09**
Yield qt/ha (Y)	34.33	24	29.33	30	22.5	19.5	24	18
Price(P) per quintal	1820	1820	1820	1820	1820	1820	1820	1820
Total Revenue (TR) = TR = Y*P	62480.6	43680	53380.6	54600	40950	35490	43680	32760
Variable costs								
Seed cost	3000	3000	3000	3000	3000	3000	3000	2510
Fertilizer cost	2510	2510	2510	2510	2510	2510	2510	2510
Labor cost	4000	4000	4000	4000	4000	4000	4000	4000
Total Variable	10510	10510	10510	10510	10510	10510	10510	10510
Fixed costs								
Cost of land	3000	3000	3000	3000	3000	3000	3000	3000
Total fixed	3000	3000	3000	3000	3000	3000	3000	3000
Total cost (TC) =	**13510**	**13510**	**13510**	**13510**	**13510**	**13510**	**13510**	**13510**
Gross Margin (GM)=TR-	51970.6	33170	42870.6	44090	30440	24980	33170	22250
Profit=GM-	**48970.6**	**30170**	**39870.6**	**41090**	**27440**	**21980**	**30170**	**19250**
Return on vestment	**3.62**	**2.23**	**2.95**	**3.04**	**2.03**	**1.63**	**2.23**	**1.42**

NB: all costs and incomes were calculated in ETB (Ethiopian Birr); 1 ETB=0.021USD

Table 8. Variety wise comparison of net gain across locations (in ETB)

B.Boshe			**Wayu Tuqa**			**Diga**			**Ilu Harar**		
Gain (K)	Gain (B)	Diff.	Gain (K)	Gain (B)	Diff.	Gain (K)	Gain (B)	Diff.	Gain (K)	Gain (B)	Diff.
48970.6	30170	**18500.6**	39870.6	41090	-1219.4	27440	21980	**5460**	30170	**19250**	10920

Gain (K): Net gain from Kumsa; Gain (B) = Net gain from Bako-09; Diff. Difference in gain

ETB= Ethiopian Birr i.e.; 1 ETB= 0.02113647

Training of farmers, Experts and DAs

Stakeholders participated on finger millet production and management across the districts is depicted in (Table 6). As indicated in the table, a total of 112 participants from the four districts have taken part in the training. Accordingly,12 district experts, 16 DAs , 4 supervisors, and 80 farmers took the training.

Table 9: Stakeholders training participants by district and gender

Participants	Districts				Total
	Boneya Boshe	Wayu Tuqa	Diga	Ilu Harar	
Experts	3	3	3	3	12
DAs	4	4	4	4	16
Supervisors	1	1	1	1	4
Farmers	20	20	20	20	80
Total	27	27	27	27	112

Field Visit/Mini field days

Field visit was also arranged across the districts so as to evaluate/select best performing varieties, to enhance farmers' knowledge on teff production and management and to collect feedback from all relevant stakeholders' for further way forward. On the field visit event organized a total of 120 participants; 92 (75 M and 17 F) farmers, 16 (14 M and 2 F) DAs and Supervisors and 12 (11 M and 1 F) agricultural experts participated across the districts.

Table 10. Participants of mini field day by district and gender

Participants	Number of participants		
	Male	Female	Total
Experts	9	3	12
DAs	12	4	16
Farmers	75	17	92
Total	96	24	120

Farmers' perception of the varieties

The farmers have appreciated the selected finger millet variety for the following merits; perceived better yielder than the commercial varieties, perceived better resistance to disease, perceived better Seed color, tillering capacity and marketability. Apart from these traits the farmers liked the higher biomass and leaf to stem ratio of the improved variety (Kumsa) that is an important characteristics as a dry season animal feed and other benefits like thatching roof making and plastering materials in some of the locations more specifically the low land areas of Diga district. Following this selection, the farmers showed their demand so that the variety would be used for wider scaling up next season.

Conclusions and recommendations

The current study aimed at demonstrating a recently released improved finger millet variety, Kumsa to farmers in selected districts of western Oromia region. The variety was planted along with a standard check, Bako-09; on plot size of 100m^2 each on 16 famers plots following recommended agronomic practices. The result of participatory evaluation conducted at maturity reveals that the new variety excelled the standard check in terms of both qualitative and quantitative parameters/criteria used to evaluate and select the varieties. Furthermore, the financial analysis revealed the highest net return from the new variety as compared to the standard check planted along with it. The farmers appreciated the new variety and showed keen interest for future large scale dissemination. Based on these facts, Kumsa variety was recommended for further scale up and scale out of demo districts to other similar agro ecologies within the districts and beyond.

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Participatory Demonstration and Evaluation of Improved Finger millet Technologies in selected Districts of East Wollega Zones

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Abstract
The study was conducted in Boneya Boshe, Wayu Tuqa, and Diga districts of western Oromia, during the 2020 main cropping season. The objective of the study was to demonstrate a recently released finger millet variety to the farmers in the study areas. A new variety (Bako-09) was planted along with standard checks (Gute and Gudetu) on 100 m^2 adjacent plots, adhering to breeder recommendations. Both qualitative and quantitative data were collected and analyzed for this study. At maturity, participatory variety evaluation was done using qualitative and quantitative traits/criteria set by the farmers to select the best variety for future use. Disease resistance/ tolerance, grain yield performance, tillering capacity, number of fingers per head and seed colour were the first five most important criteria considered by the farmers in their order of importance. The new variety was ranked first on the basis these criteria and was selected as the first option for future use by the farmers. An independent sample t-test was used to analyze quantitative data, while qualitative data were analyzed and described qualitatively. The mean grain yield performance of the varieties (qt ha^{-1}) was 24.73 ±1.05, 20.23±0.73 and18.36 ±0.34 for Bako-09, Gute and Gudetu, respectively which is statistically significant ($p<0.01$). The new variety, exhibited a yield advantage of 22.24% and 34.7%, respectively over Gute and Gudetu varieties. The technology gap and technology index for Bako-09 were 5.07 qt and 17.01%, respectively while the values for Gute and Gudetu were 14.77 qt and 42.2%; 4.4 qt and 20.17 %, respectively, witnessing more stability and feasibility of the new variety to the farmers. The result of financial analysis revealed that the net gain of 31755.83 ETB, 24073.33 ETB and 20672.5 ETB were accrued from Bako-09, Gute and Gudetu varieties, respectively. Thus, based on these facts, the new variety was recommended for further scaling up in the study area and areas with similar agro-ecological conditions.

Key words: Bako-09, ETB; Kumsa; Participatory evaluation; Technology index; Technology gap; Variety

Introduction

Finger millet, (Eleusine coracana L.) Gaertn. ssp. coracana), is the second most widely grown millets on the continent of Africa and it is an important crop grown in low input farming systems by resource poor farmers in eastern and southern Africa (Damar et al., 2016). Being indigenous to the highlands of Uganda and Ethiopia, finger millet is widely produced by small scale landholders and consumed locally (Adugna et al., 2011). It is a climate-resilient crop with highly nutritious and antioxidant properties (Gupta et al., 2017). Finger millet is grown mainly by subsistence farmers in the drier regions of Africa and serves as a food security crop because of its high nutritional value, excellent storage qualities and as a low input-requiring crop (Dida et al., 2008).

It is extensively cultivated in the tropical and sub-tropical regions of Africa and India, and is known to save the lives of poor farmers from starvation at times of extreme drought (Kotschi, 2006). It is adapted to a wide range of environments and grown mainly by subsistence farmers and serves as a food security crop because of its high nutritional value and excellent storage qualities and its importance as a low input crop (Dida et al, 2007). In Ethiopia, finger millet, which is considered as a poor man's crop, is being grown by the rural poor farmers in marginal lands with low yielding potential, mainly in Amhara and Oromia regions (Adugna et al., 2011; Ayalew, 2015). Today, in response to increased drought and soil fertility degradation, a significant number of farmers in Ethiopia are opting for finger millet and, consequently the area under the crop is currently on significant increase.

According to CSA 219, in Ethiopia cereals accounted for the largest share of grains in terms of both area and volume of production. The report of CSA, 2019 reveals that it accounted for 81.4 % of the total area of grain crops and 87.97 % of the total volume of production of the same. Finger millet, one of the cereals grown in the country accounted for 4.31 % and 3.73% of total area and volume of production of cereals for the same production season, respectively (CSA 2019). Its capacity to tolerate acidic soil conditions and thriving on low input has recently made the crop more preferable in mid and low land areas of western Oromia in general, and east Wollega in particular. Low grain yield due to lack of stable and high yielding varieties with disease resistance is a major problem constraining widespread cultivation and use of finger millets in Ethiopia (Dagnachew et al., 2015).

To curb this productivity bottle necks, thus, developing and popularizing adaptable, stable, high yielding and disease resistant varieties is currently gaining due importance. Consequently, during the past two decades, significant effort has been made by the national and regional research programs to develop improved finger millet varieties and promote the technologies to the end users. More specifically, Bako agricultural research center (BARC) has been making tremendous efforts to release improved finger millet varieties to potential production areas under its mandates. Bako-09 variety was among those varieties recently released and recommended to suitable agro ecologies under BARC's mandate. As this variety excels the local variety by more than two-fold, demonstrating it to the farming communities to create awareness and availing options to the farmers is the first step in technology scaling up. This activity, thus, was designed with the following objectives:

Objectives of the study

- To demonstrate and evaluate improved tef technologies;
- To evaluate the productivity and profitability of the technology under farmers' condition;
- To create awareness on the importance of the improved tef technologies;
- To collect feedback from the participants for further research design and the way for ward.

Methodology

Site and farmer selection

A three-stage sampling was used to undertake the activity. In the first stage, three districts were purposively selected based on their accessibility and potentiality for finger millet production. On the second stage, one potential and representative farmers' Association (FA)

was selected in each of the identified districts. Finally four hosting farmers were selected with the help of Development Agents (DAs) of the respective FAs selected earlier. Accordingly, Boneya Boshe, Wayu Tuqa and Diga districts were used for the activity. In each district one FRG unit comprising of 4 hosting farmers and 11 follower farmers was established and managed. Accordingly, a total of 12 hosting farmers were selected and participated on the activity.

Stakeholders training

Following the establishment of FRGs and identification of hosting farmers, both theoretical and practical training was given to farmers, Development Agents and experts of the respective districts. The training covered areas such as finger millet production, management, and post harvest procedures including seed quality maintenance. The aim of training was to create awareness of farmers, Development Agent and district experts on improved finger millet technologies.

Stakeholders responsibility sharing

The success of the current work and the guarantee for the successive works ahead cannot be exclusively handled by the researchers alone. Consequently, identification of key stakeholders and making agreement on roles and responsibilities was an essential part of the activity. On this basis, the following four stakeholders, FRG member farmers, researchers, Development Agents and district agricultural experts were identified and shared roles and responsibilities. List of the stakeholders, their roles and responsibilities is depicted in Table 1.

Table 1. Stakeholders' Roles and Responsibilities

Actors	**Their role and responsibility**
Farmers	• Providing land free of rents • Provide Labor for all field activities(land preparation, planting, weeding, harvesting and threshing) • Follow up of the activities • Evaluate and select the best variety/ies
Researchers	• 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 • Farmer selection and group (FRG) formation. • Writing useful information produced from the technology demonstration
District experts	• Organizing farmers in group with cooperative office • Organizing training for farmers • Organizing field days and experience sharing forum among the GRGs and other farmers • Coordinating all the field activities
Development Agents	• Select appropriate field • Select appropriate farmers • Collaborate in FRG formation • Follow up the FRGs and the fields • Communicate with researchers about status of the field • Collaborate organizing field visits/ field days

Treatments

One newly released improved finger variety (**Bako-09**) was planted along with two standard checks (Gudetu and Gute) on 100 m^2 adjacent plots each. A seed crate of 15 kg ha^{-1} was used while fertilizer was applied at the rate of 105 kg ha^{-}, and 65 kg ha^{-1} for NPS and urea, respectively. An inter-row spacing of 40 cm was used and planting was done by drilling. The fields were periodically supervised to check the status and identify gaps.

Data type and Methods of Data collection

Both qualitative and quantitative data were collected for this activity. Data for this study were collected through direct observation (measurement) and individual farmers interview. The quantitative data collected includes yield data, total number of farmers participated on training, total number of farmers, DAs and district experts participated on field visits, trainings, costs of production and income accrued to the farmers. Farmers' perception on the attribute of the technology was the qualitative data collected for the study.

Data analysis

Quantitative data were subjected to SPSS software and were analyzed using simple descriptive statistics such as mean and standard deviation (SD). An independent sample t- test was used to analyze mean, to check if there is significant yield difference between the two varieties. Qualitative data were summarized using narrative explanations. Besides; score ranking techniques was used to evaluate and select best bet variety/ies and /or technology/gies and to rank their criteria and parameters according to real situation of the area. Finally, gross margin analysis was done to calculate profitability of the new variety. The gross margin analysis is very useful in a situation where fixed capital forms a negligible portion of production. It shows the difference between gross income and the total variable cost (Mohammed *et.al*, 2016). Furthermore; technology gap and technology index e were calculated using the following formula.

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

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

Results and Discussions

Training of farmers, Experts and DAs

Stakeholders participated on finger millet production and management across the districts is depicted in (Table 6). As indicated in the table, a total of 84 participants from the four districts have taken part in the training. Accordingly, 9 district experts, 12 DAs, 3 supervisors, and 60 farmers took the training.

Table 9: Stakeholders training participants by district and gender

Participants	Boneya Boshe	Wayu Tuqa	Diga	Total
Experts	3	3	3	9
DAs	4	4	4	12
Supervisors	1	1	1	3
Farmers	20	20	20	60
Total	28	28	28	84

DAs= Development Agents

Field Visit/Mini field days

Field visit was arranged across the districts so as to evaluate/select best performing varieties, to enhance farmers' knowledge on teff production and management and to collect feedback from all relevant stakeholders' for further way forward. A total of 113 participants; 92 farmers (75 M and 17 F), 12 DAs and Supervisors (8 M and 4 F) and 12 agricultural experts (10 M and 2 F) were participated in the field visit.

Table 10. Participants of mini field day by district and gender

Participants	Participants		
	Male	Female	Total
Experts	6	3	9
DAs	8	4	12
Farmers	75	17	92
Total	89	24	113

DAs= Development Agents

Results of variety evaluation

Productivity trait is an important but not the only criteria farmers consider for evaluating and selecting a given variety from available options. Farmers also consider other qualitative traits putting grain yield performance at the center. Cognizant of this fact, listening to the farmers to elicit these qualitative traits is winning the attention of researchers that in turn helps looking for technological options that suits the needs of the farming community. Despite many informal evaluations made at different plant growth stages, final joint evaluation was done when the crop was at its maturity stage.

Accordingly, mini field day was arranged in which FRG member farmers, neighboring farmers, researchers, DAs and district experts participated. This was a special platform for participatory variety evaluation and selection accompanied by acquainting other farmers with the technologies. At this platform farmers and researchers listed evaluation criteria at random, which was then ordered using pair-wise technique. The evaluation criteria were ordered in such a way that the trait with highest score was ranked 1st, and was considered as the most important criteria, while the least score denotes criteria of lower importance in the order. Each variety was then evaluated against the ordered criteria.

Accordingly; FRG members scored each variety for individual traits they considered important. For each measurable traits ranking was done on a scale of 1-5units, 1 being very poor and 5 being the highest score representing superiority. At the end of the evaluation process, result of the evaluation was displayed to the evaluators, and discussion was made on the way ahead. The variety/ies selected, accordingly, were proposed for further scaling up. The evaluation criteria suggested by the participating farmers at random were grain yield performance, disease tolerance; early maturity, lodging tolerance; number of fingers per head; seed color; seed size; tillering capacity and finger length.

Based on the overall mean score most preferred variety was evaluated and selected. Accordingly, in all the districts, Bako-09 was selected first followed by Gute and finally Gudetu where Bako-09 was selected on the second position. Selection criteria was based on a ranking scale from 1-5, with 1representing important to 5 implying the least important.

Pair-wise ranking of varietal traits

Pair-wise ranking technique was used to order the criteria on the basis of the weight attached to the criteria. Disease tolerance, early maturity, lodging tolerance, number of fingers per head, seed color, seed size, tillering capacity, finger length and grain yield were considered to select finger millet varieties (Table 2). Among the criteria, disease resistance/ tolerance, grain yield performance, tillering capacity, number of fingers per head and seed colour were the first five most important criteria considered by farmers in their order of importance.

This indicates that these criteria are the traits that researchers should seriously consider for future breeding design and way forward to develop farmer preferred variety/ ies. Of the listed criteria/ traits, early maturity received less attention for selection of varieties. This is mainly because in Western Oromia the intensity and distribution of rain fall may not be a problem. During the course what have been learnt was that the farmers' selection criteria are beyond yield and most of the farmers gave priority for qualitative traits such as resistance to disease-pest, lodging tolerance and seed color (marketability) of the varieties.

Table 2: Pair-wise matrix ranking format for finger millet varieties

Criteria	1	2	3	4	5	6	7	8	9	Freq.	Rank
1		1	1	1	1	1	1	1	1	8	1st
2			3	4	5	6	7	8	9	0	9
3				4	3	6	7	8	9	2	6th
4					4	4	7	4	9	5	4th
5						5	7	5	9	3	5th
6							7	6	9	3	5th
7								7	9	6	3rd
8									9	2	6th
9										7	2nd

NB: 1-9= Farmers' selection criteria: 1= Disease Tolerance; 2= Early Maturity; 3= Lodging Tolerance; 4= No of fingers per head; 5= Seed color; 6= Seed size; 7= Tillering capacity; 8= finger length; 9= Yield

Varietal score ranking

Varietal score ranking of the varieties across locations is depicted in (Table 2). According to the collective ranking, the highest score, (4.65) was recorded for Bako-09 variety followed by Gute (3.91) and Gudetu (3.89).Consequently, Bako-09 variety was ranked as the first option in all of the locations followed by Gute and finally Gudetu variety.

Table 3: Varietal score ranking in the respective locations

variety	Bilo Boshe			Wayu Tuqa			Diga			Over all mean	Overall rank
	Total	Mea	Rank	Total	Mea	Rank	Total	Mea	Rank		
Bako-09	42.3	4.7	1st	42	4.67	**1st**	43	4.59	**1st**	4.65	1st
Gute	36.6	4.07	2nd	36	4	**2nd**	33	3.67	2nd	3.91	2nd
Gudetu	36.6	4.	2nd	36	4	**2nd**	33	3.67	2nd	3.89	2nd

Table 4: Varietal ranking based on farmers' selection criteria

No	Varieties	Rank	Reasons
1	Bako-09	**1st**	Higher disease tolerant, Higher yielder, many tillers, many fingers
2	Gute	**2nd**	Disese tolerant, Moderate yielder, few tillers, relatively less fingers , good color
3	Gudetu		Moderately disease tolerant, low yielder, fewer tillers, relatively less fingers , good color

Grain yield performance of the varieties

The combined grain yield performance of the varieties demonstrated is summarized in (Table 5) below. Accordingly; a mean grain yield of 24.73±1.05 qt ha^{-1}, 20.7± 0.73 qt ha^{-1} and 18.36 ± 0.34, was recorded for Bako-09, Gute and Gudetu varieties, respectively. The mean grain yield difference between the three varieties is statistically significant ($P < 0.01$). Accordingly, Bako-09 was found to be the highest followed by Gute with regard to grain performance. The variability in yield performance might have stemmed from difference in the status of soil fertility, and variability in rainfall intensity and pattern that slightly differs between locations.

Table 5: Mean grain yield performance of the varieties across the districts

Variety	N	Mean grain yield	SD	Min	Max	**P**
Bako-09	11	24.73±1.05	3.5	20	30	0.001
Gute	11	20.23±0.73	2.41	18	26	
Gudetu	11	18.36 ±0.34	1.12	17	20	

Yield Advantage

Calculating yield advantage of the varieties helpful to reveal the extra benefit in percentage that the farmers obtained from producing improved variety. Additionally, it is used to make recommendations based on the relative yield advantage of the demonstrated variety/ies over the commercial check. The result from yield advantage calculation reveals that the new variety (Bako-09) had a yield advantage of 22.24% and 34.7% over Gute and Gudetu varieties, respectively.

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

$$\text{Over Gute} = \frac{24.73 \text{ qt ha}^{-1} - 20.23\text{qt ha}^{-1}}{20.23\text{qt qt ha}^{-1}} \times 100 = 22.24\%$$

$$\text{Over Gudetu} = \frac{24.73 \text{ qt ha}^{-1} - 18.36 \text{ qt ha}^{-1}}{18.36 \text{ qt ha}^{-1}} \times 100 = 34.7\%$$

Technology gap and Technology index

Technology gap indicates the gap in the demonstration yield over potential yield. The observed technology gap is attributed to dissimilarities in fertility, acidity, rainfall and other natural calamities. The yield gaps can be further categorized into technology index which is used to show the feasibility of the variety at the farmer's field. The lower the values of technology index the more the feasibility of the varieties. Accordingly, the technology gap and index of demonstrated varieties were calculated using the underlying formulas and presented in below table.

Technology gap = Potential yield (qt ha^{-1}) - Demonstration yield (qt ha^{-1})

Technology gap for Bako-09= 29.8- 24.73= 5.07 qt

Technology gap for Gute= 35-20.23= 14.77 qt

Technology gap for Gudetu= 23-18.36=4.4 qt

Technology gap:

The technology gap for the three varieties was calculated as shown above and was summarized in (Table 6). As can be seen from the table, the technology gap for the varieties was 5.07 qt, 14.77 qt and 4.4 qt, for Bako-09, Gute and Gudetu varieties, respectively. Comparing the three varieties for this parameter, the gap is relatively higher for Gute as compared to the Bako-09 and Gudetu varieties. This indicates that the relatively lower gap was observed on Gudetu and Bako-09 variety which in turn shows the demonstration yield is very close to the potential yield for these two. This might be due to the fact that the Gute variety was under production for longer time with likely consequential contamination (impurity) which is one factor, among others, that contribute to yield reduction.

Technology index:

The demonstrated grain yield performance of the two varieties and their respective potential yield were compared to estimate the yield gaps which were further categorized in to technology index. The technology index for the two varieties was calculated as indicated below and was summarized in (Table 6). The result shows that the value was 14.22 for Kumsa (the new variety) while it were 23.42 for the standard check (Bako-09). The average value of the index (18.82 %) reveals that the varieties are feasible to the farmers in the study area and other similar agro-ecologies. However, as lower value of the index denotes more feasibility of the technology to farmers, it can be learned that it is more feasible to produce Kumsa variety than to produce Bako-09 under farmers' condition.

$$\text{Technology index (\%)} = \frac{\text{Potential yield (qt ha}^{-1}) - \text{Demonstration yield (qt ha}^{-1})}{\text{Potential yield}} * 100$$

$$\text{Technology index for Bako-09} = \frac{(29.8 \text{ qt ha}^{-1} - 24.73 \text{ qt ha}^{-1})}{29.8 \text{ qt ha}^{-1}} * 100 = \mathbf{17.01\%}$$

$$\text{Technology index for Gudetu} = \frac{(23-18.36)}{23} * 100 = \mathit{20.17}$$

Technology index for Gute= (35-20.23/35)*100=42.2 %

Table 6. Yield advantage, technology gap and technology index of the varieties

Variety	Potential yield (qt ha^{-1})	Demo yield (qt ha^{-1})	Technology gap (qt)	Technology Index (%)	Yield advantage (%)
Bako-09	29.8	24.73	5.07	17.01	
Gute	35	20.23	14.77	42.2	22.24
Gudetu	23	18.36	4.4	20.17	34.7

Financial analysis

In terms of profitability and returns that could be gained from each of the varieties, financial analysis result of the study was summarized and presented in (Table 7). On average a net gain (ETB) of 31755.83, 24073.333 and 20672.5 ha^{-1} were gained from Bako-09, Gute and Gudetu varieties, respectively. Variety wise analysis reveals that the highest gain was from producing Bako-09 as compared to producing the standard checks. Brief summary of gain difference on the basis of district and variety is depicted in (Table 7). Based on inter-varietal gain comparison, farmers could gain an additional ETB 11083.33 if they produce Bako-09 instead of Gute variety. Likewise, farmers could gain an additional ETB 7682.5 if they resort to produce Bako-09 instead of Gute variety.

On the other hand, location wise analysis indicates that the highest average net gain per hectare (31755.833ETB) from the new variety was accrued to the farmers at Boneya Boshe, while the least average gain per hectare was accrued to the farmers at Diga (20672.5 ETB). The lowest gain for the farmers at this site was due to the relatively low performance of the demonstrated variety (Bako-09) exhibited at this specific location. Further, the study result also revealed the highest returns to investment (2.76) was gained from Bako-09 followed by Gute (2.09) and finally from Gudetu variety which was 1.80. One can learn from the current study that Bako-09, apart from the qualitative traits mentioned earlier, demonstrated both

yield advantage and profitability as compared to the standard checks against which it was compared.

Table 7: Financial analysis for the varieties across the districts

	B.Boshe			Wayu Tuqa			Diga		
	Bako-09	Gute	Gudetu	Bako-09	Gute	Gudetu	Bako-09	Gute	Gudetu
Yield qt/ha (Y)	24.67	19	18.67	26	22	18.5	23.5	20	18
Price(P) per	1750	1750	1750	1750	1750	1750	1750	1750	1750
Total Revenue	43172.5	33250	32672.5	45500	38500	32375	41125	35000	31500
Variable costs									
Seed cost	2000	2000	2000	2000	2000	2000	2000	2000	2000
Fertilizer cost	2510	2510	2510	2510	2510	2510	2510	2510	2510
Labor cost	4000	4000	4000	4000	4000	4000	4000	4000	4000
Total Variable	8510	8510	8510	8510	8510	8510	8510	8510	8510
Fixed costs									
Cost of land	3000	3000	3000	3000	3000	3000	3000	3000	3000
Total fixed costs	3000	3000	3000	3000	3000	3000	3000	3000	3000
Total cost (TC) = TVC+TFC	11510	11510	11510	11510	11510	11510	11510	11510	11510
Gross Margin (GM)=TR-TVC	51970.6	33170	24162.5	42870.6	44090	23865	30440	24980	22990
Profit=GM-TFC	31662.5	21740	21162.5	33990	26990	20865	29615	23490	19990
Return on investment	2.75	1.89	1.84	2.95	2.34	1.81	2.57	2.04	1.74

All costs and revenues in this table are in ETB, the Ethiopian currency called Ethiopian Birr
1 ETB= 0.02113647

Table 8. Variety wise comparison of net gain across districts (in ETB)

B.Boshe			**Wayu Tuqa**			**Diga**		
Gain (B)	Gain (Gut)	Gain (Gud).	Gain (B)	Gain (Gut)	Gain (Gud).	Gain (B)	Gain (Gut)	Gain (Gud).
31662.5	21740	21162.5	33990	26990	20865	29615	23490	19990

Gain (B): Net gain from Bako-09; Gain (Gut) = Net gain from Gute; Gain (Gud) = Net gain from Gudetu
ETB= Ethiopian Birr i.e.; 1 ETB= 0.02113647

Farmers' perception on tef technology

The farmers' have appreciated the selected finger millet variety for the following merits; perceived better yielder than the commercial varieties, perceived better resistance to disease, perceived better Seed color, tillering capacity and marketability.

Conclusions and recommendations

The current study aimed at demonstrating a recently released improved finger millet variety, Bako-09 to farmers in selected districts of western Oromia region. The variety was planted along with a standard check, Gute and Gudetu varieties; on plot size of 100m^2 each, following recommended agronomic practices. A total of 16 farmers were involved in the activity. The result of participatory evaluation conducted at maturity reveals that the new variety excelled the standard checks interms of both qualitative and quantitative parameters/criteria used to evaluate and select the varieties. Furthermore, the financial analysis revealed the highest net return from the new variety as compared to the standard checks planted along with it. The farmers appreciated the new variety and showed keen interest for future large scale dissemination. Based on these facts, Kumsa variety was recommended for further scale up and scale out of demo districts to other similar agro ecologies within the districts and beyond.

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Pre-extension Demonstration of Fishing gear, Retaining cage and Processing Table at Koka Reservoir, East Showa Zone, Oromia Region, Ethiopia

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Abstract

Pre-extension Demonstration of Fishing gear, Retaining cage and Processing Table was conducted in Lume district of East Showa Zone at Koka Reservoir. The main objective of the study was to demonstrate fishery technologies: gill-net, retaining cage and processing table. Demonstration was conducted through organizing two FREG with a total 50 fishermen who participated in fishing activities. In awareness creation, a total of 54 participants were participated on both theoretical and practical training. During technology demonstration, 64 participants were attend the program and provided their feedback. Based on the different attribute, among the farmers interviewed all respondents had been responded that Gill-net with 10cm mesh size is help to improve fish harvesting process through attaining sustainable production. In similar way, almost all fishermen (100%) stress that utilizing processing table Improve hygienic status and Improve customer demand. About 65.22% and 76.1% of fishermen also mentioned as processing table is easy to established and Increase household income by 200 birr/day/boat. The interviewed fishermen also agreed on retaining cage technology that used to minimize loss of production, help to store production during bulk production, help to maintain fresh fish until market hold, easily made and install in the water. Overall, demonstrated fishery technologies are mainly contribute to minimizing loss of production, maintaining trading and marketing chain, Improve income and insuring resource sustainability. Thus, fishery technologies were recommended for father scaling up in different fish production potential site.

Key words: Demonstration, Gill-net, Retaining cage, Processing Table, Training

Introduction

In 2010 global capture fisheries and aquaculture from both marine and inland waters produced 148 million tons of fish, which was valued at US$217.5 billion (FAO, 2012). The context in which this production takes place is one in which an estimated 1.4 billion people are in poverty, 868 million people are estimated to be chronically hungry and an estimated one third of children in the developing world under five years of age are stunted (Conway, 2012). At the same time, demand for fish products are likely to rise as a result of rising populations that are expected to reach 9.3 billion by 2050. On the other hand, fisheries provide a wide range of benefits, beyond income. Beyond material benefits (food, income and employment), it supports of wider household livelihood strategies such as seasonal contributions and safety nets. Fisheries also have a role in supporting relationships and well-being within communities, often through reciprocal arrangements and collective action.

Gears commonly operated in Ethiopian fisheries include gillnets, beach seines, long-lines, hook-and-line, and cast nets. Various forms of traps, scoop nets and baskets made of plant materials and wires are also used, particularly in the rivers of Ethiopia. Even though it is a land locked country, the country Ethiopia has a number of beautiful lakes, reservoirs and small water bodies that distributed throughout the country and covering a total surface area of about 13, 637km^2 (Tesfaye and Wolff, 2014). It has a number of lakes and rivers with substantial quantity of fish stocks.

The fish production from these water bodies is supporting the livelihood of poor farmers living around water bodies in providing inexpensive, but high-quality protein and diversifying sources of income (Gebrekidan *et al.*, 2012). But, in most case fish catches from lakes and other water bodies were used as customary practice from handling to processing. Especially, the processing (gutting or filleting) is done at shore of the lake with poor quality that leads many contamination and production damage (Ignatius and Zelalem, 2011).

The region of Oromia is endowed with numerous water bodies including lakes, reservoir and rivers. Additionally, the country is actively exploiting its water resources by building dams, reservoirs, irrigation and diversion canals and hydropower stations that used as source of irrigation drinking water, fish farming and flood control. Koka reservoir is one of the major reservoir at which major fish resource are available and a lot of fishermen livelihood are depend on fishing activities. However, fishermen around Koka reservoir are still performing fishing with traditional and customary practice. Due to its nature, fish start to spoil immediately after harvesting and the problem is become series during handling and processing stage.

In the study area around Koka Reservoir fishermen utilize un-recommended mesh size of Gill-net for fish catch. Additionally, throughout all landing site there is no appropriate processing mechanism and utilize on ground for fish gutting and filleting purpose which directly affect the quality of product in the market. On the other hand, if fishing activities supported with research and technologies it bring a positive impact on community's livelihood improvement. Besides, improving fishermen knowledge and skill with proper fishery technology, it need to demonstrate efficiently and proper fishing technology like fishing gears, processing table and Retaining cage with all recommended packages for resource sustainability.

Fishing gears, processing table and Retaining cage are some evaluated technologies and provide a positive result on fishing activity to utilizing the open resource. Fish processing tables is a kind of fish filleting tables that enables fish processors to produce top quality fillet and also help to prevention of physical damage, protecting fish from direct dirty soil and bacterial contamination. Retaining g cage technology designed to prolog the time that the fish stay alive at landing in water during lack of market and high production season. Gil-net with recommended mesh size mainly contributes in resource sustainability in particular water bodies. Therefore, the study was aim to demonstrate important fishery technologies in Lume district adjacent to Lake Koka reservoir of East Showa zone.

The specific objectives of the study were to;

- ✓ Evaluate fishing gear, retaining cage and fish processing table at selected site
- ✓ Create awareness on demonstrated fishery technology utilization
- ✓ Assess stakeholders feedback for further technology development/improvement

Material and methods

Description of the study area

Koka reservoir is one of the main lakes that used for different economic and ecological purposes for local community. Administratively it is found in Oromia Regional State, between East Shoa Zone (between Lume and Bora district), and Arsi Zone (bordered with Dodota district) (Lume District Livestock Development and Fishery Office, 2020). It is situated at around 90 kilometers southeast of Addis Ababa. It has a surface area of about 255 km^2 with a maximum depth of 14 m. The mean depth of the reservoir is around 9m with shore line of 195-205km distance. The reservoir is supported with the major two inlet rivers namely Awash and Mojo that flow toward to the Lake.

Its water in- and outflow is mainly provided by the Awash River. However, the Mojo River is mainly generating inflow during the rainy season. It is among the most important lakes for Ethiopian small scale fisheries in general and riparian societies in particular (Tesfaye and Wolff, 2014). The reservoir is serving for different purposes, such as hydroelectric power generation and from small to large irrigation. It is also important for fishing activities (Ann Gorfon *et al.,* 2007) that mainly used people living in the vicinity of the water body.

Site and fishermen selection

Development agent and experts were participated on specific landing site selection. The landing site was selected based on accessible to market and road, suitability for technology demonstration and shade construction, and high number of fishermen slips in and out from Lume district adjacent to Koka Reservoir. Fishermen also selected based on their readiness to work as group, willingness in taking any provide information to share any information for others farmers and good history with local community

Technology demonstration techniques

Participatory approach such as FREG was used to enhance technology demonstration efficiency and effectiveness. One FRG was established that organized along Koka reservoir at Dungugii Bekele Keble. Training, joint monitoring and evaluation were used as mechanism for technology demonstration and information exchange among fishermen's. Filed day was also organized to facilitate technology and information transfer at selected site with Zone and Districts Livestock and fishers offices.

Methods of data collection

To obtain the relevant information, quantitative and qualitative data were collected through filed observation, FGD, interview and measurement though preparing sheet/checklist.

Data collected

Quantitative data such as technologies demonstrated, total number of fishermen and farmers participated in training and field days were collected using checklist. In addition, qualitative data such as, role of farmers and other stake-holders in technology demonstration and feedback were collected. Regarding on the fishing activities the secondary data were taken from Agricultural office.

Materials used

Cement, Stone, String, plank, floater, sinker, nail, meter, twine, needles, metal and Staffa.

Roles and responsibilities of participants

In technology demonstration stakeholders: fishermen, research team and extension worker had their own responsibility. Especially fishermen were provided land for processing shade construction for processing table installation.

Table 1: Role of fishermen and other stakeholders in technology demonstration

Actors	Roles
Fishermen	Land provision, facilitation, Involving in technology installation, participating on training and field day, field monitoring, evaluation technologies and providing feedback.
Research Team	Provision of training, Preparing extension materials, delivering all necessary materials, facilitating activities and different stakeholder participation, feedback and all data collection and analysis
Extension worker	Facilitating and organizing, information transfer, provide technical support as local condition, continuous follow up and monitoring

Data Analysis

Quantitative data were analyzed using the statistical analysis system of Statistical Package for social science (SPSS Ver. 21 software. Descriptive statistics such as mean and frequencies were used in analysis and describe in table.

Results and Discussions

Training on capacity building

Training is the main approach that was used to create awareness on demonstrated technology being to capacitate fishermen, DAs and expert knowledge and skill. Fish post-harvest researcher which comprised of socio-economics, researcher from extension was participated to facilitate extension efforts. Theoretical and practical trainings were given to fishermen, DAs and district experts from all technology preparation to utilization process.

Moreover, the capacity building was given mainly focus on the promotion of utilizing recommended fishing gear for sustainable production. Intensive training also was given for participant fishermen and other stakeholder on Retaining cage and fish processing technology that mainly help to reduce post-harvest lose. Additionally, awareness creation was given on fish collection, handling and processing methods on those demonstrated technologies. Overall, a total of 54 participants were participated on training at selected site (table 2).

Due to the nature of activity, male is dominated and mostly manipulated in different fish potential area including Koka reservoir due to the reason that, fishing activity is mainly done during night time and early morning, time that is not suitable for women and the activity need much energy. This finding is in line with Shetimma *et al*. (2014) and Salau *et al. (*2014) who indicated that fishing is mainly undertaken by male group. In addition to FRG members, 4 local farmers were participated in awareness creation program related with those prepared technology utilization.

Table 2: Training to stakeholders on demonstrated technology

Fishermen			DAs			SMS		
Male	**Female**	**Total**	**Male**	**Female**	**Total**	**Male**	**Female**	**Total**
46	0	46	2	-	2	6	-	6

Demonstration and Technology transfer

Before technology demonstration, processing shade was constructed with size of 72m^2 (12mx6m) at selected landing site. Six (6) processes tables (1.2mX0.6m size) were made and installed in processing shade based on research recommendation. Gill-net with10cm mesh size and two retaining cage also used as technology demonstration and transfer to fishermen. Technology demonstration was jointly organized in collaboration with fishermen and district livestock and fishery office. Non-FRG member also were participate to create opportunities for stakeholders to see and learn from technology demonstration and promotions. In demonstration a total of 64 participants were attend the program to create demand for the technologies and provide feedback for further technology improvement/development (table 3).

Table 3: Number of Participants on Technology Demonstration

Participants	Male	Female	Total
Fishermen	46	-	46
DAs	2	-	2
SMS	6	-	6
Others	8	2	10
Total	62	2	64

Fishermen feedback and reaction

As fishery technology Gill-net, fish Retaining cage and fish processing table were prepared and demonstrated with fishermen and other stakeholders. Based on those participant reactions, the demonstrated fishery technologies had preferred for its intended purpose. Especially, those all participants were responded as Gill-net and fish processing table extremely good in fishing sector due its more contribution in minimizing loss of production and improve income gain from the sector. On fish retaining cage, according to absolute category rating test, about 78.26% and 21.74% had responded it is extremely good and good technology that mainly contributes in prolog the time trough staying fish alive at landing in water.

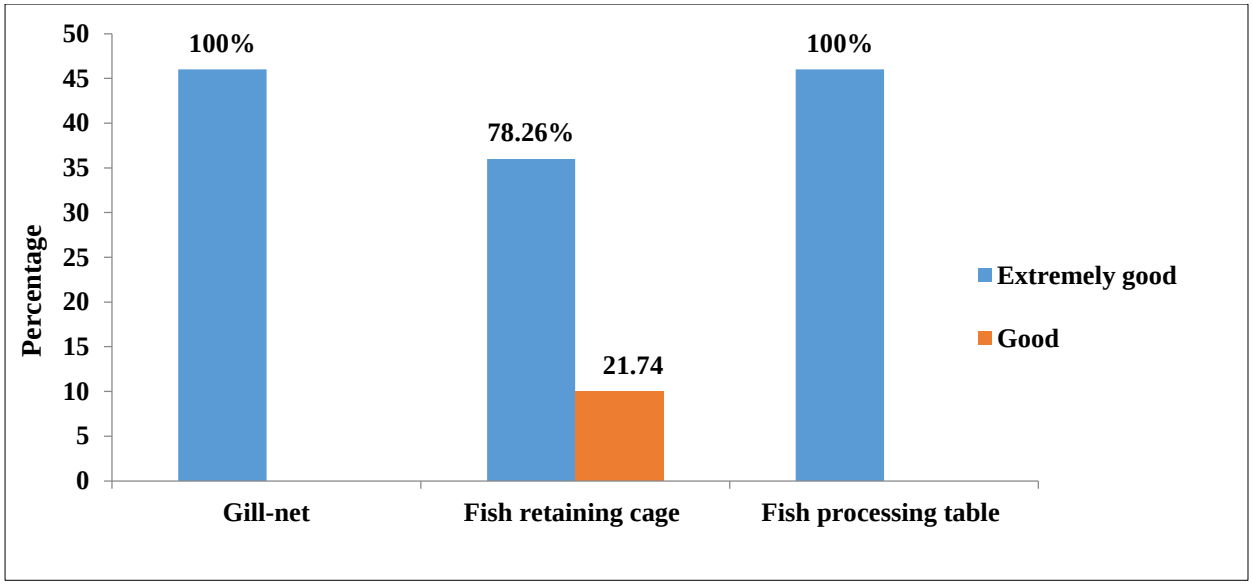

Figure 4: Stakeholder evaluation level with absolute category rating test

Again, participant fishermen were seen the three technologies based on some attributes like improve fish harvesting process, insure sustainability, easy to established and used/process, improve hygienic status, improve customer demand, increase household income, minimize loss of production and need low cost to establish. Among fishermen interviewed, all respondent had been responded that Gill-net with recommended mesh size was highly help to improve and sustain fish harvesting process.

Currently in the study area fishermen were use Gill-Net, Beach seine and Hooke with different size for fish collection. But, the mesh size of Gill-net or Beach seine was 6cm which is below with the current Research recommendation for Lake Fishery production 10 to 12cm. As male age of 32 key informants Mr. Goshu Teka confirmed that, around the reservoir almost all fishermen were utilize Gill-net with mesh size of 6cm due to fish size that available in the water bodies. As literature confirmed that, the size of the fish targeted determines the type and the size of the gear we have to use (Getachew, 2015). But, it has a negative implication on resource management and sustainable production. .

Table 4: Stakeholders feedback on demonstrated technologies (n=46)

Name of technology	Attribute	SA		A	
		Freq.	%	Freq.	%
Gill-net	Improve fish harvesting process	46	100	-	-
	Insure sustainability	46	100	-	-
Processing table	Easy to established and used/process	30	65.22	16	34.78
	Improve hygienic status	46	100	-	-
	Improve customer demand	46	100	-	-
	Increase household income	35	76.1	11	23.9
Retaining cage	Minimize loss of production	34	100	-	-
	Contribute in improving income	34	100	-	-
	Need low cost to establish	34	100	-	-

SA (Strongly agree), (ii) (A) agree

On the other hand, about 65.22% of interviewed fishermen were strongly agreed on processing table in terms of its installation and utilization status in different landing site (table 4). Moreover, all participants were agreed that fish processing technology under shade highly contribute to improve hygienic status and more attract customer for purchasing in marketing situation. In terms of income status about 76.1% of respondents had responded as the technology mainly contribute in income improvement due to minimizing production lose during processing stage.

As fishermen confirmed that, with customary practice on the ground preparing one kilo of filleted fish takes 20-30 min with poor quality status. On the other hand, during technology demonstration under shade on processing table one kilo of filleted fish was completed in10-15 min with good quality status. As Focus Group Discussants told that, due to lack of appropriate processing methods and technology on average about 2.5-5kg of fish is lose on the shoreline /day/boat under normal production. So, with effective utilization this improved technology can rapidly minimize such lose and improved income of fishermen by 200 birr/day/boat. Making fish processing on specific site can minimize pollution of the fishing source water body as well as the surrounding environment with effective utilization of collected fish. This also open other income source through selling by product of fish for further processing stage that mainly used as commercial fish and other animal feed.

The interviewed fishermen also, agreed on retaining cage technology that used to minimize loss of production, help to store production during bulk production, help to maintain fresh fish until market hold, easily made and install in the water. But, they strictly mentioned on its application with the current fishery production status. They emphasis that, the currently demand in market for commercials fish is rapidly increasing with declining of the production. However, they confirmed as the technology mainly used during low demand season of fish product

As fishermen had long history in fishing sector, they well know about Gill-net with all recommendation packages. But, through gradual the harvested fish sizes come to decline and fishermen also minimize Gill-net mesh size which is out of research recommendation. According to the majority of group discussants fish processing table under shade is better technology that utilized under any level of fish production and more recommended technology than the other.

Conclusion and Recommendation

The activity was conducted at Koka reservoir on representative landing site from Dungugi Bekele Kebele specific site was selected purposively selected based on its accessibility for technology demonstration. FRG was organized and used to demonstrate Gill-net, retaining cage and fish processing table technology with fishermen and other stakeholders. Capacity building was given related with demonstrated technology utilization as well as on the overall fish production and postharvest techniques. Fishermen were benefited from improved fishery technologies, which enable them to produce better quality fish products with sustainable manner.

Based on participant reactions, from demonstrated fishery technologies fish processing table under shade were highly preferred that contribute in minimizing loss of production and improve income gain from the sector. Again, participant stakeholders were evaluate the technologies and agreed on its contribution toward improving hygienic status, improve market interest and easy to established and used/process. Overall, Gill-net with appropriate mesh size (10cm), retaining cage, and processing table have highly contribution on fishing sector with improving method of collection, processing and handling. Therefore, those fishery technologies were preferred by stakeholders and recommended for pre-scaling up on unaddressed fish production potential site of Oromia Region.

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Pre-extension Demonstration of Integrated Fish-Poultry-Horticulture-Livestock Feed Production System at Wayu Tuka District, East Wollega Zone, Oromia Region, Ethiopia

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Abstract

Integrated fish farming is a promising and cost effective technology in which waste of one component as an input for other with emphasis on fish culture. The current study was aim to demonstrate Integrated fish-poultry-horticulture-animal feed production system in East Wollega Wallega Zone, Wayu Tuka District. Participatory approach were employed on technology demonstration. Awareness creation was covered for a total of 68 beneficiaries that focus on site identification, pond excavations, poultry house construction constriction, netting, overall farm management, fish harvesting and other processing. For technology demonstration a total of 360m2 ponds size were prepared. Each pond have an area of 120 m^2 was constructed and a total of 245 fish fingerling were stocked with stocking density of 2.04fish/m^2. The average final weight of fish was 243.7, 892.57 and 679.4 for O.niloticus, C. carpio and C. gariepinus with daily growth rate of 0.64, 2.42 and 1.82 respectively. 21015 eggs were collected from 90 Lohmann brown pullets under integrated farm. On horticultural production 110kg of Solanum iycopersicum was produced per 50m^2 and a total of 1450kg Allium cepa was produce on 500m^2 of land. P. pedicellatum and Chloris gayana were used that grown on the dike of fish which produce a dry matter yield of 8,333 and 379 kg ha^{-1}, respectively. Farmers were generating revenue from all components and the highest profit was obtained from egg and fish production which is cover a total ETB of 102,217.5 and 28,808.4 respectively. Overall, 99,090.90 Birr was generated from integrated farm under farmer condition. With this result, the main stakeholder farmers confirmed as integrated farming system is feasible in terms of its contribution to family food, income generation, and employment opportunity. So, Government and other stakeholders have to support extension for wider implementation at aquaculture potential site.

Key words: Demonstration, fish integration, poultry, production, vegetable, wastes recycle

Introduction

Ethiopia is endowed with several productive freshwater (Lakes and rivers) that is suitable for fishing activities. Aquaculture is contributes to human food fish demands, poverty alleviation and rural development and is often mooted as the fastest growing food production sector in the world (FAO, 2017). It has been the fastest growing food production sector in the world and now supplies more than half of the world's food fish (FAO, 2010). In Ethiopia, Aquaculture is remained more potential than in actual practice, despite the fact that the country's environmental and socio-economic conditions support for its development. Considerably large area of Ethiopian land is suitable for fish pond culture (Eshete and Zemenu, 2012) which is the priorities and strategy of Ethiopian government to develop the fisheries sub–sector.

It is a potential alternative source of fish supply to fill the increasing demand for fish on the market, if developed in a sustainable way with supported by skilled expertise. Due to increased population growth and problems such as environmental degradation, land and water scarcity, the integration of aquaculture with agriculture has been advocated in order to increase resource use efficiency. Integrated fish farming is the blending of various compatible agricultural enterprises into a functional or unified whole farming system for the purpose of sustainability. It is a multi-commodity farming system with the waste recycling as the key feature and fish culture as the major activity than other integrated commodities. The integration farm increases diversity and the yields of multiple products, waste material of one component used as the main input for other under the system that helps to access the healthy foods and enhances the local economy (Anderson *et al.,* 2017).

There is a best practice in Ethiopia that integrated farming activity has opened new horizons of increasing production per unit area at low inputs cost through an increased interest in utilization of animal manures. Based on last evaluation result; It is a no waste, low cost and low energy production system in which the by-products of one item is recycled into another as input (Lema, 2017). In such integrated system, waste from poultry is used to fertilize fish pond substituting feed supplement for the fish, and nutrient rich water from fish pond is used to irrigate the Vegetable/horticulture crop during the water exchange for fish that substituting fertilizer use in crops (Daba *et al*., 2017).
The technique recycles waste for food production and saves environment from pollution which saves production cost and is easy to manage at small scale farmer's level in different aquaculture potential site. The system maximizes productivity and economic efficiency of smallholder fish farmers through enhancing the productivity per unit area of land.

The specific objectives of the study were;

- To create awareness on integrated fish-poultry-horticulture-livestock feed production system
- To evaluate integrated fish-poultry-horticulture-livestock feed production system
- To assess feedback information for further technology development/improvement

Materials and Methods

Description of study area

The activity was conducted in East Wollaga Zone Wayu Tuka district which located between 8050'48"- 9011'15"N latitudes and 36033'54" - 36047'51"E Longitudes, extending for about twenty-one minutes (21') north to south and about fourteen minutes (14') east to west. The district is contiguous with Sibu Sire in the East, Leka Dulecha and some part of Guto Gidda in the West, Guto Gidda in the North, and Jimma Arjo, Nunu Kumba, and Wama hagelo in the South direction. This district is divided in to three distinct Agro ecological areas namely; high land (37.55%), midland (49.22%) and lowland (13.23%).

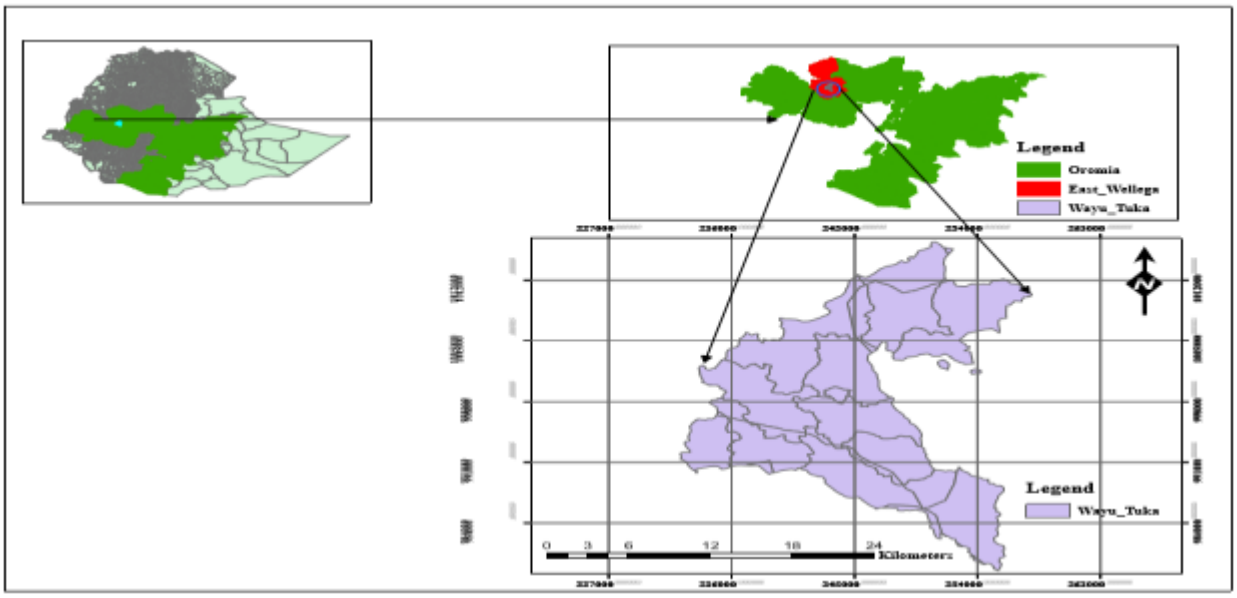

Figure 1: *Map of the Study Area*

The district has a mean annual temperature of 25^0c to 35^0c, and mean annual rainfall of 1200mm to 2400mm of minimum and maximum respectively. Again, the majority part of the district had good access to water that suitable for irrigation purpose and aquaculture development. Many farmers were participating on producing sugarcane, sweet potato, potato, orange, mango and other vegetable and fruit crop with irrigation. With rain feed system the majority of farmers were participates in producing maize and teff.

Site and farmer selection

Purposive sampling method was employed to select potential site from Wayu Tuka district. Therefore, one Kebele was selected purposively based on accessibility and suitability for aquaculture development, water availability, topography of the land (sloppy land), soil type, weather condition (adaptability of fish species, different horticultural crop and poultry), accessibility to road and other non-FREGs and market outlet were the main criteria to identify site for integration. Targeted farmers were also selected based their willingness to cost-sharing (Land allocation and taking farm management), ability to share information to others farmers and good history with local community.

Technology demonstration methods

Participatory approach was followed to enhance technology demonstration efficiency and effectiveness. FREG members and other follower farmers were encouraged to participate on different extension events organized on trial farmers. Training, Mini field day, joint monitoring and evaluation were used as mechanism for technology demonstration and information exchange among farmers.

Roles and responsibilities of participants

Cost-sharing participatory approach was used in this technology promotion in which farmers provide land without compensation. Overall, form trial farmer to area administrative office all of participants had own responsibility during research implementation process.

Table 1: Role of farmers and other stakeholders in technology demonstration

Actors	Roles
Trial farmers	Land provision, management, record keeping, field monitoring, providing report the case of emergency and providing feedback
FRG members	Involving in pond and poultry house construction, management, participating on horticultural land preparation, evaluation the output from whole components, and providing feedback
Research Team	Provision of training, Preparing extension materials, delivering all necessary materials, facilitating activities and different stakeholder participation, all data collection and analysis
Extension worker	Facilitating and organizing communities, information transfer, provide technical support as local condition, continuous follow up and monitoring
Other stakeholder	Community facilitation and information dissemination

Fish pond construction

The integrated farms consists fish, poultry, vegetable and animal feed components that conducted on selected site. For establishing the system three rectangular shaped earthen ponds having area of 12m X 10m (120m^2) and depth of 1.0m to 1.30m with water inlet, outlet and overflow were excavated on a gentle slope land. Water inlet canal was prepared for pond with one silt boxes for the protection of mud/sand siltation. The water was streamed to the pond through a pipe fixed on ponds and in similar way water out let pipe/canal was fixed to the pond at bottom part that helps to discharge water from pond through gravity.

The excavated ponds were liming before filling with water for the purpose to maintain the extreme change in pH and to kill some harmful microorganisms and parasites. This action also promote the biological productivity through neutralizes sulfides and some acidic substance. Three weeks after liming, the ponds were filled through canal system on inlet side after poultry house construction completed.

Poultry house construction

Poultry production was one of the main components under integrated farm. For poultry production poultry house were constructed at each site with local available materials. *The house was having a total area of 12m^2 (4m X 3m) that have two partitions/class at each site. The first class was footing on the ground and all sides were covered by strong wood and mud. It had an area of 6m^2 (4m X 1.50m), which serves for resting, night time stay and has nests for egg laying. The second class (4m X 1.50m) was open* to air and light *that enclosed by mesh wire around the poles and hanging over the pond. This class was used for the poultry to stay during day time where they eat and drink from hanged feeders and watering containers.*

The bottom of this class supporting the chicken was covered by stronger mesh wire protecting chicken against predators and competitors, allows poultry droppings passing down to the pond water. The roof of the house was covered by tin. After the completion of poultry house construction, a total 90 Lohman brown breed of poultry pullets with three months of age were purchased and stocked. Similarly, the recommended commercial feed was provided to the chicken. The feeding system was given based on the age of chicken from 80 to 120 gm. per day with all required management and care.

Method of data collection and analysis

Quantitative and qualitative data were collected through filed observation, FGD, interview and measurement and data sheet/checklist. *The qualitative data were carefully collected, recorded and narrated under each topic. The quantitative data were analyzed by using appropriate descriptive statistics like mean and percentages. Data generated from the various sources were presented as tables, figures or graphs. Fish data for the parameters such as fish growth rate and survival rate (%) are calculated from initial number and weight (g) of stocked fishes, and final number and live-weight (g) of fish. The survival rate of the O. niloticus, C. carpio and C. gariepinus was analyzed from the date of stocking to harvesting, during 381 culturing period.*

So, daily growth rate and survival rate was calculated using the following formulas;

$$Daily\ growth\ rate\ (DGR, g/day) = \frac{Final\ weight\ (g) - Initial\ weight\ (g)}{Experimental\ days}$$

$$Survival\ rate\% = \frac{(Number\ of stocked\ fish\ - Number\ of\ dead\ fish)}{Number\ of stocked\ fish} X\ 100$$

Results and Discussions

Training

The first awareness creation was given for farmers, development agents and experts with multidisciplinary research team (Aquaculture, agricultural extension and socio-economic research team) *on aquaculture site selection, pond design and construction, poultry house and onion land preparation, fish and pond management and mainly focus on the benefit integrated farming system before its implementation. In addition to this, trainings were given on fish harvesting techniques, processing (gutting and filleting) and on food preparation in the form of soup, fried and boiled fish.*

Generally, subsequent trainings were given for the beneficiaries at each stage of production starting from the farm preparation up to the harvest and consumption of the products. Moreover, farmers intensively attended and participated in every activity of the farm during pond, poultry house and horticulture land preparations. The training was covered a total of 58 farmers, 8 development agents (DAs) and 4 fishery experts from potential districts of East Wollega zone.

Table 2. Number of participants in the training

Participants	**Gender**		
	Male	**Female**	**Total**
Farmers	49	9	58
DAs	4	-	4
Experts	5	1	6
Total	**58**	**10**	**68**

Mini field day was also other strategy to create demand for different stakeholders. Accordingly field-day was organized in Wayou Tuka District, Wara-baabu menya Kebele to facilitate experience, information sharing and to create better linkage among relevant actors. During field day a total of 76 stakeholders out of them 64 were male and 12 female were participated.

Table 3: *Number of participants in mini field day*

Trainee	**Participants**		**Total**
	Male	**Female**	
Farmers	49	9	58
DAs	4	0	4
Experts	5	1	6
Researcher	4	0	4
Others	2	2	4
Total	**64**	**12**	**76**

Fish Production

Under fish production three species were used under integrated farm namely Nile Tilipia (Oreochromis niloticus), African catfish (Clarias gariepinus) and Common carp (Cyprinus carpio). One month after poultry stocking, a total of 245 fishes fingerlings of three species (200 Oreochromis niloticus, 30 Cyprinus carpio and 15 Claries gariepinus) were collected from Research Center and stocked for each farmers with stocking density of 2.04 fish/m^2 on February 2020. The sizes of the fish at stocking were 9.4g, 12.8g and 18.7g for *O.niloticus*, *C.carpio* and *C.gariepinus* respectively (table 4). *The fishers were managed properly by exchanging water regularly, protecting fish from predators and maintaining inlet and outlet pipes to maintain the water status with pond size.*

Throughout culturing period supplementary feed was not provided to the fish under integrated farm. Based on the integrated concept poultry waste is either eaten directly by fish or fertilizes pond water to support the growth of plankton that used by fish as natural organic feed. Then, the nutrient rich water from fish pond is used us organic fertilizer for growing horticultural crop. The average weight of fish was 243.7, 892.57 and 679.4 for O.niloticus, C. carpio and C. gariepinus respectively (table 4).

Table 4: Summary of fish data in the integration

Parameters	O.niloticus	C. carpio	C. gariepinus	Total
Number stocked	600	90	45	735
Average weight at stocking (g/fish)	9.4	12.8	18.7	-
Culture period	364	364	364	-
Average weight at harvest (g/fish)	243.7	892.57	679.4	-
DGR (g.d-1)	0.64	2.42	1.82	-
Number harvested	585	75	45	705
Survival rate (%)	97.5	83.33	100.00	-
Actual yield/pond/culture period in kg	142.56	66.94	30.57	240.07

At the end of the trial in 364 days, the *O.niloticus* - attained final body weight ranging from 144 to 385g with a mean of 243.7± 89.79g with mean daily growth rate of (DGR) 0.64g/day. This report is almost similar with Daba *et al*. (2017) specified that the mean daily growth rate was 0.65g/day under integrated farm. The fish growth rate in this trial (0.64g.d-1) is close to the previous result of DGR 0.75g.d-1 reported by Endebu, *et al.* (2016) in the integrated ponds. *C. carpio* and *C. gariepinus* attained mean body weight of 892.57±68.54g with DGR of 2.42g/d and 679.4±38.32g with DGR of 1.82g/d in 364 culturing days respectively. The result DGR of 1.82g/d attained by *C. carpio* was relatively on a better level as compared to the 1.7g/d that reported by Endebu *et al*. (2016) under integrated farm.

However, this result is different with Daba *et al.* (2017) who specified that the DGR of *C. carpio* was reach 4.01g/d. This difference was attributed due to higher initial weight and longer culturing period in the current study as compare with previous work. Under this integrated farm the fish had no any supplementary feed throughout culturing period. In integrated poultry-fish farming, the protein-rich chicken dropping was made available to the fish either directly or indirectly. The survival rates of the fishes, *O. niloticus, C. carpio* and *C. gariepinus* was 97.5%, 83.33% and 100.00% respectively (table 4). Generally, a total of 240.07 kg fish was produced from integrated farm during the culture period.

Egg Production

The Lohmann brown pullets in the integrated farm started laying eggs two months after stocking in March 2020, at age of 20 weeks. The maximum production of egg was recorded on the month of January 2021. As the recorded result indicated that the production was fluctuated from at different month in the year. The research team was not deliver poultry feed as expected due to covid-19 emerged in our country and security problem of the site. Especially, from moth of May to July the production was declining due to luck of commercial feed for stocked poultry. But, starting from the month September commercial feed was delivered by the research team that significantly shows the increment of egg production. As Daba et. al. (2017) indicated that some irregularities and decline in egg production observed when the chickens were fed with locally made cracked grains during shortage of commercial feed supply.

Later, poultry start to decline its production from the age of 17 month and is not economically feasible (figure 6). Similar study result show that, the production of egg decreases in later ages and becomes uneconomical after chickens reach the age of 18 months due to change in their physiology (Daba et al., 2017). The same report also specified by Hirpho (2017) in which the egg production decline in later age of chickens. Generally, *21,015* eggs were collected from the 90 layers in 12 months. The collected eggs were sold by the beneficiary farmers to the local people at price rate of 4.5 Ethiopian Birr (ETB) per egg. The contribution of eggs as a protein source for the local people and the income from the selling to the beneficiary farmers are also valued.

Figure 7: *Average egg production per hen per month in the integration farm*

Horticulture production

Horticultural production under integrated farm is mainly contributing in developing organic agriculture that primarily use in home consumption and local market. It is one of the alternative ways of vegetable production as a source of income, help to minimize input cost and protect environment from pollution. On this technology demonstration *onion (Allium cepa) and tomato (Solanum iycopersicum) was used without applying any chemical fertilizer that minimizes the cost of production in the system. It also minimize environmental pollution duet to waste from poultry farm and fish pond.* The yield obtained from *S.* ijcopersicum and A. cepa that integrated with fish were separately analyzed and changed in terms yield per hectare (table 5). The production of *S. ijcopersicum* was 130kg per 50m^2 and estimated to produce 26000kg/ha which is slightly higher than the average production of tomato 2.5kg/m^2.

Regarding on production of onion (*Allium cepa*), *a total of 1450kg was produce on 500m^2 of land that estimated to 29,000kg when extrapolated to hectare base. The obtained yield was significant and almost similar with previous work on integration farming system that conducted at different site of Oromia region. As the study conducted by Daba et al., (2017) at Wayu Tuka District, a total of 21,600kg/ha was produced from 520m^2 of land under integrated system.*

Table 5. Yield of *Allium cepa and solanum iycopersicum*

Type of Vegetable	Area coverage	Total Yield	Yield	Sale
	(m^2)	(kg)	(kg ha^{-1})	(Eth. Birr)
Onion (Allium cepa)	500	1450	29,000	23,200
Tomato (Solanum iycopersicum)	50	130	26,000	2,600

Forage production

Under forage production Desho grass (*P. pedicellatum)* and Rhodes grass *(Chloris gayana)* were used that grown on the dike of fish pond with the water source of integrated system. The dry matter yield of each grass was separately calculated and estimated in terms of hector. *P. pedicellatum* and *Chloris gayana* were produced a total of 8,333 and 379 kg ha^{-1}, respectively (table 6). *Choris gayana* is primarily useful forage of moderate to high quality with leafy grass and harvest a total of 200-300kg/ha on less fertile soil (FAO, 2017). By nature this type of grass is a spring and summer-growing grass that found in open woodlands, river banks and pond dike which is very tolerant to either cutting or grazing. *Choris gayana* is used as year round fodder that begins to produce valuable forage within 6 months after sowing and provides regular harvests, even monthly cuts under sufficient moisture or during rainy season.

Table 6. Forage yield under integrated system

Type of forage	Area (m^2)	Total Yield in kg	Yield (kg ha^{-1})
Pennisetum pedicellatum	132	110	8,333
Choris gayana	132	5	379

On the other hand, *Pennisetum pedicellatum* is grows in its native geographic location, naturally spreading across the escarpment of the Ethiopian highlands (Smith, 2010). It is an ideal for livestock feed and can be sustainably cultivated on small plots of land. In addition to animal forage, *P. pedicellatum* is becoming increasingly utilized along with various soil and water conservation techniques, as local methods of improving grazing land management and combating a growing productivity problem of the Region. Both grass type is an important fodder that grown in the dike of pond in integrated system. Additionally, planting such grass on the dike of pond helps to protect soil from erase during heavy rainfall.

Partial budget analysis

Simple calculation was made to know the economic feasibility of the integrated farm comparing input costs against outputs in money value. Labor cost was considered in all activities performed on integrated farm and all necessary materials were considered in partial budget analysis process interims of Money. On establishment of integrated farm, the poultry house and fish pond construction was estimated in terms of money and considered as depreciation values in production costs. All products from the integrated farm were used for local consumption after they were estimated in terms of money.

Revenue generated from the selling of eggs, fish, onion, tomato and animal feed were used. The chicken and all purchased equipment's were also estimated for their current value in terms of money. All products from integrated farm was used for home consumption and sold to the local market with negotiable price. The revenue generated and *production costs were presented and analyzed trough partial budget analysis. From budget analysis the total cost of fish, poultry, horticulture and forage production were 6285, 47900, 5950 and 300 Ethiopian Birr (ETB) respectively (table 7).*

On the other hand, 28808.4, 102,217.5, 19400 and 3000 Ethiopian Birr (ETB) were the revenue generated from fish, poultry, horticulture, and forage production. The highest profit was obtained from egg and fish production as comparing with other components. Overall, the total cost incurred in integrated farm and the final revenue generated were 60,735 and 153,425.9 Birr respectively. From this the total profit of the system was 92,690.9 Birr.

Table 7: Partial budget analysis

Components	Items	Production cost (in birr)	Revenue (in birr)	Amount (in birr)
Fish production	Fingerling purchase	735	Fish selling (120 birr/kg x 240.07Kg)	28,808.4
	Pond depreciation cost	3500		
	Fishing net depreciation	350		
	Estimated labor cost	2000		
	Total cost in fish	6585	Total revenue	28,808.4
Poultry production	Pullets purchasing	9900	Revenue from egg production(21,015 Egg*4.50)	94,567.5
	Poultry feed purchase	35300	Estimated value of poultry at the end of the trial(Cull out hen) (45 *150)	6750
	Poultry feeders & equipment	1200	Estimated value of equipment	900
	Estimated labor cost	1500		
	Poultry house depreciation	1200		
	Total cost in poultry	47900	Total revenue	102,217.5
Horticulture production	Estimated cost for land preparation, weeding, etc	3000	Selling of onion	23,200
	Purchase of seedling	2500	Selling of tomato	2600
	Purchase of pesticide	450		
	Total cost in horticulture	5950	Total revenue	19400
Forage production	Pennisetum pedicellatum	150	Estimated revenue	1500
	Choris gayana	150	Estimated revenue	1500
	Total cost in forage	300	Total revenue	3000
Net benefit from the system		99,090.90 ETB Birr		

Stakeholder's feedback

Pre-extension Demonstration of Integrated Fish-Poultry-Horticulture-Livestock Feed Production System *was fully completed according to research plan on selected site. Farmers, other local community, Development Agent and experts from districts and Zonal level were participating from training to providing feedback on technology demonstration and result. All stakeholders confirmed and understood that, the integrated farming system is feasible in terms of its contribution to family food, income generation, and employment opportunity. Specially, FREG farmers specified that, integration of fish, poultry, horticulture and animal feed production system is a promising technology to generate income for household on a small plot of land having access to water source.*

Challenge encountered in technology demonstration

- Lack of commercial feed for poultry
- Security problem

Conclusion and Recommendation

Integrated fish-poultry-horticulture-animal feed farming system was implemented in East Showa Zone, Wayu Tuka District. Site and trial farmers were purposively selected based on its potentiality of site for fishing activities and other criteria's. Under this technology, one component is used as input for the other component and relatively small plot of land as compared to the traditional farming system with lower costs of inputs. From the system farmers were generate about 99,090.90 ETB Birr within one year which is highly contribute on the status of famer's income level. The result also confirmed that, the system is cost effective and efficient enough to generate more many from small plot of land as compare with customary traditional method of farming.

Moreover, it helps to produce different king of item which helps to diversify the farmers in production and is good resilience approach to produce sustainable food for rural farmers. The *technology is promising in agriculture sector in all potential sites and* economically efficient under farmer's condition. Overall, Integrated farming of fish, poultry, horticulture and animal feed production system has been effective approach for sustainable production, income generation and employment opportunity for resource poor rural households. So, government and NGO should be make an emphasis on its wider population (scaling-out) as one of aquaculture strategy that can be adopted by smallholder farmers of the country to increase farm returns from per unit area of land.

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Participatory Demonstration and Evaluation of Plastic Boat and Yebala in Lake Ziway and Langano, Oromia, Ethiopia

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Abstract

Plastic bottle is the extremely useful and versatile set of materials that rapidly increase across the world. The wasted plastic bottles inspire the idea of making boat using the wasted plastic bottle. The main objective of the study was to demonstrate and evaluate plastic boat in selected landing site with fishermen and other stakeholder. The activity was undertaken on Lake Ziway (Hara Dembel) and Lake Langano. All qualitative and quantitative data were collected and analysed using descriptive statistics. Participatory approach was employed for technology demonstration, evaluation and feedback process. Among 34 fishermen interviewed, about 58.82% and 41.18% had responded as simple and medium to made plastic boat as compare with wooden boat. In terms of safety, of the plastic boat was also considered as one main criterion and about 58.83%, 11.76% and 29.41% of the respondent responded that safety of plastic boat is very low, low and medium respectively. Based on cost analysis result, plastic Yebala was need low cost that wooden Yebala. But, based on fishermen reaction Yebala boat not resist medium to strong wind during fish collection. Again, body width and length also need modification as feedback data collected from fishermen. Plastic boat size also needs to minimize and standardize that help to easily operate on the water under different condition. Overall, the weight, length and width of Yebala need revision and consider as technology gap. On other side, width of plastic boat also need make standardize as comfortable to operate on lake in fishing. So, as fishing activity has risky by itself, firstly such technology gap must be understand and completed before recommending for further scaling up stage.

Key words: Demonstration, Plastic boat, Lake Ziway, Lake Langano, Training, Yebala

Introduction

Plastic bottle is the extremely useful and versatile set of materials that rapidly increase across the world for packing different food items and non-food items. Collecting and managing solid and human waste is a big problem and challenge for countries across the world. Similarly, the leakage of waste plastic into the environment is a significant challenge facing developing countries, aggravated by changing consumption patterns (which includes increased consumption of packaging, in particular plastic) and weak waste collection services United Nations Environment Programme (UNEP, 2018).

This problem is often magnified in cities where a dense concentration of people leads to a substantial amount of waste generation (Zerbock, 2003).In developing countries like Ethiopia, this problem is aggravated by an influx of people moving to urban centers (Montgomery, 2008). Densely populated areas are more susceptible to health risks as disease can be spread quickly. The trend in the changing life style of the Ethiopian people in drinking bottled water at home, work place, recreation and travel in and outside the country provided another opportunity to sale bottled water as a product in the local market and sought its potential sale in the international market as far as international water quality standards are met.

Beside this, the waste plastic bottle has a trend of increasing over the year in the country. While, the recycle bottled for different proposes shows not an increasing rate and the recycled rate is far less behind the wasted rate. Burning plastics is unhealthy that pollutes the environment by releasing toxic substance. The smoke and ash can irritate eyes and lungs, which is especially bad for people with asthma or heart disease. It leads to wildfires, property damage and sometimes loss of life.

On the other hand, 40 millions of waste plastic bottle are throwing away a day in world. In contrast, the recycling rate for plastic soft drink bottles is around 30 percent. The community nowadays still lack of aware about the consequences of producing waste plastic. Additionally, boat that made from the timber is noticed to have high possibility to crack at the different side of the boat with heavy wave and other accident. Moreover, shortage of timber also happens for making wooden boat in the area as well as in the country in general. But, the plastic bottles are dropped by users after drinking the liquid parts and in the long run may impacts on the environment. Hence, recycling of such materials for different purposes, like for boat is environmentally important.

The specific objectives of the study were;

- To evaluate plastic bottles as a use of fishing boat on Lake Langano and Lake Ziway.
- To assess feedback information on plastic battle for further technology development/improvement

Materials and Methods

Area Description

Technology demonstration and evaluation was conducted in Central Rift-Vally Lake with fishermen on Lake Ziway and Langano. Lake Zeway is bordered and hence controlled by three districts belonging to two administrative Zones of Oromia regional state. East Shoa Zone (Dugda and Adami Tullu Jiddo Kombolcha district bordering the Lake in North-west, and Western to South- Western part respectively, while Arsi Zone with Zeway Dugda district bordering the Lake in eastern to South-Eastern part. The lake extends over an area of approximately 434 km^2 and has a maximum of 9 m and an average depth of 2.5 m with a shoreline length of 137 km. (Hengsdijk and Jansen, 2006). It has a maximum length of 32 km and maximum width of 20 km. It is the most upstream of the Central Rift Valley (CRV) lakes of Ethiopia.

Besides seasonal runoff and groundwater movement, runoff from the watershed drains into the lake through the two Feeder Rivers – the Katar from East and the Meki from North West which and has one outflow in the South, Bulbula River which flows into Lake Abiyata. Lake Langano is also one of the Central Rift Valley Lake which is 200 km by road south of the

capital Addis Ababa between East Showa and Arsi Zone. It is 18km long and 16km wide, with the maximum depth of 46 meters. The main source of water via several small rivers is from Arsi Mountains.

Site and fishermen selection

Demonstration and Evaluation of plastic bottles as a use of fishing boat was conducted in two potential lake of East Showa Zone at Lake Ziway and Langano. Purposive sampling method was employed to select one representative landing site from each lake based on its accessibility. 28 Active fishermen were selected from each water body based on interest to be held as group for technology evaluation.

Materials used and plastic boat design

Materials needed for the production of plastic boat such as plastic bottle, a few wooden and rope were prepared and used for making plastic boat based on the research action plan and schedule. A total of 1969 and 200 empty west plastic bottles (Selam) having the capacity of 2000 ml was collected from the surrounding to construct the boat and "Yebela" respectively. Also thin rope used to tight the plastic bottles based on the designs.

During the construction of plastic boat (figure 1 (a)) the structure of the boat had three view parts. The first one is behind view that had 1.57 m and 1.45m length at the top and bottom part respectively. The second view is inside part which had 4.33 m total length and 2 m total width. The final view was side view that had 45 cm height. In addition to west plastic bottle "Yebela" was made with 2.7 m of total length and .70 m width (figure 1 (b)).

Technology evaluation and demonstration techniques

Training was given for fishermen, Development Agents and Experts before the actual technology demonstration. Technology demonstration was conducted in the presence of fishermen and different stakeholders. The plastic boat was tested and compared with local boat and used both method and result demonstration techniques. Participatory approach such as Farmers Research Extension Group (FREG) was the main strategy used during demonstration of the technology.

Data collection and analysis

To obtain the relevant information, quantitative and qualitative data were used and collected through interview and group discussion. Secondary data also used from literature and office of agriculture. For quantitative data analysis, descriptive statistics such as percentage and frequency were employed and described in tables. Fishermen provide feedback and analyzed through absolute category test (five level scales). All others necessary qualitative information that collected through verbal discussions were carefully recorded on note book and systematically narrated. Finally, plastic Boat and Yebala was evaluated in terms of cost with comparing locally available boat/yebala.

Results and Discussions

Training on capacity building

The research team was provided capacity building program at each selected site for fishermen, Development agent and experts. About 18 and 19 participants were participated in training at Lake Ziway and Langano respectively. Totally, 37 participants who are 29 fishermen, 3 DAs and 5 experts were attend training on utilizing plastic bottle as the use of boat and its significance in fishing activities. It also gave an overview on strengthening linkage among stakeholders especially, agriculture and natural resource office, research center and fishermen through crating joint action.

Table 1: Training participants on plastic boat use

Lake	Participants	Male	Female	Total
Ziway	Fishermen	15	-	15
	Experts	2	-	2
	DAs	1	-	1
	Fishermen	14	-	14
Langano	Experts	3	-	3
	DAs	2	-	2
Ground total		**37**		**37**

Mini filed day was used as strategy to share information and evaluate the prepared technology trough practical operating Plastic Boat and Yabala on the lake. During mini field day a total of 36 stakeholders were participated. Then, feedback data were immediately collected from participants; fishermen, Development Agents and Experts.

Fishermen perception

Evaluation was made to know how fishermen perceived on demonstration of plastic boat/yebala. As evaluation criteria fishermen specified and focus on plastic boat/yebala making and operation status, portability of technology, safety and suitability in fishing activities, resistance to strong wind, Speed, Price to afford technology and its relation with environment. Before making any response those fishermen were test plastic boat as use of fishing boat. Among the fishermen interviewed 58.82% and 41.18% had responded that it was simple and medium to made plastic boat (table 2). Regarding on operation status the technology is very simple to all fishermen to control on the lake. This result is due that those fishermen have a long history on utilizing manual operating boat in fishing sector.

As far as portability of technology concerned all (100%) respondent fishermen responded that the demonstrated technology was very simple and easy to transport plastic boat from place to place. Traditionally, after completion of fish harvesting fishermen allow to stay almost all fishing material (especially boat) on the border of lake. Now a day, fishermen were exercise with continues losing of those materials due to theft and invasive movable weed water hyacinth. As fishing communities specified that, under this challenge still not change the customary practice to move those wooden plastic boats from shore line of lake after completing fishing activities due to overweight of the wooden boat. But, this plastic boat is very light and easily move from landing side to home that help to save fishing material from an expected theft and damage.

Table 2: Fishermen feedback on plastic boat making, operation and portability status (N=34)

No	Criteria	Response level	No of respondents	Percentage (%)
1	Plastic boat making	Very simple	0	0
		Simple	20	58.82
		Medium	14	41.18
		Difficult	0	0
2	Operation status	Very simple	34	100
		Simple	0	0
		Medium	0	0
		Difficult	0	0
3	Portability of technology	Very simple	34	100
		Simple	0	0
		Medium	0	0
		Difficult	0	0

Fishermen are mainly making fishing activities at evening and early morning from the maximum depth of lake. Under this situation, strong wind and other unexpected challenge may happen in the middle of lake on day or night time. So, safety of fishing materials is the main criteria for those fishing community to overcome sudden change of Lake Environment. As evaluation process, safety of the plastic boat was also considered as one main criterion with comparing the local wooden boat. From interviewed result, about 58.83%, 11.76% and 29.41% of the respondent responded that safety of plastic boat is very low, low and medium respectively. They also stress that, the prepared plastic yebala is not resist the strong wind that continuously happen on the lake during fishing activities.

On the other hand, all fishermen responded that plastic boat had high speed than the local wooden boat due to its low weight. On price of afford technology; about 70.59% and 29.41% of respondents fishermen responded that the cost of technology was medium and low to afford the technology (table 3). The new boat is easily made from everywhere the local available plastic bottle. Again, the respondent had a positive view with ideas as it is totally environmentally friend.

Table 3: Feedback on safety, speed, price and its environmental situation relation (N=34)

Criteria	Response level							
	High		Medium		Low		Very low	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Safety	0	0	10	29.41	4	11.76	20	58.83
Speed	20	58.82	14	41.18	0	0	0	0
Price to afford technology	0	0	24	70.59	10	29.41	0	0
Environmentally friend	34	100	0	0	0	0	0	0

Cost analysis

In cost analysis the Plastic Yebala and local made wooden Yebala were compared and analyses in terms of cost needed. On the other hand Plastic Boat and local made plastic boat were compared for making cost analysis for utilizing in fishing activities. Empty 1000ml plastic bottle and rope are the main materials that needed for making plastic Yebala. As table 4 shown that, about 900 and 1200 ETB were need for making plastic Yebala and Wooden Yebala respectively. This figure shown that the cost of plastic Yebala decrease by 14.28% than wooden Yebala.

Table 4: Cost analysis of plastic Yebala and Wooden Yebala

Plastic Yebala		**Wooden Yebala**	
Items	**Cost in birr**	**Items**	**Cost in birr**
Plastic bottle	200	Wood	400
Rope	100	Labor	800
Labor	600	-	-
Total cost	**900.00**	**Total cost**	**1,200.00**

On Lake Ziway (Hara Danbale) and Lake Langana wooden boat is the majority operating fishing gear among many fishing communities. It mainly constructed with selected wooden type which tolerate the moisture to serves a long time in fishing activities. In this research plastic boat was evaluated with such wooden local available boat type. The cost of plastic boat and locally wooden boat making was needed 4500 and 7000 birr respectively in which plastic boat decrease by 21.74% than wooden boat (table 5).

Table 5: Cost of plastic Boat and wooden Boat

Plastic Boat		**Wooden Boat**	
Items	**Cost in birr**	**Items**	**Cost in birr**
Plastic bottle	1200	Wood	3000
Rope	400	Nail	800
Some wood	200	Painting cost	600
Labor	2700	Labor	2600
Total cost	**4500.00**	**Total cost**	**7000.00**

Lessons learned and Technology gap

Before technology demonstration theoretical training was given to fishermen from general to on specific prepared technology. From those they understood that the waste plastic bottle used for fishing activities rather than spoiled the environment. Moreover, fishermen were observed and operate the prepared plastic Boat/Yebela on the lake to understand the actual performance of plastic boat in fishing activities. Accordingly, all participants in the demonstration process preferred this technology over the traditional local wooden boat based on different criteria's. But, they forward some ideas that critically need modification before recommending to the end user for fishing sector.

Currently, almost all fishermen were used fishing through manually operated wooden boat for fishing activities. As all stakeholders mentioned that, the prepared wooden boat width was wider than the local wooden boat which is not convertible to operate on the lake special during strong wind. They also told as, as width of boat is wider it need additional force even highly decrease the speed of boat movement that make fishing activities tiring.

On the other hand, fishermen and other stakeholders were evaluate and show technology gap in terms of Yebala length and width status as comparing with the traditional wooden Yebela. From those stakeholders' feedback, the length and width of plastic Yebala was not totally enough for operating on the lake during fish collection. They also mentioned that, Low size of width and length make fishing activities exhausting as the boat luck space for storing and transporting the collected fishing population from any distance of lake to landing site. Even, as they responded that the newly prepared plastic Yebala was lack strong place to murder very huge fish in the deep lake during harvesting time.

Moreover, all stakeholders were not sure to move on the lake with such plastic Yebala for fishing purpose. As they forwarded, plastic Yebala was not to resist the wind due to lack of enough weight. Those all maintained critical point is some of the technology gap given by end user and should be modify before wide utilization in fishing sector.

Conclusion and Recommendation

Plastic bottles as a use of fishing boat was demonstrated in Lake Ziway and Langano with fishermen, development agent and other participants. Site and fishermen were purposively selected based on its accessibility and interest to be held as group respectively. Plastic boat was demonstrated and evaluated with locally available wood boat in different criteria's. Participatory approach such as Farmers Research Group (FRG) was the main strategy used during demonstration of the technology. Capacity building was given for fishermen, development agent and other experts on technology utilization.

Related with feedback collected, the majority of interviewed respondents responded as plastic Boat/Yebala was comparatively good in terms of portability, speed and maintaining environmental pollution with the principle of utilizing waste local available materials. However, regarding of the safety of the technology almost all interviewed respondents were terrified/frightened to utilize for fishing purpose from any distance of Lake. Overall, lack of enough weigh and challenge to operate under wind are the main technology gap that identified by end user. Overall, the study concluded that, plastic yebala is need some modification before forwarding recommendation for further pre-scaling up stage. So, as fishing activity has risky by itself, firstly such technology gap must be understand, completed and further evaluating should be held before forwarding recommendation to utilize technology in fishing sector.

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Pre-Extension Demonstration of Improved Haricot Bean Technologies at Midland Districts of Guji Zone, Southern Oromia, Ethiopia

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Abstract

Participatory demonstration of improved haricot bean technologies was conducted in two potential midland districts of Guji zone in 2020. The main objective of the study was to popularize improved haricot bean variety at midlands of Guji zone. Adola Rede and Wadera districts were selected based on their potential to grow haricot bean and two kebeles from each district were selected in criteria of their accessibility. Participatory approaches were followed to implement the activity. 15 farmers of gender inclusive were established as FRG at each kebele. From one FRG, three experimental farmers were nominated based on their consent to provide sufficient and suitable land for experiment. An improved haricot bean of Ibbado variety with one commercial variety was planted on selected farmers' land with a plot size of 10 m x 10 m. Recommended seed rate of 100 kg ha^{-1} with a spacing of 40 cm and five cm between rows and plants was used respectively and an inorganic fertilizer (NPS) rate of 100 kg ha^{-1} at planting time. Farmers, DAs, SMSs, and different stakeholders were participated on organized training, field visit & joint monitoring and evaluation and field day on which two way communication and experience was shared. Quantitative data such as yield and knowledge change of the farmers were analyzed using independent t test and paired sample t test respectively whereas farmers' feedbacks were analyzed qualitatively. The result of this study showed that mean difference in knowledge score before and after experiment was significantly higher. From the trial 23 quintals ha^{-1} and 12.4 quintals ha^{-1} were harvested from improved and commercial variety respectively. The improved variety also revealed a yield advantage of 85.48% and incremental benefit cost ratio of 19.27 over the commercial. Therefore, recommended for further scaling up.

Key Words: Demonstration, Ibbado, Participatory approach, Midlands

Introduction

Legume seeds are an important staple foods and sources of dietary minerals that potentially provide all of the 15 essential minerals required by humans. Common bean is the most vital grain legume for direct human consumption. The species has high diversity as seen in its morphological variability, uses and growth habits and patterns (Baeta *et al*., 2010; Heuze *et al*., 2013). Other names of the common bean include dry bean, kidney bean, haricot bean, French bean and field bean. It is particularly important legume crop grown worldwide. It grows best in warm climates at temperatures of 18 to 240c (Gebre- egziabher Murtu *et al*., 2014).

Haricot bean plays an imperative role at household level as source of cash, nutrient dense food crop ("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 and nitrogen fixer to replenish soil fertility (Zerihun G. *et al.*, 2017). Haricot bean is an important source of nutrients for more than 300 million people in parts of Eastern Africa and Latin America, representing 65% of total protein consumed, 32% of energy and a major source of micro nutrient, E.g. Iron, Zinc, thiamin and folic acid (petry *et al*., 2015). It is described as non-sensitive crop to soil as long as it is well drained and fertile (Rahaman *et al*., 2014). It can be grown successfully on most soil types, from light sands to heavy clays, but friable, deep and well drained soils are best preferred (Gifole Gidago *et al*.,2011).

According to Margoret *et al*., (2014), common bean in sub- Saharan Africa (SSA) is an important crop for food- security and nutrition. It plays a big dietary role, supplying proteins, carbohydrates, essential elements and vitamins to both rural and urban households. It is estimated that the crop meets more than 50% of dietary protein requirements of households in SSA. The annual per capita consumption is higher among low-income people who cannot afford to buy nutritious food stuff, such as meats and fish (Arenas *et al*., 2013).

Common bean is also a major food and cash crop in Ethiopia as well and it has considerable national economic significance. It is often grown as cash crop by small scale farmers and used as a major food legume in parts of the country where it is consumed in different types of traditional dishes (Kedir Oshne *et al*., 2014). For a very long time, it has been cultivated as a field crop. Moreover, for more than 40 years it has been an export crop (Rahmeto Negash, 2007). Besides, the farmers also grow common bean to use the straw as forage for livestock, source of fuel, mulching, bedding, and covering materials. The production potential of the country, Ethiopia is 17.62 quintals ha^{-1} while the Oromia region and Guji zone is 18.92 quintals ha^{-1} and 18.09 quintals ha^{-1} respectively (CSA, 2021).

The value of Haricot bean in terms of economic return and food security increases with the use of recently adapted varieties that have better yield and resistance to disease and moisture stress. Although there is a general understanding and recognition on the benefit of using improved varieties, the accessibility of improved haricot bean varieties are lacking and farmers are growing unknown varieties in the study areas. This resulted in low productivity of haricot bean. The productivity of haricot bean per unit area could be increased by adopting scientific and suitable management practices using suitable high yielding varieties. As the participatory variety selection trial of haricot bean at multi location and at Adola sub site showed, Ibbado variety was preferred by farmers in its potential to give high yield (27 quintals ha^{-1}), color, palatability, marketable and disease tolerant. Taking in to account the above considerations, this study was made the first move to demonstrate in a systematic manner on farmers' field to show the worth of new variety and convincing farmers to adapt improved production management practices of haricot bean for enhancing productivity of haricot bean production with the aim of popularizing improved haricot bean variety in midlands of Guji zone.

General Objective

- To popularize improved haricot bean variety at midlands of Guji zone

Specific Objectives

The specific objectives of this study were to:

- ✓ Evaluate yield performance of improved haricot bean varieties under farmers' conditions.
- ✓ Assess farmers' feedback for further improvement of haricot bean production.
- ✓ Evaluate the economic profitability of improved haricot bean variety.
- ✓ Enhance knowledge and skill of farmers on production of improved haricot bean.

Materials and Methods

Description of the Study Areas

Adola Rede District

The district is located in Southern part of Oromia, Ethiopia, at a distance of 468 km from Finfinne, the capital of Ethiopia. Astronomically, the district is located between 5º44'10"- 6º12'38" latitudes and 38º45'10"- 39º12'37" longitudes. The district is characterized by three agro- climatic zones, namely humid, sub humid and dry arid zones. In terms of the agricultural calendar, the rain fall pattern of the district is bimodal for lowlands and midland areas and mono- modal for highland parts. The dry arid agro- climatic zones attributed to little rainfall while the humid agro- climatic zones receives extremely high rainfall. Rain-fed agriculture is a common practice for many farm households in this district. However, a semi-nomadic economic activity is also practiced as a means of livelihood by some of its dwellers. The farmers of this district produce both in autumn and spring seasons. They produce cereals such as teff, wheat, barley and maize, pulses such as haricot bean and others such as fruits and vegetables. Overall, haricot bean, maize and teff are the major crops cultivated by the farmers in these study areas. They also engaged in the production of coffee as means of livelihood.

Wadera District

Wadera district is situated at a distance of 535km from Finfinne and 60 km from the zonal capital town, Negele. Astronomically, the district is located between 5º39'5" - 6º2'28" northing latitudes and 39º5'30" - 39º27'52" easting longitudes. It is an area where mixed farming economic activities take place, which is the major livelihood of the people. Wadera district is bordered by Bale zone to East, Girja district to North, Adola Rede and Oddo Shakiso district to the North West and South West respectively and Gorodola district to South East direction. The district is characterized by two types of typical climatic zones, namely, an arid (60%) and semi-arid (40%) climate with mean annual temperature ranges from 12 C^0-34 C^0 and it has a bimodal rainfall pattern. It is the most hot and sub hot condition, which has relatively shorter growing season. The annual rainfall ranges between 915 mm and up to 1900 mm.

The district extends from 500 m and the larger portion of the district lies between 950 m up to 1900 m mean sea level. The long rainy season start from mid-March to May (45-60) days while the short rainy season starts from mid-September to October (30-40 days) in years. The district is drained by Genale, and Sokora Rivers, similarly Banti Stream are the major rivers and streams of the district. The major soils of the district are combo soil, nito soil, fluvial soil, luvi soil, chromic soil, eurtic soil, litho soil are found in the district. The color of the district soil has known as red soil with dominal textures of sand soil. The soil of district for utilization is good under natural vegetation. Generally, Teff, maize, haricot bean, wheat, barley are the major crops produced in the district.

Sites and Farmers Selection

Pre extension demonstration of improved haricot bean technologies was conducted in two potential mid land districts of Guji zone, Adola Rede and Wadera. Purposive sampling methods were employed to select two representative districts and two kebels from each district based on their potential for haricot bean production and their accessibility.

Participatory approach using Farmers Research Groups (FRGs) were the main strategy used during demonstration of the technologies. Selection of FRGs member farmers was based on farmers' consent to be held as member, accessibility for supervision of activities, good history of harmony with groups and genuineness and transparency to share innovations to other farmers. Hence, one FRG having 15 members including gender with proportion of 70% to 30% men and women respectively was established at each kebele. Three experimental farmers were nominated among FRGs member farmers based on their interest to provide sufficient and suitable land for experiment, vicinity to roads for 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 other farmers and share knowledge, skill and experience for further promotion mechanism. Consequently, three representative experimental farmers were selected at each kebele from each FRG while the rest FRG member regrouped by their village cluster proportionally.

Table l. Number of FRG members established in each demonstration site.

Districts (kebeles)	No of FRG	Composition of FRG members by gender		
		Male	Female	Total
Adola Rede (Kiltu Sorsa and Gobicha)	2	20	10	30
Wadera (Tulam-Oda Dima and Calo)	2	20	10	30
Total	4	40	20	60

Materials Used and Field Design

An improved haricot bean variety (Ibbado) with one commercial variety was planted on selected farmers' land at a plot of 10 m x 10 m in the main cropping season. The varieties were treated with full recommended haricot bean production and management packages. The recommended seed rate of 100 kg ha^{-1} with a spacing of 40 cm and 10 cm between rows and plants respectively was used and inorganic fertilizer (NPS) rate of 100 $kgha^{-1}$ at planting time. All agronomic practices and land preparation like ploughing three up to four times using oxen plough, planting, weeding, leveling, harvesting and threshing were carried out by FRGs member farmers.

Technology Demonstration and Evaluation Methods

For the sake of enhancing efficiency and effectiveness, participatory approach was followed. Thus, FRG members were encouraged to participate on different extension events organized at each trial site. These were mechanisms used to enhance farmer-to-farmer learning and information exchange such as training, field day, joint monitoring and evaluation like regular field visit by extension agents and extension counterparts at different crop stages etc.

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 haricot bean production activities to fill the gap on knowledge, skill and attitude (KSA). Thus on spot training was organized.

Field Day

Field day is a method of motivating people to adopt new practices and variety/es by showing what has already achieved under field conditions. In other words, it is to show the performance and profitability of new practices/technology/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. Therefore, mini field day was organized. Besides, 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 needed.

Data Type and Method Data of Collection

Both qualitative and quantitative data were collected. Grain yield, cost and income gained were recorded. Total number of farmers participated on training; field visits and mini field day were recorded by gender composition using data collection sheets through observation and measurement. Farmers' feedbacks were collected using checklist by conducting group discussion and key informant interviews.

Variety Preference Using Direct Matrix Ranking

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

Data Analysis

The collected agronomic data was organized, summarized and analyzed by statistical tool (T test) using Statistical Package for Social Science (SPSS) Version 20. Independent T test was used to compare the mean yield of two varieties. The financial data was employed to analysis the costs incurred and the net benefit gained from the production of each variety and location used for the demonstration using excel and presented by table. The calculations were done by converting the parameters per hectare. The final selling price used was the farm gate selling price during the harvest season. Farmers' variety preferences were also analyzed qualitatively. Knowledge level of the farmers at pre and post experiment about improved production practices of haricot bean was measured and compared by applying dependent t test. The dependent t test is often used to compare 'pre' and 'post' scores in experiments for the determination of the significant change that has occurred. It compares the means of two conditions in which the same (closely matched) participants participated. Two samples are said to be dependent on each other when the elements of one are related to those of the other in any significant or meaningful manner. In fact the two samples consist of observations made of the same objects, individuals or more generally, on the same selected population elements.

Yield Advantage

The yield advantage of improved haricot bean technology over commercial is calculated in the following formula.

$$\text{Yield advantage\% of Ibbado} = \frac{\text{Yield of Ibbado variety - commercial}}{\text{Commercial}} \times 100$$

Results and Discussion

Yield Performance of Demonstrated Varieties

Table 2 below shows the result of yield performance of the varieties demonstrated. According to the results, a mean grain yield of 23 and 12.4 quintals ha^{-1} was obtained from Ibbado and commercial varieties, respectively.

Table 2.Comparison of mean yield of haricot bean varieties demonstrated.

Mean yield of haricot bean varieties demonstrated (quintalsha^{-1})								
Varieties	Mean [Std. Deviation]	Stad. Er mean differenc e	Cal. t value	Tab. t value at v 22	P value	95% Confidence interval		Yield advantage (%)
						Lower	Upper	
Ibbado	23[0.759]	0.266	39.855*	1.717	0.044	10.401	10.799	85.48
Commercial	12.4[0.523]							

**Significant at 5% probability level, v is degree of freedom and std. deviation in parenthesis*

As clearly indicated in table 2, information such as calculated t value (39.855) greater than the tabulated t value (1.717), the confidence interval does not contain zero value and the p value (0.044) greater than the alpha value (0.05). This shows that the mean difference in grain yield between the two varieties were significantly higher. The mean yield of pre extension demonstration of improved haricot bean variety (Ibbado) was greater than the previous demonstration result which was 20.5 quintal ha^{-1} (Kebede *et al*., 2018). However, it was less than 27 quintals ha^{-1} obtained during participatory variety selection (Tekalign *et al.*, 2020). This yield difference could be associated with disparities in management practices and the fertility status of the soil. Yet the variety still had an extra yield advantage than their commercial check (table 2).

Feedbacks and Preferences of Farmers

Farmers' preferences towards the demonstrated haricot bean varieties were assessed by enhancing them to reflect their preference to varietal attributes by setting their own varietal selection criteria. During the course of the demonstration process and at the final stage of the activity, an assessment was made to know how the farmers perceived the technologies. Results of the assessment revealed that improved haricot bean variety liked by farmers as it can tolerant disease and drought conditions, matures early and attributes for double cropping. Color, marketability and palatability were also the best traits preferred by farmers. Consequently, the participant farmers preferred improved haricot bean variety (Ibbado) as their first choice.

Table 3.Direct matrix ranking of the varieties demonstrated based on farmers preferences (N= 20).

Variety	Rank	Reasons
Ibbado	**1st**	Very good yield, drought tolerant, disease tolerant, early mature, marketable, preferred color and palatability
Commercial	**2nd**	low yield, susceptible to disease, not tolerant to drought, not as such marketable and its palatability not as such Ibbado

Capacity Development and Experience Sharing

On spot training on full package of haricot bean production methods and management practices and concepts and principles of Farmer Research Group (FRG) was given to farmers, Development Agents (DAs), and Subject Matter Specialists (SMSs) before starting the activity. Exchange visit was also conducted between two sub FRG groups (five members each) and lesson was learnt on the field about the performance of the technologies happened due to strengths and weaknesses of the members in management practices. As indicated in table 4 below a total of 73 participants attended the training and exchange visit. In order to show the performance of the demonstrated haricot bean varieties and create awareness, mini field day was arranged on which FRG member farmers shared experience and knowledge of production about demonstrated haricot bean varieties to the participants. A total of 46 participants were participated (table 4).

Table 4.Capacity building methods and participants

Capacity building methods	**Participants**	**Number of participants from both Adola Rede and Wadera districts**		
		Male	Female	Total
A. On spot training	Farmers	40	20	60
	DAs	3	1	4
	SMS	2	-	2
B. Exchange Visit	Farmers	8	2	10
	DAs	1	1	2
C. Mini field day	Farmers	29	11	40
	DAs	3	1	4
	SMS	2	-	2
D. Joint monitoring and Evaluation	Farmers	15	5	20
	DAs	3	1	4
	SMSs	3	-	3

Monitoring and Evaluation

The activity was monitored majorly by researchers and Agriculture and Natural Resource Office of the districts which they represented by the development agents (DAs) in the peasant associations. The DAs see and monitor the activity day to day since they are nearer to the farmers' jurisdiction and also give technical assistant to the farmers. Joint monitoring and evaluation of the activities was conducted among the participating farmers of the districts based on the necessities and requirements. As a result, DAs, SMSs and researchers had offered advice based on the practical problem observed on the trial sites.

Economic Analysis of Haricot Bean Varieties Demonstrated

Production costs and returns of demonstration of haricot bean varieties were collected from experimental farmers. Production costs included were variable and fixed costs. Variable costs like for land preparation, seed, fertilizer (DAP), and planting, weeding, harvesting, threshing, sack and for transaction cost. Fixed cost referred here was cost for land contract. This cost was included in this experiment as all the farmers in the study areas could not own enough farm land and contract some from their fellow farmers. So, this fixed cost parameter helps us to have insight about the profitability of this crop enterprise as a business for rented farm land as well. During the production season the average fixed cost of farm land for one season was 2000 ETB ha^{-1} at the study areas. Average farm gate price of improved haricot bean (Ibbado) and commercial varieties at market during 2020 production season was 25 ETB Kg^{-1} and 20 ETB Kg $^{-1}$ respectively. The variation in price was due to color and palatability attributes. Pre-extension demonstration of improved haricot bean was profitable with net return of 44387 ETB ha^{-1} and 13187 ETB ha^{-1} from improved variety (Ibbado) and commercial respectively. As shown in table 5 below the improved variety was more profitable than the commercial variety with incremental benefit cost ratio of more than 15 indicating that with some additional cost to the improved variety, there was higher benefit cost ratio which is economically more feasible over the farmers'(commercial) variety.

Table 5.Economic analysis

Variable	Cost of cultivation	Growth return	Net return	Benefit cost ratio
Ibbado	13113	57500	44387	3.39
Commercial	12013	25200	13187	1.01
Additional in demonstration	1100	32300	31200	28.36*

Incremental benefit cost ratio

Knowledge Level Before and After the Trial Period

Knowledge level and skills of respondent farmers on various aspects of improved haricot bean production technologies before conducting the demonstration and after implementation was measured and compared by applying dependent t test. A list of simple yes or no and open ended questions were designed and administered to a total of 12 experimental farmers to rate their knowledge level before and after the trial period. Farmers were subjected to the same questions at both occasions. The questions were asked during training period before starting the experiment and after the experiment. It was revealed in table 5 that farmers' mean difference in knowledge score before and after implementation of demonstration was 15.75. The mean difference in knowledge score of farmers was observed significantly higher. The computed value of t (44.34) was statistically significant at 5% probability level. It means there was significant increase in knowledge level of the farmers due to demonstration. This shows positive impact of demonstration on knowledge of the farmers that have resulted in higher adoption of improved farm practices and improved haricot bean. The results so arrived might be due to the combined effect of concentrated educational efforts made by the researchers and the potential of the improved haricot bean variety, proved itself to give maximum yield.

Table 6.Difference mean score in knowledge levels of respondent farmers (n=12).

Farmers knowledge score before and after demonstration	Std. deviation of mean difference in knowledge scores	Stad. Error of mean difference	Calculated t value	Tabulated t value at v = 11
15.75	1.23	0.093	44.34*	1.796

** Significant at 5% probability level, v is degree of freedom*

Conclusions and Recommendations

Despite the widely cultivation of haricot bean in the midland districts of Guji zone, the production and productivity of the crop is very low. The low productivity of haricot bean is stemmed from among others, inaccessibility of improved varieties and poor management practices in the study areas. Taking this in to consideration, the pre-extension demonstration of improved haricot bean technologies was conducted in Adola Rede and Wadera districts purposively because of accessible and potential districts for haricot bean production. The main objective of the study was to popularize improved haricot bean variety at midland districts of Guji zone. Participatory research approaches were followed in implementing the activities. Independent and paired sample T tests, and excel were used to calculate the mean grain yield and change in knowledge level of farmers and economic viability of the demonstrated technologies respectively. The results indicated that the improved variety gave promising yield (23 quintals ha^{-1}) having a yield advantage of 85.48% over farmers' (commercial) variety. Furthermore, the improved variety is profitable with incremental benefit cost ratio of 19.27. The knowledge level of participating farmers was found to be changed positively towards the production and management practices of improved haricot bean variety. This was happened due to the concentrated and committed effort of the researchers in imparting knowledge. Based on farmers' preference criteria like yield, drought tolerant, disease tolerant, early maturity, marketability, color and palatability, Ibbado variety was selected as first choice and farmers of the areas were demanding for scaling up and popularization.

Based on the findings of this study the following recommendations were drawn: The demonstration activity did not ensure the wider popularization of this improved variety as the amount of seed and land used, and number of farmers participated were minimal. Therefore, recommended for up scaling in the midland districts of Guji zone. To do so, it is procedurally allowed to go a step ahead for Agricultural Research Extension Division. However, for the scaling up activity to proceed, Agricultural Research Extension Division of Bore Agricultural Research Center (BoARC) needs to secure seed of Ibbado variety. It is strictly recommended that Office of Agriculture and Natural Resource at zonal level should take these recommendations and aware their fellow office at midland districts the way Ibbado variety of haricot bean could be multiplied. So that farmers in the midland areas could easily access and use haricot bean of Ibbado variety. Any development agents and researchers working with farmers should respect farmers' belief, value and culture and patiently coach farmers the way they could easily understand about the technologies under demonstration.

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Pre extension demonstration of improved potato at midland districts of Guji Zone, Southern Oromia, Ethiopia

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Abstract

Highland and midland districts of Guji are well potential for potato production. However, there is shortage of extension service in providing improved potato varieties and lack of farmers' knowledge and skill on potato production. So that this pre extension demonstration of improved potato was initiated to evaluate yield and profitability of improved potato varieties, to enhance the knowledge and skills of farmers' on production of potato and to identify farmers preference of varietal traits for potato production. The study was conducted during 2020 year at Adola Rede and Wadera districts. Two kebeles per district was selected based on their potato production potential. Gudane and Bubu varieties were demonstrated on 5mx5m area with seed rate of 18 quintals/ha, 75cm between rows and 30cm between tubers. 200kg/ha NPS and 100kg/ha of UREA fertilizers were applied. Data was collected by measurement, observation and interview and analyzed by descriptive statistics, net benefit analysis, matrix ranking and t test. Training, exchange visit and mini field day were used to increase knowledge and skills of farmers' on potato production. The result of this demonstration indicated that high yield (209.17 qt/ha) was obtained from Gudane variety than Bubu variety (158.33 qt/ha).In addition, Gudane variety had more number of tubers than Bubu. Both varieties give more yield at Adola Rede than Wadera district. The result of t-test (p =.042 <.05) showed that there was significant difference (at 5%) in yield between Gudane and Bubu variety. Gudane variety generated a net benefit of 13313.33 ETB/ha than Bubu variety (88813.13ETB/ha). Gudane variety was selected by experimental farmers based on its high yield, more disease tolerant, more number of tubers per plant and non-lodging status than Bubu variety. Thus, pre scaling up of Gudane variety was recommended for potato production in the study area.

Key words: *Gudane, Bubu, Potato, Demonstration, Guji*

Introduction

In Ethiopia, potato (*Solanum tuberosum* L.) has improving the quality of the basic diet in both rural and urban areas (Abebe *et al*., 2017). Potato became one among the most economically important crops as a source of food and cash especially on the highland and mid-altitude areas of the country (Adane *et al.*, 2010). Potato has been considered as a strategic crop to enhance food security and economic benefits to the country (Korji and Kebede, 2017). In Ethiopia about one million farmers produced potato on 85,988 hectares. Almost halve of this area (41,734ha) was produced in Oromia region. However, productivity of crop at the region is lower than the national which was 120 and 132 qt/ha respectively (CSA, 2021).

The potential for high yield, early maturity, and excellent food value give the potato great potential for improving food security, increasing household income, and reducing poverty (Devaux *et al.*, 2014). It contains practically all essential dietary constituents like carbohydrates, essential nutrients, protein, vitamins, and minerals (Sriom *et al*., 2017).

The government of Ethiopia and its agricultural research institutions have invested a lot of money and time to improve potato production for smallholder farmers (Basha *et al.*, 2017). Over 32 improved varieties were released and/or recommended for wider and specific production areas in different parts of the country (Abebe, 2019).

Highlands and midlands of Guji are highly suitable for potato production. Despite the zone is potential the production of crop is mainly characterized by lack of improved varieties and inaccessibility of tuber seed for farmers. To solve these problems adaptation of different potato varieties were done at different parts of the zone. The result showed that Bubu (39.64 t/ha) and Gudane (39.25 t/ha) were recommended for production at midland areas (Arega and Solomon, 2021). However, adaptation study by biological researchers may not fulfill farmer's preference for varieties unless farmers themselves observed the varieties on their field. Thus, pre extension demonstration is important for further promotion of improved potato varieties in the target areas. Therefore, this activity was initiated with the objectives to evaluate yield performance of improved potato varieties under farmers' condition, to enhance the knowledge and skills of farmers on production of potato, to estimate profitability of potato production at the study area and to identify farmers' preference of varietal traits for potato production.

Research Methodology

Description of study areas

Adola Rede District is located in Southern part of Oromia, Ethiopia, at a distance of 468 km from Finfinne, the capital of Ethiopia. The district is located between 5º44'10"-6º12'38" latitudes and 38º45'10"-39º12'37" longitudes. The district is characterized by three agro-climatic zones, namely humid, sub humid and dry arid zones. In terms of the agricultural calendar, the rain fall pattern of the district is bimodal for lowlands and midland areas and mono-modal for highland parts. The dry arid agro-climatic zones attributed to little rainfall while the humid agro-climatic zones receive extremely high rainfall. Rain-fed agriculture is a common practice for many farm households in this district. However, a semi- nomadic economic activity is also practiced as a means of livelihood by some of its dwellers. Teff, wheat, barley and maize, pulses such as haricot bean, and others such as fruits and vegetables

were produced by farmers in the district. They also engaged in the production of coffee as means of livelihood.

Wadera district is situated at a distance of 535 km from Finfinne and 60 km from the zonal capital town, Negele. Astronomically, the district is located between 5^0 39'5"–$6^0$2'28" northing latitudes and 39^0 5'30" –39^0 27'52" easting longitudes. Wadera district is one of agro pastoral district of Guji zone bordered by Bale zone to East, Girja district to North, Adola Rede and Odo Shakiso district to the North West and South West respectively and Goro Dola district to South East direction. The district is characterized by two typical climatic zones, namely, an arid (60%) and semi-arid (40%) climate. The annual rainfall ranges between 915 mm and1900 mm and mean annual temperature of 19°C. The larger portion of the district lies between 950-1900 masl. Generally, teff, maize, haricot bean, wheat, barley, tubers and fruits are the major crops produced in the district.

Site and experimental farmers' selection

Adola Rede and Wadera districts were selected purposively based on potential potato production and accessible for monitoring the activity. From each district two kebeles were selected based on their potential production for potato variety. At each *kebele* 15 farmers were grouped as one Farmer Research Group (FRG).From each FRG two experimental farmers were selected based on their willingness to provide land for the activity. Totally there were experimental farmers at Adola Rede district and 4 experimental farmers at Wadera district. Due to covid-19 and insecurity at Wadera district the activity was not appropriately monitored on time so that two experimental farmers' data was missed for data analysis.

Materials used and research design

The two improved Irish potato used for demonstration were Gudane and Bubu varieties. The activity was conducted during 2020 cropping season. Land was prepared by farmers during onset of rain mainly in April month. For each variety 5mx5m area was used with seed rate of 18 quintals/ha. 200kg/ha NPS and 100kg/ha of UREA fertilizers were applied. UREA was used in the form of split (1/2 at planting and ¼ at earthing and ¼ at flowering stage). A space of 75cm between rows and 30cm between tubers were used. Weeding, hoeing and earthing up were done by farmers.

Methods of data collection and analysis

Yield data, farmers' preference and costs of potato production were collected by measurement, observation and interview. The collected data was analyzed by descriptive statistics, net benefit analysis, matrix ranking and t test. Tables and histogram were used to present the data.

Results and Discussions

Capacity building

The main intention of agricultural extension is to enhance the knowledge and skills of farmers on recommended agricultural technologies. Therefore, during this demonstration farmers' knowledge and skills were enhanced by training, exchange visit, mini field day and monitoring and evaluation on demonstrated potato varieties (Table 1).

Table 1. Capacity building and number of stakeholders participated on potato demonstration

Capacity building methods	Stakeholders	Composition		
		Male	Female	Total
On spot training	Farmers	40	20	60
	DAs	3	1	4
	SMSs	2	-	2
Exchange visit	Farmers	8	2	10
	DAs	1	1	2
	SMSs	-	-	-
Mini field day	Farmers	29	11	40
	DAs	3	1	4
	SMSs	2	1	3
Monitoring & Evaluation	Farmers	15	5	20
	DAs	3	1	4
	SMSs	3	-	3

Yield and tuber/plant of demonstrated varieties

Table 2 indicated that Gudane variety gave higher yield (209.17 qt/ha) than Bubu variety (158.33 qt/ha). This yield result was much lower than the participatory variety selection by Arega *et al.*, 2021 who reported 438 qt/ha and 417qt/ha for Gudane and Bubu variety respectively. This could be due to location (soil) variation, management practices or other constraints. In addition, Gudane variety had more number of tubers per plant (13.33) than Bubu variety (11.83).In both varieties more yields was obtained at Adola Rede district than Wadera district (Figure 1).

Table 2.Yield performance and number of tubers/plant of potato demonstration

Variety	Parameters	N	Min	Max	Mean	Std. Dev	Independent t test result t-test for Equality of Means			
							T	Df	Sig. (2-tailed)	Mean difference
Gudane	Yield (qt/ha)	6	150	250	209.17	38.78	2.336	10	.042	50.833
	Number of tubers/plant	6	7	22	13.33	5.57				
Bubu	Yield (qt/ha)	6	120	200	158.33	36.56				
	Number of tubers/plant	6	6	17	11.83	4.12				

Independent t test was used to explain the mean yield (qt/ha) difference between potato varieties. A significance value of .042 (less than .05) indicates that there was a significant difference mean yield between Gudane and Bubu variety. Based on the results of independent t-test ($p = .042 < .05$), it was concluded that there was significant difference in yield between Gudane and Bubu variety in the study area (Table 2).

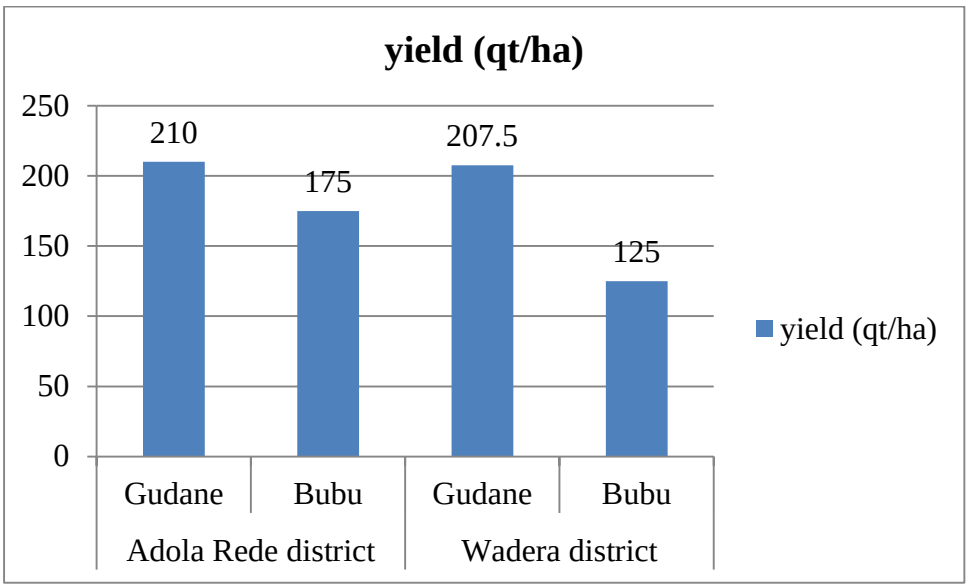

Figure 1. Yield performance across districts

Profitability of potato demonstration

During production season one quintal (1qt=100kg) was sold by 800 ETB (Ethiopian birr) at harvesting time. Cost of seed (tubers) of Bubu during plantation was 1200 ETB/qt. Gudane variety was 1000 ETB/qt. For one hectare 18 quintals was recommended. Two quintals of NPS and one quintal of UREA was the recommended for potato production. One quintal of NPS costs 1400 ETB and UREA costs 1400 ETB. Therefore, 4200 ETB was required for total fertilizers required for potato production. Total variable costs included for potato production was costs of seed, fertilizer, sowing, weeding, harvesting and other costs. Fixed cost was the cost of land used for potato production. Total revenue was calculated as yield obtained times farm gate price and gross margin is calculated as total revenue minus total variable costs. Net benefit was calculated as gross margin minus fixed cost. Accordingly, Gudane variety generated higher return (133133.33 ETB) than Bubu variety (88833.33 ETB). This showed

that potato production at midland districts of Guji was profitable for farmers. The high standard deviation on net benefit might be due to variation of experimental farmers' management on potato production. Good managements (weeding and earthing up of potato) increase the yield which had direct impact on net benefit.

Table 3. Profitability of potato demonstration

Parameters	Bubu variety		Gudane variety	
	Mean	Std. Dev.	Mean	Std. Dev
Yield/ ha in quintals	158.33	36.56	209.17	38.78
Farm gate price	800.00	.000	800	.00
Cost of seed	21600.00	.000	18000.00	.00
Cost of fertilizers	4200.00	.000	4200.00	.00
Cost of weed	3450.00	561.25	3450.00	561.25
Cost of sowing	975.00	133.23	975.00	133.23
Other costs	208.33	80.10	208.33	80.10
Cost of harvesting	675.00	98.74	675.00	98.74
Total fixed cost	6000.00	.00	6000.00	.00
Total variable costs	31108.33	785.12	27508.33	785.12
Total costs	37175.00	806.07	33508.33	785.12
Total revenue	126666.67	29248.36	167333.33	31026.87
Gross margin	95558.33	28750.94	139825.00	30676.21
Net benefit	88833.33	29235.71	133133.33	31026.87

Farmers' preference on potato production

Experimental farmers of the study were asked to traits preferred on potato production in their area. Yield per hectare, disease reaction, lodging status and number of tubers per plant were identified by farmers as the most traits used for potato production in midland areas. The trait number to appear most times said to be the most important trait. In this case trait "yield per hectare" appears more times (three times) in the matrix than any other traits. Therefore, yield trait was considered to be the most traits to be focused on potato research and development (Table 4). Gudane variety gave higher yield than Bubu variety. But the seed size of Bubu variety was greater than Gudane. Maturity, marketability and sweetness traits were the same for both varieties. Gudane variety was more disease reaction, had more number of tubers per plant and lower lodging status than Bubu. Thus, farmers selected Gudane variety for potato production in their area (Table 5). This variety selection was in line with Arega *et. al.*, (2021).

Table 4.Farmers' selection trait on potato varieties (n=6)

	Yield	Lodging status	Disease reaction	Number of tubers per plant	Total score	Rank
Yield					3	1
Lodging status	Yield				0	4
Disease reaction	Yield	Disease reaction			1	2
Number of tubers per plant	Yield	Number of tubers	Disease reaction		1	2

Table 5.Direct ranking of potato varieties by farmers (n=6)

Selection criteria	Yield	Disease reaction	Number of tubers	Lodging status	Total score	Rank
Relative importance	4	3	3	2	-	-
Bubu	16 (4)	9 (3)	6 (2)	9 (3)	40	2nd
Gudane	20 (5)	9 (3)	9 (3)	9 (3)	47	1st

Note. Numbers in the bracket indicates the performance rating value of each variety given from 1-5 (5 = excellent, 4 = very good, 3 = good, 2 = poor and 1 = very poor) and numbers written outside the bracket indicate total score which was obtained by multiplying the relative weight by the performance rating number in the bracket. The relative weight (5 = the most important, 4 =very important, 3 = important, 2 = somewhat important, 1 = little important).

Conclusions and Recommendation

Pre Extension Demonstration of potato was done in midland areas of Guji zone to evaluate yield and profitability of improved potato varieties. Two improved potato varieties namely Bubu and Gudane were demonstrated on farmers' field. Higher yield was obtained from Gudane variety (209.17 qt/ha) while lower yield was obtained from Bubu variety (158.33 qt/ha). Production of Gudane variety generated a net benefit of 133133.33ETB/ha than Bubu variety (88813.13). Variety that generates more yields was preferred by farmers. Gudane variety was selected by experimental farmers based its high yield, more disease tolerant, more number of tubers per plant and non-lodging status than Bubu variety. Gudane variety was more selected by farmers at midland areas. Thus, pre scaling up of Gudane variety was recommended for potato production in the study area.

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Pre extension demonstration of oat technologies at midland areas of Guji Zone, Southern Oromia

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Abstract

Ethiopia is leading Africa in number of livestock but production and productivity of livestock at household level is low. In midland districts of Guji zone there was lack of improved forage varieties due to lack of demonstration. So this demonstration was initiated to evaluate improved oat varieties, increase the knowledge and skills and to identify farmers/agro pastorals preference on improved oat varieties. Jasari and ILRI 5453 oat varieties were demonstrated on 100m^2 areas of 8 experimental farmers and 7 agro-pastorals at Adola Rede and Wadera district respectively. Training and exchange visit were used to increase farmers' and agro-pastorals' knowledge and skills on oat production. Observation, measurement and interview were used to collect the data. Data was analyzed by t test, mean and narration form. The result of demonstration showed that more seed yield (37.47qt/ha), high dry biomass (2.02t/ha) and more number of tillers (7.4) was obtained from ILRI 5453 than Jasari which gave a seed yield of 31.47qt/ha, 1.58t/ha dry biomass and 5.8 number of tillers. Both varieties gave good seed yield at Wadera than Adola Rede district. This showed that oat production was more preferable at agro-pastoral area. T-test showed that there was significant difference at (1%) in seed yield and dry biomass between demonstrated varieties. Demonstrated varieties were early matured and hence compatible for double cropping. ILRI 5453 was selected by farmers and agro-pastorals based on its yield, dry biomass and number of tillers. Therefore, ILRI 5453 oat was recommended for further promotion at midlands and agro-pastorals of Guji zone.

Key words: Oat, Jasari, ILRI 5453, Demonstration, Guji

Introduction

Ethiopia has the highest livestock populations in Africa and accounts for 17% of cattle, 20% of sheep, 13% of goats and 55% of equines in Sub-Saharan Africa. Livestock production in Ethiopia is mainly of smallholder farming which accounts for 12%-16% national GDP, 30% of the total agricultural Gross Domestic Product (GDP), 16% of national foreign currency earnings and 30% agricultural employment. Ethiopia holds large potential for dairy development due to its large livestock population, the favorable climate for improved, high-yielding animal breeds, emerging market opportunity, improved policy environment for involvement of private sectors, and the relatively disease free environment for livestock (Tewodros et al., 2019).

Livestock development in Ethiopia are mainly limited by technical problem (insufficient and low quality feed sources) and institutional factors (poor linkages between research centers and end users, limited extension and financial services (Tewodros et al., 2019; Hidosa and Tesfaye, 2018; Emana et al., 2017, MOA, 2013). Due to these problems the production and productivity of livestock remains low. However, the Ethiopian government's second Growth and Transformation Program (GTP II) has envisaged to increasing by 2020 the productivity and total production of livestock through improving genetics and feed services (MOA, 2015).

Feed is the most important input in livestock production and its adequate supply throughout the year is an essential prerequisite for any substantial and sustained expansion in livestock production (Jimma *et al.,* 2016; Jabessa *et al.,* 2020). Feed shortages, poor quality of available feeds and nutrient deficiencies become more acute in the dry season in both the highlands and lowlands. To feed the increasing human population by continuous cereal growing, available grazing is on the decline. Cultivation of forage is not widely adopted and commercial feed production is not developed (Jimma *et al.,* 2016).

Pastoral and agro-pastoral production systems were not given due attention with respect to feed research and development interventions. Feeding guidelines for the different classes of animals and production systems based on available feed resources were scanty. Information on nutritional quality of major feed resources is limited. Improved forages required for on-farm production and research interventions are not adequately available (Jimma *et al.,* 2016).

Despite Guji zone is well known by potential of livestock production the major problem of Guji midland districts was lack of improved forage species. Due to this each year agro pastoral and agricultural offices of the zone were purchased feed resources from other zones due to lack of demonstration and multiplication of forage varieties in their zone. But purchasing feed system is not a sustainable option to solve lack of forage varieties unless adaptation research study followed by demonstration and scaling up of forage varieties were conducted in the area. With the prolonged drought effect the available feed is not sufficient for livestock production. As a result many livestock were died each year.

Tegegne *et al*. (2013) has mentioned that low accessibility of extension services and inadequacy of practical demonstrations as the causes of poor performance of the livestock extension service among small dairy holders. Improved technologies and approaches to mitigate feed problem of agro pastoral should be developed and implemented. One approach could be demonstration of improved forage species to smallholder farmers and agro pastoralist. From adapted varieties Jasari and 5453 were selected based their fresh biomass 1.8 t/ha and 2.2 t/ha respectively. Jasari gave seed yield of 33.3 qt/ha while 5453 was 49.2 qt/ha. Based on their organic matter (Jasari 78.6% and 5453 was 76.4%). With these advantages adapted oat varieties recommended for further promotion in midland Guji zone. Therefore, this activity was initiated to demonstrate adapted oat varieties on farmers and agro pastorals land.

Objectives

1. To evaluate improved oat varieties on farmers and agro pastorals land
2. To improve the knowledge and skills of farmers and agro pastorals in production of oat varieties
3. To identify farmers/agro pastorals preference on demonstrated improved oat varieties

Materials and Methods

Description of study areas

Adola Rede district is 468KM away from the Addis Ababa to the South. The district is bordered by Ana Sora district in the North, Wadera district in the South and Odo Shakiso in the West and Girja district in the East directions. The district has altitude range of 1350-2340 meter above sea level, annual mean of 1000mm rainfall and annual average of 28C° of temperature. Mixed farming, mining and forest product production are the major livelihood of Adola Rede farmers. Adola district has diverse agro-ecologies which are suitable for production of different crops. The rainfall pattern of the district is bimodal for lowland and midland areas and uni-modal for highland parts. Sandy, clay and silt are the major soils of Adola Rede district. Wadera district is one of agro pastoral areas of Guji zone.

Wadera district is situated at a distance of 535 km from Finfinne and 60 km from the zonal capital town, Negele. Astronomically, the district is located between 5^0 39'5"–$6^0$2'28" northing latitudes and 39^0 5'30" –39^0 27'52" easting longitudes. Wadera district is one of agro pastoral district of Guji zone bordered by Bale zone to East, Girja district to North, Adola Rede and Odo Shakiso district to the North West and South West respectively and Goro Dola district to South East direction. The district is characterized by two typical climatic zones, namely, an arid (60%) and semi-arid (40%) climate. The annual rainfall ranges between 915 mm and1900 mm and mean annual temperature of 19°C. The larger portion of the district lies between 950-1900 masl. Generally, teff, maize, haricot bean, wheat, barley, tubers and fruits are the major crops produced in the district.

Sites, farmers and agro-pastorals selection

The experiment was conducted at two midland districts of Guji Zone, Southern Oromia. Purposively, Adola Rede and Wadera districts were selected. Two kebeles per district was selected based on their potential livestock population. There were three experimental farmers/agro-pastorals from each kebele. Experimental farmers/agro-pastorals were selected based on their willingness to provide land for oat production.

Research design and packages used

The activity was done during 2019 and 2020 cropping season. Improved oat varieties of Jasari and ILRI 5453 were demonstrated on 10 m x 10 m land of farmers/agro pastorals. 80 kg/ha of seed rate of oat varieties were sown by 30cm between rows and drilling of seed in the lines of rows. 100kg/ha of NPS and 50kg/ha of UREA was used at planting stage. Sowing was done early May month. Hand weeding, harvesting and threshing were done by farmers with technical support of Bore Agricultural Extension Researchers and Development Agents assigned in kebeles.

Extension methods used

Farmers, agro-pastorals, Development Agents and Subject Matter Specialists (SMSs) were trained on packages of oat production. This training enhanced farmers' and agro-pastorals' knowledge and skills on oat production. In addition, exchange visit and field day was organized for experience sharing and promotion of oat varieties in the study area. Experimental farmers evaluate the performance of oat varieties on their field.

Methods of data collection and analysis

Observation, measurement, interview and focus group discussion were used to collect the yield, biomass and farmers/agro-pastorals preference. The collected data was analyzed by t test, mean, range and narration form. Histogram and table was used to present the results.

Results and Discussions

Capacity building on oat production

The main intention of agricultural extension is to enhance farmers' and agro-pastorals' knowledge and skills on the recommended agricultural technologies. Therefore, during this demonstration farmers and agro-pastorals knowledge and skills were enhanced by training, exchange visit and mini field day on demonstrated oat varieties (Table 1).

Table 1. Capacity building and number of stakeholders participated on oat demonstration

Capacity building methods	Stakeholders	Composition		
		Male	Female	Total
Training	Farmers and agro-pastorals	75	30	105
	Das	9	2	11
	SMSs	7	3	10
Exchange visit	Farmers and agro-pastorals	8	2	10
	Das	1	1	2
	SMSs	-	-	-
Mini field day	Farmers	29	11	40
	Das	3	1	4
	SMSs	2	1	3
	Das	3	1	4
	SMSs	3	-	3

Yield and on farm performance of oat varieties

Higher seed yield was obtained from ILRI 5453 (37.47 qt/ha) than Jasari variety (31.47 qt/ha). The yield result of this demonstration was lower than adaptation result where 49.2qt/ha and 33.3qt/ha for ILRI 5453 and Jasari respectively (Jabessa *et al.*, 2020). This yield difference between demonstration and adaptation might be due difference in management practices between farmers and biological researchers. ILRI 5453 variety had higher dry biomass yield and number of tillers per plant than Jasari.

Table 2. Yield performance of oat varieties

Varieties demonstrated	Parameters	N	Min	Max	Mean	Std. Dev.
ILRI 5453	Seed yield (quintal/ha)	15	30	49	37.47	6.32
	Dry biomass (ton/ha)	15	1.8	2.2	2.02	0.130
	Number of tillers/plant	15	5	10	7.40	1.68
Jasari	Seed yield (quintal/ha)	15	26	35	31.47	2.74
	Dry biomass yield (ton/ha)	15	1.2	2	1.58	0.25
	Number of tillers/plant	15	4	8	5.80	1.14

More seed yield was obtained from Wadera district (agro-pastoral area) than Adola Rede district (more agricultural area) in both ILRI 5453 and Jasari variety. This shows that oat varieties production were more suitable for agro-pastoral areas (figure 1).

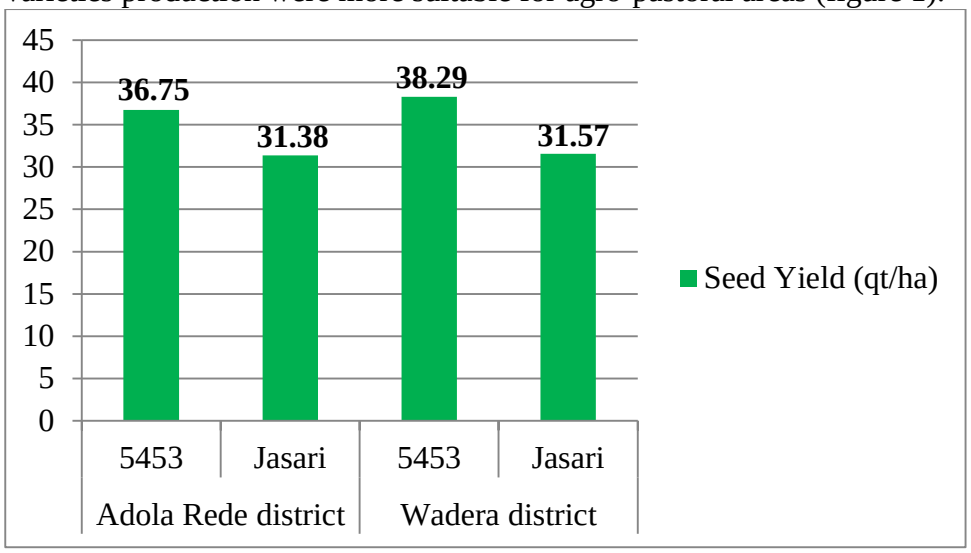

Figure 1. Seed yield across districts

Independent t test was used to explain the mean yield difference between oat varieties. A significance value of .002 (less than .05) indicates that there was highly (at 1%) significant difference yield between ILRI 5453 and Jasari variety. Based on the results of independent t-test ($p = .002 < .05$), it was concluded that there was significant difference in yield between ILRI 5453 and Jasari variety in the study area. Similarly, there was a significant (at 1%) difference in dry biomass yield of demonstrated varieties.

Table 3. Independent t test for seed yield and dry biomass mean between the two varieties

Parameters	t-test for equality of means				
	t	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Seed yield	3.371	28	.002***	6.000	1.780
Dry biomass	5.813	28	.001***	.434	.075

*** indicates significant at 1%

Farmers' and agro pastorals' perception and preference

Demonstrated oat varieties were early matured forage. Unlike other forages which stay long months and not used for double cropping the demonstrated oat varieties were compatible for double cropping when sown at early of May month. Experimental farmers and agro-pastorals mentioned that yield, fresh biomass and dry biomass of oat were used for livestock feeding. It was palatable for cattle both during vegetative and after harvesting so that oat production helped farmers and agro-pastorals both during wet and dry season feeding. Though ILRI 5453 variety had more lodging status than Jasari it was preferred by farmers and agro-pastorals based on its higher dry biomass and yield than Jasari variety. High number of tiller of ILRI 5453 might lead to more lodging when compared to Jasari variety. More fertile land could resulted lodging of ILRI 5453 variety. Therefore, lodging of ILRI 5453 might be determined by fertility of the land.

Conclusions and Recommendation

Pre extension demonstration of adapted oat varieties was conducted to evaluate yield performance and preference of farmers on oat production. Two improved varieties namely ILRI 5453 and Jasari were demonstrated on 8 experimental farmers and 7 agro-pastoralists. ILRI 5453 gave higher yield and dry biomass yield than Jasari variety. ILRI 5453 variety also had more number of tillers than Jasari. Experimental farmers and agro-pastorals mentioned that yield, fresh biomass and dry biomass of oat were used for livestock feeding. It was palatable for cattle both during vegetative and after harvesting so that oat production helped farmers as feeding both during wet and dry season. ILRI 5453 was selected by farmers and agro-pastorals based on its yield, dry biomass and number of tillers. Therefore, ILRI 5453 oat was recommended for further promotion at midlands and agro-pastorals of Guji zone.

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Demonstration of bee technologies at Ana Sora district, Guji Zone, Southern Oromia, Ethiopia

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Abstract

Beekeeping practice is important as ecological conservation and economical source of farmers. Despite diverse flora in Guji zone the beekeepers were not intensively benefited from beekeeping due to lack of modern bee technologies and lack of knowledge and skills of beekeepers on beekeeping. There are many proven bee technologies but not used by beekeepers. For this study three kebeles were selected based on their honey production potential. At each kebele 15 beekeepers were selected. Cast mould, honey extractor, modern hive, queen cage, smoker and etc. were used for demonstration. Method and result demonstrations were used on construction of hive stand, bee transfer, bee management practices and harvesting. Trainings and experience of beekeepers were the major extension methods used. Some questions were prepared and interviewed to beekeepers before and after demonstration to understand the improvement of knowledge and skills of beekeepers on bee technologies. Descriptive statistics, t test, cost benefit analysis and narration were used to analysis the data. There was statistical significance difference between knowledge and skills of beekeepers before and after demonstration. This indicated that demonstration improved the knowledge and skills of beekeepers' on honey production. On average 27kg/hive of white honey was obtained. The result of cost benefit analysis revealed that demonstration of bee technologies generated a return of 3,220 birr/hive/season for beekeepers. This showed that beekeeping is a profitable business at the study area. Improved bee technologies should be disseminated at study area. Beekeepers should use bee technologies for maximum honey production and income generation.

Key Words: Bee, Bee transfer, Demonstration, Honey, Modern hive

Introduction

Beekeeping, also called apiculture, is management of honey bee colonies for pollination of crops and honey and other products (Bradbear, 2009). In Ethiopia, bee keeping practice had been an old age historical practice (Tessega, 2009). Ethiopia is the number one honey and beeswax producer in Africa and belongs to the top ten worldwide (FAOSTAT, 2020). Ethiopia's tremendous variation of agro-climatic conditions and biodiversity favored the existence of diversified honeybee flora and huge number of honeybee colonies (Nuru, 2007). The country has about 10 million bee colonies and over 800 identified honey source plant (Kebede *et al.*, 2011). The honey belt zones of Western and Southern parts of Ethiopia produce the largest quantity of honey. There are abundant apicultural resources, particularly in the South Western and South Eastern zones of the country (Kenesa, 2018). However, the potentiality of Guji zone in quantity and quality of white honey is not well documented and categorized under honey belt zones of the country.

The honey bee colony consists of three casts (Queen, Worker and Drone). The queen and workers are females and developed from fertilized female eggs and drones are male and developed from unfertilized male eggs. Queen is used to lay eggs. Another function of queen is controlling of the colony activity. For this, a queen has several glands to produce a complex of compounds called the queen substance. The relationship that exists between a queen and her colony is so close that, the success or failure during honey production depends upon the leadership quality of the queen. Workers are females which are not fully developed sexually. They do the work of the colony and maintain it in good condition. Drones are males of the colony and are produced from unfertilized eggs. Drones do not have any of the structures necessary to collect nectar and pollen. The sole function of the drones is to mate and fertilize the queen. The mating takes place in the air away from the colony (Kibebew and Gemechis, 2019).

Honey is the most important primary product of beekeeping. The bees collect from the nectar of plants (mainly composed of complex mixture of carbohydrates) by reducing the water content, store and leave it in honeycombs or honey pots to ripen and mature for their own consumption (Gebreegziabher *et al*., 2013; Oyerinde *et al*., 2014).

Beekeeping activity has important contribution economically and ecologically. It has remarkable potential to contribute to employment generation, local and global market, livelihood improvement, and biodiversity conservation and helps ensuring economic advantages of women, youths and poor households (Ajabush, 2018; Tura and Admassu, 2018; Kenesa, 2018; Tura and Admassu, 2019). Development of the Beekeeping practices could significantly enhance crop production, food security, maintenance of plant diversity and ecosystem stability (AIS, 2018).

Despite Ethiopia's great potential for beekeeping the beekeepers were not well benefited from beekeeping. This is mainly attributed to the inadequate introduction of improved technologies and skills that enhances the quantity and quality of bee products (Tura and Bareke, 2019). The government and NGOs have recognized to promote transitional and modern beehives. The promotion of modern hive-systems alone is not sufficient to improve the beekeeping situation of a beekeeper due to lack of access to beekeeping equipment and they often do not know how to use or maintain them, resulting in untapped potential (Alebachew and Eshetie, 2019). Many proven bee technologies were left on shelf due to lack of beekeepers capacity to implement on their field. When technology users capacitated the technology transfer from research recommendation to technology user is simple so that agricultural extension system should focus on capacity building.

Other bottlenecks for Ethiopian beekeeping practices include poor honey harvesting, diseases, pests, predators, poisonous plants, agrochemicals and deforestation (Kenesa, 2018). Lack of beekeeping knowledge, shortage of skills man power, shortage of bee equipments, poor infrastructure development, shortage of bee forage, type of hives and lack of research extension (Tekeba and Yeshitela, 2018; Hailemichael, 2018) were the majors constraints of bee keeping in Ethiopia.

The diverse natural vegetation found in Guji zone helps for environmental conservation and honey production. Gatame *(Schefflera absyssinica)* tree flower found in the highland areas of the zone is the most important tree used for the production of white honey. Thus, Guji zone of highland areas are well known by the quality and quantity of honey. Despite good flowers and flora species in the area beekeepers of Guji zone were not improved their honey

production. They usually used local hives and traditional management practices. Consequently, beekeepers of highlands were not lion share of honey production. Therefore, this demonstration of bee technologies was initiated to improve honey yield beekeepers.

Objectives

1. To evaluate yield performance of modern hive system
2. To evaluate profitability of modern hive system on honey production
3. To improve knowledge and skills of beekeepers on bee technologies

Research Methodology

Description of study area

Ana Sora district is situated at a distance of 410km from Addis Ababa and 180 km from zonal capital city, Negele. 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 1000-1500 mm and the annual temperature of the district is nearly about 15 up to 20°C (Girma *et al.*, 2021).

The study was conducted at Ana Sora district, at Bube Korsa Apiary Site. The area is surrounded by Sama Hindhale, Sololo Kobo and Bube Korsa kebeles. The site is well known by crop production (maize, wheat, barley, potato, enset) and rearing of livestock (mainly cattle, horse, and beekeeping). In addition to flowers of forages and crops the site is also covered by natural vegetation such as Gatame *(Schefflera abyssinica)*, Ebicha *(Vernonia amygdalina)*, Mokonisa *(Croton macrostachys*, Badesa *(Syzgium guinune)*, Reji (*Vernonia auriculifera*), Wadesa (*Cordia africana*), Tibiro (*Darbergia lacteal*) etc which is used for honey bee production during different honey bee harvesting. Gatame tree's flower is important for white honey production while the flowers of Ebicha, Mokonisa and others during *gana* season (Jun-August month) used for black honey that is used for making local beverage called *boka* that is used as traditional drinking during certain ceremonial.

Despite availability of different flowers all most all beekeepers in the study area used traditional hives for honey production. Since there is no source of bee technologies the beekeepers were not using improved bee technologies for better honey production. Even if beekeepers were using traditional hives still white honey is harvested on March and April months. Honey obtained by beekeepers was marketed to different parts of Guji Zone and to regional and national markets (Hawasa and Addis Ababa). So that beekeeping is an important activity that can generates income for beekeepers in the study area.

Bee keepers' selection

Kebeles and beekeepers were selected based on their experience on beekeeping. The selections of beekeepers were done with collaboration of Ana Sora Livestock and Fishery Resource Development Office and respective kebele Development Agents (DAs). 15 Beekeepers (10 men and 5 women) who were grouped as one Beekeepers Research Group per kebele was established. Totally, 45 beekeepers were participated on demonstration at initial stages and 36 beekeepers were attended from the initial to the final of demonstration activities. For each kebele 10 modern hives were given for selected beekeepers. On average age of selected beekeepers was 38.86 years which is productive age while their experience in beekeeping was 9 years (Table 1). The selected beekeepers owned mostly traditional hives (17.78) for honey production compared to modern hive (0. 86). This indicated that beekeepers were using traditional hives than modern and transitional hives for their honey production.

Table 1. Socio economic characteristics of selected beekeepers

Socio economic	N	Minimum	Maximum	Mean	Std. Deviation
Age	36	24	59	38.86	8.047
Experience in bee keeping activity	36	3	18	9.03	3.851
Number of traditional hive owned	36	1	100	17.78	20.692
Number transitional hive owned	36	0	10	1.53	2.197
Number of modern hive owned	36	0	8	0.86	1.710

There are many sources of bee in the study area. For female bee keepers freely returned bee was the most source of bee (Table 2). Majority of beekeepers (17) obtained swarm of bees from different sources.

Table 2. Sources of bee colonies based on sex of beekeepers

Sources of bee colonies	Sex		Total
	Female	Male	
1. Purchasing	-	3	3
2. Capturing of bee colonies	-	2	2
3. Taking from relatives	-	2	2
4. Freely returned bee	5	7	12
5. Combination of all sources	3	14	17
Total	8	28	36

Demonstrated beekeeping technologies

There are many bee technologies (tools and methods). For this activity different improved bee technologies (tools) were demonstrated during 2019/20 and 2020/21. Honey extractor, casting mold and modern hive were not accessible at the study area though others were obtained with less cost. The following bee technologies were used for the demonstration purpose.

Table 3. Demonstrated Bee Technologies

N.S	Bee technologies	Main roles of tools
1	Smoker	To smoke that can minimize the fighting of bee/to move bees
2	Honey extractor	To extract and clean honey
3	Queen excluder	To keep the queen in the brood chambers
4	Queen cage	To protect the queen until she adapted the modern hive
5	Ballast	To protect bee from soil or grass
6	Protective clothes	To protect from bee sting
7	Frame	To carry foundation sheet
8	Cast mould	To prepare foundation sheet
9	Beeswax	To make honey injera/foundation sheet
10	Bee brush	To brush bee from mats to modern hive at transferring and to brush bee from honey at harvesting time
11	Hand torch	To give light during transferring bee and harvesting of honey
12	Hive stand	To carry modern hives
13	Modern hive	To produce pure honey and to increase production and productivity of honey
14	Knife	To cut combs from traditional hives and to harvest honey

Demonstration processes

This activity principally depends on showing of improved bee technologies to the beekeepers. There are two types of demonstration used by extension agents - method demonstration and result demonstration. Method demonstrations basically show farmers how to do something. In the method demonstration, the farmer is shown step by step. The main purpose of a result demonstration is to show local farmers that a particular new recommendation is practicable under local conditions. By showing tangible results of a new practice recommended by the extension service, the agent can help to create confidence among the farmers and can greatly encourage them to try the practice themselves (FAO, 1985). During this activity method demonstration was used to capacitate beekeepers on improved bee technologies from the beginning to the end of research activity. It is used to show all process of site cleaning, construction of hive stand, bee transfer and bee management practices. Result demonstration focused on harvested honey (yield obtained as a result of demonstration) and demonstrated bee technologies.

Wax processing

Beeswax is secreted in small wax platelets form by worker honeybees from four pairs of wax glands on the underside of the abdomens which are functional when the bees are about 9–17 days old after being engorged with honey and resting suspended for 24 hours together (Brwon, 1981). Ethiopia is known for the production of beeswax. More beeswax is obtained from traditional hive than modern hives (Gupta *et al.*, 2014; Negash and Greijing, 2017). Most rural bee keepers in the study area did not know the importance of beeswax though they mostly used traditional hives. Once they harvest their honey they overthrew the beeswax. This is due to lack of knowledge and skills on beeswax that can be re used for frame attachment for modern hive and foundation sheet. In addition, it was used as a decoration since it can be fashioned by different shape. Moreover, it is used as light in place of worship and rural areas.

For optimum usage of beeswax it should be processed based on the following steps: The first step is cleaning. Beeswax should be cleaned by pure water again and again in container. Secondly, after cleaned, it should be freeze for 12 hours. Thirdly, melting is needed to liquefy the freeze beeswax by heating. This step should be repeated as many times to get pure beeswax. Fourthly, after heating, it should be filtered by cloth/sack. The droplet from the filter will be stored on the bucket while the dust will remain on the filter materials. The fifth step is cooling in the bucket and it should be placed a right position without moving from place to place. This is important to have a good shape of beeswax. Movement of bucket can bend the shape of beeswax. The cooled beeswax should be dried and stored for different usages. In case for attachment of frame the stored beeswax should be re melt. These steps were shown to beekeepers in order to preserve their beeswax from traditional hives. For the purpose of demonstration 30kg of pure wax was purchased. It was melt and foundation sheet was prepared from it. Ten frames of each 30 modern hives were attached by the processed beeswax.

Apiary site management practices

Hive stand was constructed from locally available trees. It ups 60cm above the ground and 40cm below the earth surface. This hive stand was showed to beekeepers to minimize the effect of rainfall drop to the hives as well as minimizing entrance of insects. Following the construction of hive stand the site was cleaned every month. The hive stands were lubricated by burned oil to protect entering of ant to the hives.

Bee transferring

Bee can be transferred to modern hives through different options. One option is putting modern hive on its placement. Bee colonies can enter to the modern hive provided that the environment is good for the bees. The other method of transferring of bee is finding the queen. Once the queen is obtained she should be put in the modern hive. In this case beekeepers should care for the queen since she may die during handling. For this demonstration 30 bee colonies were transferred by cutting all the combs of traditional hives and kept on the ballast and finally moving the bees from ballast to modern hive. The following steps were considered for bee transferring from traditional to modern hive.

1. Cleaning of apiary site
2. Cable/wire the frame
3. Dressing protective clothes
4. Place the mat on the floor
5. Putting traditional and modern hives on the mat
6. Preparing smoking materials and smoking to traditional hive by smoker
7. Cutting all the combs and moving bee colonies from the traditional hive by knife and brush respectively.
8. Put three brood combs on the three frames of modern hive for bees feed
9. After the bees completely moved in to the modern hive put modern hive on the constructed hive stand. Traditional hives must be away from apiary site because bees may be returned to it from modern hive.

Feeding bee during dearth period

During no flowering of crops and trees bees were fed by *shiro* (a powder of field pea which has a good smell that can attract bees). 25kg of shiro was purchased and fed bees during dearth period. 15kg of sugar was purchased. Sugar was dissolved in water and given for bees. During the day the feeding material was put beside of hives and during the night and rainy times the materials were taken away from the field and kept under shade where there is no wetness. This was important to protect the bad odor when materials spoiled with moisture. *Shiro* and dissolved sugar feedings were showed to beekeepers during the demonstration. Though not demonstrated to beekeepers giving honey is also another method of feeding the bees during unavailability of flowers in beekeeping activity.

Adding and removing super hives

Adding super is one of bee management in modern beekeeping practice. The importance of adding super is to expand the volume of hive for growing of bee population, to increase honey yield and to prevent swarming. When bees over crowded in the base hive they might panic and flight from the hive. Therefore, to stay bees in the modern hive it is necessary to add another hive where bees are freely moved to prepare quality honey. Beekeepers should also know the time of adding super needed by observing their apiary site. This can be known when bees were observed on external parts of the hive and when the whole combs were covered by bees during active period. Adding super is also known by opening the hive and when beeswax was secreted and observed on frames or on the top bar. Nature of bee (activeness) can also determine adding and removing the super. If the bees were weak it is not necessary to add super. In adding supper, the arrangement of lower (base) and the upper frames should be taken to consideration. The empty frame of the second super frame is placed on the top of the first super frame of full of honey frame. Super hive was removed after honey was harvested and during weak period.

Replacing the absconded bee colonies

Absconding is a great problem in beekeeping activity. During this demonstration 19 transferred bee colonies were absconded from the modern hive. Therefore, it was necessary to replace the lost bee. As to indigenous knowledge to local beekeepers the lost bee will come back to their own hive when the hive is cleaned and smoked by excellent aroma trees. Considering this indigenous knowledge on demonstration, modern hive was smoked with *anonu* tree which have very important aroma for bees. Four bee colonies were returned after the modern hive was smoked by *anonu.* 10 bee colonies were re purchased and transferred from traditional to modern hives. Totally, 14 bee colonies were replaced after absconding.

Extension methods used for demonstration

Appropriate extension methods are important in technology demonstration that can increase adoption of demonstrated technologies in the community. Applicability, complexity and usage of technologies should be clearly stated by extension methods that can foster technology adoption. Therefore, during bee technologies demonstration on spot trainings, field day and experience sharing among beekeepers were the major extension methods intensively used.

Methods of data collection

Observation was used to collect data at apiary site. Questions were prepared and interviewed to beekeepers before and after demonstration in order to understand the improvement of knowledge and skills of beekeepers on bee technologies used for honey production.

Methods of data analysis

Before and after analysis (paired t test), descriptive statistics, cost benefit analysis and narration were used to analysis the data.

Results and Discussions

Capacity building methods on bee technologies

Most agricultural sector needs land for production. However, beekeeping did not necessarily need much of land. It can be started by landless youth, female, male or associations provided that beekeepers were capacitated to produce honey. This indicated that beekeeping practice is a business entry point for resource poor communities because most activities were done by bees. The most important for beekeepers is information (knowledge and skills) and materials (bee technology accessories) used for honey production. The main intension of agricultural research extension (technology transfer) is capacity building on the recommended technologies.

During demonstration of bee technologies knowledge and skills of beekeepers were capacitated by on spot trainings, farm visit and field day. Three times trainings were given for 45 selected beekeepers at different stages of demonstration (during construction of hive stand stage, bee transferring stage and bee harvesting stage). Demonstration site was monthly visited and monitored by researchers. During monitoring, the demonstration site comments and suggestion were given for beekeepers. Field day was organized in order to enhance bee technologies to large communities (Table 4). Despite small land is required the bee technologies, for instance, honey extractor, cast mould, modern hive and even protective clothes were not accessible and expensive for beekeepers at study area. For this demonstration 30 modern hives were obtained from Jimma Agricultural Engineering Research Center while other accessories were taken from Bee Research Team of Bore Agricultural Research Center.

Table 4. Capacity building on bee technologies demonstration

Trainings topics	Beekeepers		Subject matter specialists		Development Agents	
	Male	Female	Male	Female	Male	Female
Hive stand construction and bee transferring	31	14	5	-	5	-
Seasonal management	30	15	3	-	4	1
Honey harvesting and management	30	15	4	-	4	2
Field day	96	19	24	7	17	4
Total	187	63	36	7	30	7

Knowledge and skills improvement on demonstrated bee technologies

Agricultural productions not only need the labor but also need knowledge and skills to implement. The main intention of agricultural extension is to enhance the knowledge and skills of farmers on recommended agricultural technologies (Basha *et al.*, 2021). Beekeeping, whether it is result or method demonstration, needs knowledge and skills on honey bee production. Availability of materials alone did not a guarantee for honey production unless utilizing the knowledge and skills recommended for technologies. Improvement of knowledge and skills of demonstration is required for sustainability of activity by end users. Thus, information delivered during trainings, follow up and monitoring were used to remind the knowledge and skills transferred for the selected beekeepers. Knowledge and skills demanded questions were prepared and interviewed to the selected beekeepers before demonstration (Appendix I). The same questions were re interviewed to the beekeepers at the end of demonstration. The result of paired sample t test showed that there was statistical significance difference (0.001 was less than 0.05) between knowledge and skills before and after demonstration of beekeepers on bee technologies at the study area. This indicated that this demonstration improved knowledge and skills of beekeepers' on honey production.

Table 5. Knowledge and skills test result

Test	Mean	N	Std. Dev	T	df	Sig. (2-tailed)
Knowledge and skills after demonstration	72.38	36	8.73	-	-	-
Knowledge and skills before demonstration	50.58	36	16.03	-	-	-
Knowledge and skills after demonstration - Knowledge and skills before demonstration	21.80	36	17.30	7.60	35	.001

Yield and Cost Benefit Analysis

At the study area two types of honey can be harvested (April month the white honey and August month the black honey). For this demonstration, only white honey was harvested while black honey which is mostly used for local consumption was not harvested and left for bees feed during dearth period. Honey also harvested from the super added (two supers) hives and not from the base hive. For the analysis purpose only honey obtained from the super was considered. Honey was harvested from each 10 frames of modern hive. On average 27 kg/hive of white honey was obtained from this demonstration. The result of this demonstration was above the results of Beyene *et al.* (2016) and Gemechis (2016) who reported that the average honey yield of transitional and modern hives ranges from 15 to 20 kg and less than the maximum of 47kg/hive in Europe where modern hive systems are dominant (FAOSTAT, 2020).

Cost benefit analysis was used to estimate the profitability of bee technology demonstration on honey production. Only white honey harvested from the added super was used for profitability analysis. If the black honey which was left for bee feed was considered the harvested honey and profitability gained from this demonstration would be greater than this result. The farm gate price of 1kg of honey at the time of harvest was 250 birr. Total Revenue (honey harvested multiplied by the price) was 6750 birr/hive. Many costs were used to estimate the costs of honey production. One modern hive can serve 10 years. At the study area, the cost of modern hive during demonstration was 2,500 birr. Strong bee colonies were purchased from surrounding apiary site. One traditional bee hive colony was purchased by 500 birr. 1kg of pure beeswax was purchased by 300 birr. Hive stand was constructed from locally available trees which were estimated to 180 birr. To feed bees during dearth period sugar and *shiro* was purchased for 300 birr. The result of cost benefit analysis revealed that demonstration of bee technologies generated a return of 3,220 birr/hive/season for beekeepers (Table 6).

Table 6 Yield and Cost Benefit Analysis

Parameters	Value in ETB
Honey harvested per hive in kg (q)	27
Farm gate price (p)	250
A. Total revenue (TR= q*p)	6750
Cost of modern hive	2,500
Depreciation of modern hive (a)	2250
Cost of bees purchased (b)	500
Beeswax in kg (c)	300
Costs paid for hive stand construction (d)	180
Bee feeding costs (e)	300
B. Total costs (TC= a+b+c+d+e)	3,530
Benefit gained (A-B)	**3,220**

Beekeepers opinion on beekeeping practice

As far as beekeeping is important for income generation and honey consumption beekeepers provide their opinion regarding the current status of beekeeping in their area. Bees need flowers (trees, vegetables, crops, shrubs, etc.) for honey production. This indicated that beekeeping is interlinked with crop production activities. Due to the bees' nature, many ecosystems depend on the pollination of bees for their existence and for increasing their genetic diversity (cross-pollination). A decline in bee colonies and bee species could therefore threaten the survival of plant species that depend on the pollination services of bees (Addisu, 2017). In order to increase the production and productivity of crop production that can feed the growing human population the current agricultural extension system in the country in general and at Ana Sora district in particular recommended full packages of chemicals (herbicides and fungicides) to control weed, rusts and insects. Beekeepers explained that the amount of bee colonies available in their area was decreased from season to season due to application of chemicals that kills bees at the time of collecting nectars from plants. Diseases also affected the bees. However, bee colonies become source of income as some beekeepers were selling their bee colonies from traditional hives.

Absconding of bees was the critical problem of beekeepers at study area. Though beekeepers used indigenous knowledge in replacing absconded bees the main reason of absconding was not known. Despite the area was potential for honey production the beekeepers mentioned that there were no suppliers of bee technologies in their district.

Conclusions and Recommendations

Highland Guji zone is a potential for white honey production. However, due to lack of improved bee technologies and lack of management practices the beekeepers were not much benefited from beekeeping practices. Therefore, demonstrating improved bee technologies is needed for sustainable honey production. Different bee technologies (modern hive, cast mould, honey extractor, etc.) were demonstrated. Different trainings were given for beekeepers so that there was improvement on knowledge and skills of beekeepers after demonstration of bee technologies. In addition, 27kg/hive of honey was obtained from the demonstration. Availability of improved bee technologies can increase bee keepers' honey production. Use of improved bee technologies and conducive conditions can increase honey production at highlands of Guji zone. The result of cost benefit analysis revealed that demonstration of bee technologies generated a return of 3,220 birr/hive/season. This showed

that beekeeping at Ana Sora district was a profitable business for beekeepers. Despite good honey harvested and profitable the beekeepers of study area generally face different challenges such as decline of bee colonies, diseases, chemicals, deforestation of trees, absconding and lack of bee technology suppliers were the major challenges of beekeepers at the study area.

Demonstration of bee technologies increased the yield of honey that can maximize income of beekeepers. Therefore, improved bee technologies should be disseminated at potential areas of honey production. Improved bee technologies should be supplied by government as starting point. Beekeepers should use bee technologies for honey production. Farmers should give consideration when using chemicals that can affect the bees. Apiculture sector should find solutions for absconding and diseases of bee at the study area.

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Pre-extension demonstration and evaluation of Hybrid maize Technologies at Highland district of East Hararghe Zone

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Abstract

*In spite of the large area under cultivation, the national average yield of maize per hectare is low. The yield gap is attributed to a number of factors. Lack of sufficient knowledge and awareness of farmers on the production and benefits of the improved maize varieties with good agronomic practice and potential yield is a leading constraint. Demonstration of hybrid maize varieties is essential to alleviate these problems. Therefore, this study was undertaken to enhance the productivity of maize through demonstration of high yielding maize varieties with improved management practices at Meta district. It was conducted at Dursitu bilisuma kebele through FRG approach. A total of 9 trial Farmers were selected based on their interest and land ownership. Damot and BH661 were provided to farmers with full packages. Each variety was planted on a plot size of 10mx10m/farmer, with seed rate of 25kg/ha and 75cm*25cm space between row and plant respectively. Likewise, fertilizer (NPS) was applied with rate of 100kg/ha. Training and field visit were organized as a means to facilitate uptake and diffusion of technologies through farmers as well as to evaluate performance of the varieties and share the lessons with different stakeholders. The average yield for Damot and BH661 is 54.69qt/ha and 41.83qt/ha respectively. The mean score for knowledge test before and after implementation is 3.65 and 5.95 respectively. These results indicate an improvement in the awareness and production of beneficiary farmers. Based on their criteria, farmers have preferred and ranked as first Damote variety. Therefore, it is better if effort is exerted for pre scaling up of the technologies.*

Keywords: *Demonstration, Hybrid Maize, Knowledge test*

Introduction

Maize (*Zea mays* L) is one of the most important cereals broadly adapted worldwide (Christian et al., 2012). It is widely grown in most parts of the world over a wide range of environmental conditions ranging between 480 latitude North to about 400South latitude (Geremew et al., 2009). It has the highest average yield per hectare and is third after wheat and rice in area cultivation and total production in the world (Mandefro et al., 2002). Maize is among the most important and widely grown crops in Ethiopia. It ranks first in total production with over 7.23 million tons of produce whereas it ranks second in area coverage next to Teff. Annually maize covers about 2.11 million hectares of land (CSA, 2015). The popularity of maize in Ethiopia is partly because of its high value as a food crop as well as the growing demand for animal fodder and source of fuel for rural families (Tsedeke et al., 2015). Despite the large area under maize cultivation, its national average yield is about 3.2 t/ha (CSA, 2014). This yield is by far below even the world's average yield which is about 5.21 t/ha (FAO, 2011). The average yield in eastern Hararghe is still low (24.06 quintal/ha) compared to the national and regional average of Oromia 32.54 and 33.19 quintal/ha respectively (CSA, 2013/14). The yield gap is attributed to a number of factors like frequent occurrence of drought, declining of soil fertility, poor agronomic practice, limited use of input, poor seed quality, disease, and others (CIMMYT, 2004).

In Eastern Ethiopia, especially Eastern Hararghe farmers traditionally use local variety of maize, for production for a long period of time. The performance of improved maize varieties were evaluated for adaptability and stability to recommend the best one for highlands of eastern Hararghe and similar agro-ecologies. As a result, Damote and BH661 varieties were recommended with average yield of 44.09qt/ha & 34.15qt/ha respectively.

Lack of sufficient knowledge and awareness of farmers on the production and benefits of the improved maize varieties with good agronomic practice and potential yield is a leading constraint. (Die et al., 2016a).Thus, this study was conducted to demonstrate and evaluate the productivity and profitability of improved maize under farmers' condition.

Objectives

- To evaluate the productivity and profitability of improved maize under farmers condition.
- To demonstrate and select best performing varieties for pre-scaling up
- To enhance farmers' knowledge and skills on Maize production and management technique
- To strengthen linkage and create awareness among the different development practitioners on improved maize production technologies.

Materials and Methods

Description of the study area

The study will be conducted in East Hararghe Zone of Oromia National Regional State which covers an area of about 90,620 square kilometers with an altitude ranging between 700 and 3,400 meters above sea level, and mean annual rainfall ranges between 315 and 1040 mm. The land holding per household ranges roughly between 0.3 and 1.5 hectares. The capital town of East Hararghe, which is Harar, is located on distance of 526 kms from national capital city Finfine in direction of country's eastern part. The climatic condition of the zone includes highland, midland and lowland.

Site and farmers selection

Meta district was selected from east Hararghe zone purposively. From the district, Dursitu bilisuma kebele was selected purposively. Farmers were selected based on their interest, land holding and willingness to learn and share experiences for other farmers in collaboration with experts from wereda agriculture and natural resource office and development agents. The selected farmers were grouped as Farmers Research Group (FRG) with the member of 15 farmers in consideration of gender issues (women, men and youth). A total of 30 farmers were grouped in 2FRGs. Each FRG have selected their own leader who played facilitation role and communication with development agents and researchers in the process. In the FRG, 4 farmers were trial farmers (3 male and 1 female) and 11 farmers were fellow farmers. Hence, 30farmers are addressed within duration of this project.

Implementation design

Two improved (Damot and BH661) Maize varieties were used for the study. Each variety was replicated across eight trial farmers. Each variety was planted on a plot size: 10mx10m, at seeding rate of 25kg/ha. Space between row and plant was 75cm*25cm respectively. Likewise, fertilizer (NPS) was applied with rate of 100kg/ha. Field management was undertaken by hosting farmers with close supervision of researchers and development agents.

Capacity building and experience sharing

Training was given to farmers, DAs and experts on agronomic practices and post-harvest handling before plantation and harvesting time. Field visit was also organized on the fields of beneficiary farmers in order to evaluate the performance and final outputs of the varieties and share the lessons with different stakeholders. Famers, development agents (DAs), experts from agriculture and natural resource office, researchers and other relevant stakeholders had attended the event.

Data collection

Number of beneficiary farmers by age and sex, plot size, amount of seed provided and variable cost were collected with checklist. The grain yield data of the varieties were taken from all plot with checklist. Farmers' perception related to attributes of the varieties was collected using semi-structured interview schedule. The perception data on the varieties attributes was grouped into; grain size, grain uniformity, plant height, grain color, maturity period, number of cob per plant and grain yield. The respondents were responded their perception level on the relative advantage of each characteristics of the variety compared to previously introduced variety.

Data analysis

Quantitative data were analyzed using SPSS software version 26. Descriptive statistics such as frequency, mean, standard deviation minimum, maximum, were used and presented using tables. Cost-benefit analysis was used for economic evaluation. Qualitative data were analyzed using narrative explanation and argument.

Result and Discusions

Demographic Characteristics of beneficiary farmers

The mean age of beneficiary farmers is 41.14 years, implying that the targeted group is in production age. Out of the total beneficiary farmers, 57% are males and the remaining 43% are females.

Descriptive Results for productivity of the varieties

The maximum harvested yield per plot ($100m^2$) for Damote and BH661 is 0.725qt and 0.643qt respectively. The maximum yield estimated based on harvested yield per plot for Damote is 72.50qt/ha whereas, the maximum yield estimated based on harvested yield per plot for BH661 is 64.30qt/ha. The estimated mean yield for Damote is 54.69qt/ha, while, the estimated mean yield for BH661 is 41.83qt/ha.

Table 1. Descriptive results for yield per plot and per hectare

Locations	Varieties	parameter	Minimum	Maximum	Mean	St.dev
Dursitu Bilisuma	Damote	Yield per plot	0.36	0.73	0.546	0.1258
		Yield per hectare	35.90	72.5	54.686	12.649
	BH661	Yield per plot	0.26	0.64	0.4177	0.14286
		Yield per hectare	26.00	64.30	41.829	14.2588

Source: computed from own data (2021)

As clearly shown by the table 2 below, the result of t-test for mean difference indicates that there is no significant combined mean difference between the two varieties.

Table 2. The result of t-test for combined mean difference

Parameters	Damote (n=7)		BH661 (n=7)		
	Mean	St.Dev	Mean	St.Dev	T-value
Harvested Yield per plot	0.546	0.1258	41.83	14.26	1.785*
Estimated Yield per hectare	54.686	12.649	4182.86	1425.88	1.785*

Source: computed from own data (2021)

Table 3. Matrix Ranking of Maize Varieties

Parameters	Damote		BH661	
	Point	Rank	Point	Rank
Grain size	2	1	1	2
Grain uniformity	2	1	1	2
plant height	1	2	2	1
Grain color,	2	1	1	2
maturity period	2	1	1	2
number of cob per plant	1	2	2	1
Grain yield	2	1	1	2
Total score	12		9	
Final Rank	1		2	

Source: computed from own data (2021)

Note: Score 2 is given if the variety is highly preferred and score 1 is given if the variety is less preferred.

Damote maize variety is preferred by farmers and ranked as first for the parameters such as grain size, grain uniformity, grain color, grain yield and maturity period while BH661 is ranked second for the same parameters.

Capacity building and experience sharing

A total of 45 farmers out of which 34 are males and 11 are females have participated on field day. 3 experts (two males and one female) and 3 development agents have also participated on the event. Similarly, a total of 37 farmers (twenty four males and thirteen females), 3 development agents and 3 experts have participated on training.

Results of Knowledge Test

A simple knowledge test items were developed based on the contents of training and production package practices and knowledge level of participant farmers regarding improved hybrid maize production technologies was measured before and after implementation. Score of 1 is given for correct answers and 0 for incorrect answers. As one can observe from the table 4 below, the percentage of respondents for correct answers is increased after intervention while, the percentage of respondents for incorrect answers is decreased.

Table 3. Percentage of Respondents for each knowledge test Items

No	Test Items	Respondents' percentage			
		After		Before	
		Correct	Incorrect	Correct	Incorrect
1	Name at least one improved hybrid maize variety	80	20	60	40
2	What is the seed rate of maize required for one hectare?	70	30	50	50
3	What is fertilizer rate per hectare recommended for maize?	70	30	70	30
4	What is the recommended space between rows for maize	65	35	40	60
5	What is the recommended space between plants for maize	65	35	45	55
6	What is the Potential productivity (yield/ha) of the variety	55	45	25	75
7	The maximum maize plant density(plant population) per hectare recommended for good harvest is 53,333.33plants/ha	30	70	0	100
8	What types of yields are considered in maize production?	25	75	0	100
9	Actual yield/farmer yield/realized yield losses due to misuse of recommended agricultural practices and environmental stress	55	45	40	60
10	Economic yield losses due to post-harvest losses	50	50	35	65
11	The recommended grain moisture content for maize harvest is 15%	30	70	0	100

Source: computed from own data (2021)

The mean score for knowledge test before intervention and after intervention is 3.65 and 5.95 respectively. The result of paired-sample t-test indicates a significant difference between the mean score for knowledge test before intervention and after intervention at 1% significant level. This implies an improvement of farmers' knowledge concerning the hybrid maize technologies due to technological intervention.

Table 4. Results of paired-sample t-test for knowledge test

	Mean	St.Dev	T-value
Total score after	**5.95**	**1.877**	**7.254*** **
Total score before	**3.65**	**1.631**	

Source: computed from own data (2021)

Note: ***: refers to significance at 1% level.

Economic Analysis of Hybrid maize production

The changes in net benefit between Damote variety and BH661 variety is 15276 whereas, the change in total cost is 5300. These indicate that shifting from BH661 hybrid maize variety production to Damote hybrid maize variety production has about 9976 EB net benefit advantage.

Table 6. Economic analysis of hybrid maize production

No		Hybrid Maize varieties	
		BH661	Damote
Gross Farm gate benefits			
1	Average yield(Kg/ha)	4183	5469
2	Farm gate price(Birr/Kg)	16	16
3	Gross farm gate benefits	66928	87504
Costs			
4	Land preparation	2800	2800
5	Seed	750	750
6	Sowing	2400	2400
7	Fertilizer(NPS)	1750	1750
8	Fertilizer(UREA)	2100	2100
9	Weeding	3600	3600
10	Harvesting	4800	7200
11	Shelling	2400	4000
12	Threshing	4000	5300
13	Miscellaneous	3500	3500
14	Total cost	28100	33400
15	Net benefit	38828	54104
16	Change in net benefit		15276
17	Change in total cost		5300
18	Benefit-cost ratio	2.38	2.62

Source: computed from own data (2021)

Conclusions and Recommendations

The average yield of improved hybrid maize varieties indicates an improvement in the production of beneficiary farmers. Hence, it is better if all farmers of the study areas and those living in the same agro ecologies accept the hybrid maize varieties in sustainable manner in order to increase their production. There is significant mean difference between Damote and BH661 varieties. Therefore, the attention should be given to Damote variety. It is also good if both research center and research institute mobilize resources for pre-scaling up of the technologies.

The result of paired-sample t-test indicates an improvement of farmers' knowledge concerning the hybrid maize technologies due to intervention. Therefore, it is better if relevant government and non-government organizations focus on capacity building just to increase awareness and knowledge of farmers towards the promising technologies.

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Pre-extension Demonstration and Evaluation of Bread Wheat Technology in Metta and Jarso Districts of East Hararghe Zone

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Abstract
The study was focused on demonstration of bread wheat technologies in major wheat growing area in East Hararghe .The objectives were to evaluate and demonstrate improved bread wheat variety with their production package to the farmers and assess farmers' feedback towards improved bread wheat technology. The activity was conducted in main cropping season 2019-2020 for two year at Jarso and Metta Districts. A total of 40 trial farmers were selected from two potential bread wheat growing Districts. Four FRGs having 60 farmers were established. Two improved bread wheat varieties along with local check (Senate, Liban and Local) were planted on the plot of 10mx10m per trial farmers. Yield data, economic data, farmers' perception and preferences were collected and yield data were analyzed by using ANOVA. The results of ANOVA showed that yield of improved bread wheat showed statistically significant at 0.01% probability level of between improved and local treatments. The yield performance of the improved varieties (Senate,Liban and local) were 36.83, 30.27 and 25.47 qt/ha at Afgug and 39.14,33.23 and 28.35 qt/ha at Dursitu Bilsuma respectively. Farmer preference of improved & local variety with improved management ranks Sennate 1st and Liban 2nd at both Jarso and Metta respectively. Generally, sennate with recommended package showed higher yield advantage than Liban and local. Therefore Senate variety is recommended for further scaling up.

Key words: *Bread Wheat, Demonstration, Senate, Liban,Yield ,Metta and Jarso*

Introduction

Bread wheat (*Triticum aestivum* L.) is mainly cultivated by small scale farmers in Ethiopia. It ranks fourth in area coverage next to teff, maize and sorghum, respectively. It is the main staple food for about 36% of the Ethiopian population (Bishaw, Z., 2011). Arsi and Bale highlands are the major wheat producing regions of Ethiopia and are deemed to be the wheat belts of East Africa. The area under wheat production is estimated to be about 1.6 million hectares, which makes the country the largest wheat producer in sub-Saharan Africa (Bishaw, Z., 2011).

Wheat is an important staple food crop in Ethiopia, especially in urban areas. It is a staple food in the diets of several Ethiopian, providing about 15 percent of the caloric intake for the country's over 90 million population (FAO 2015a). It accounts close to 17 percent of acreage of arable land and a fifth of all cereal food crops produced in the country in 2013/14 (CSA, 2013/14a). After South Africa, Ethiopia is the second largest wheat producer in sub-Saharan Africa (FAO 2015b).Despite substantial increases in wheat area, 33% of the national demand is fulfilled by imports and food aids. The national average wheat yield of 1.8 tones ha-1 is below Sub-Saharan Africa and world averages (Dixon et al., 2009). There are several biophysical and socio-economic constraints affecting wheat production and productivity in the country. The national agricultural research system has developed diverse improved bread wheat varieties with key attributes such as high grain yield and quality, resistance to rusts, tolerance to drought and consumer preferences (taste, baking and nutritional quality). Farmers however have subjective preferences for different varietal attributes and their

varietal demand is significantly affected by their perceptions (Bishaw et al., 2011). Thus, this proposal initiated to demonstrate and promotes improved bread wheat varieties in the study areas.

Objectives

- To evaluate the yield performance of bread wheat varieties under farmers' condition
- To create awareness on the importance of Bread wheat technology
- To develop knowledge and skill of farmers and other stalk holders have on bread wheat varieties
- To strengthen the institutional and other stallholders linkage on agricultural research output
- To collect farmers' feedback on demonstrated bread wheat varieties

Materials and Methods

Description of the Study Area

Jarso is bordered on the south by the Harari Region, on the west by Kombolcha, on the north by the city of Dire Dawa, on the east by the Somali Region, and on the southeast byGursum. The administrative center of this District is Ejersa Goro. The altitude of this District ranges from 1050 to 3030 meters above sea level;Mountain Gara Sirirta, Aybera, Kilisa and Bekekalu are amongst the highest peaks. Rivers include the Gideya. A survey of the land in Jarso (reported in 1995/96) shows that 19.3% is arable or cultivable, 1.7% pasture, 21.6% forest, and the remaining 57.4% is considered degraded or otherwise unusable. Khat, fruits and vegetables are important cash crops.

Meta District is located in East Hararghe zone of Oromia region. Meta is bordered to the southwest by Deder District, to the northwest by Goro Gutu District, to the north by the Somali regional state, to the northeast by Kersa District, and to the southeast by Bedeno District. The administrative capital of the District is Chelenko. The District is characterized by valleys in pocket areas, and rugged topography with many hills. There are some permanent rivers in the District. Notable among these is the river that supplies water to the town of Chelenko. Besides, there are many perennial springs originating from below the mountains and crossing the valleys. One lake is also found. Groundwater resources are always there. Mixed crop production and livestock rearing characterize the farming system of the District. The major crops produced in the District include sorghum, maize, wheat, and haricot bean, vegetables of different kinds and fruit trees. Although there is no meteorological station for recording rainfall, the rainfall pattern in the District is bimodal.

Site and farmers selection

Jarso and Metta Districts were selected purposively based on the potentiality, appropriateness of the area by considering lodging, slop land scape and accessibility, suit for repeatable monitoring and evaluation. Thus Afgug from Jarso and Dursitu Bilisuma Kebele from Metta were selected and one FTC from each kebele was also selected as demonstration site to reach other farmers who visit the FTC. Farmers were selected by studying their profile with the participation of Development Agents and community leaders. The selection was done purposively based on farmers' interest, land provision for this activity, interest in cost-sharing and willingness to share experiences for other farmers. The selected farmers were grouped in a form of Farmers Research Group (FRG) with the member of 15 farmers per kebeles in consideration of gender issues (women, men and youth).Within one FRG 10 members were

trial farmers (6 male trial farmers and 4 female trial farmers) and the rest 5 farmer work with trial farmers. Generally, a total of 60 farmers were formed under four FRGS, two FRG per kebele, at Jarso and Metta Districts.

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

District	PAs	No. of trial farmers	FTCs	Area covered
Jarso	Afgug	20	1	10mx 10m for each plots
Metta	D/Bilisuma	20	1	
	Total	40	2	

Research design

Two improved varieties and one local check were used. Senate, Liban & local varieties were planted side by side with equal plot size. Senate and Liban varieties with local check were used as treatments. The trial farmers were used as replications. Each variety planted at the Plot Size: 10mx10m, Seeding rate 150 kg/ha, Spacing 25cm (between row), Fertilizer rate: NPS/Urea 100kg/ha

Technology evaluation and demonstration methods

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

Data Collection

Both quantitative and qualitative data were collected through personal field observation, individual interview, Focus Group Discussion by using checklist and data sheet tools. Types of collected quantitative data were number of farmers participated in FRG, yield performance, economic analysis and number of stakeholders participated on the training. While qualitative data were farmers' Knowledge/ perceptions towards the new technology and ranked using Matrix ranking.

Data analysis

Quantitative data was summarized using simple descriptive statistics (mean, frequency and percentage) while the qualitative data collected using group discussion and field observation and oral histories was analyzed using narrative explanation and argument. Finally, data from different sources were triangulated to get reliable information.

Results and Discussion

Training of farmers and other stalk holders

Training was organized to participating farmers before commencing the trial Multidisciplinary researchers ; crop, extension and socio-economic discipline and other stakeholders (Offices of Agriculture and Natural Resource) actively participated by sharing their experience and knowledge about bread wheat production, management, post-harvest handling and marketing and journalists for the sake of publicity of the work done.

Table 2: Type of profession and number of participants on the training at Afgug and D/Bilisuma

		Afgug		D/Bilisuma		
No.	Participants	Male	Female	Male	Female	Total
1	Farmers	30	12	33	15	90
2	DAs	12	3	10	3	28
3	District expert	4	1	6	0	11
	Total	46	16	49	18	129

Among the training participant stakeholders, 69.8% were farmers. From those farmers, 30% are female farmers. During the training 35 leaflets and 20 small manuals on the technology that are organized in Afaan Oromoo and English languages were distributed. More over different questions, opinions and suggestions were raised and reacted from the concerned bodies. Most farmers showed high interest towards improved bread wheat technology production because of better yield and earned income by selling it for different stakeholders (neighbors' farmers and Non-Government Organizations). Generally, all farmers were very interested to have the technology for their future production. Therefore, all concerned bodies were shared their responsibility for the future intervention and wider reach out of the technology.

Agronomic and yield performance

The following table describes the yield performances of the demonstrated bread wheat varieties across the study site. The yield performance of the improved varieties (Sennate, Liban and local) were 36.83, 30.27 and 25.47 qt/ha at Afgug, 39.14, 33.23 and 28.35 qt/ha at Dursitu Bilisuma respectively. The average yield performance of Sennate and liban were higher than local variety at both location but statistically no significant difference between two improved varieties across the locations was observed.

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

PA	**Varieties**	**N**	**Std. Deviation**	**Mean (qt/ha)**	**Maximum**	**Minimum**
Afgug	Senate	20	1.94	36.83	39.40	31.50
	Liban	20	.58	30.27	31.10	29.50
	Local	20	.59	25.47	26.30	24.70
Bishan Bahe	Senate	20	1.25	39.14	40.30	37.30
	Liban	20	3.44	33.23	39.10	29.00
	Local	20	2.39	28.35	33.50	24.00
	Total		5.13	32.22	40.30	24.00

Source: Own computation 2019/2020

Table 4: ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2465.99	2	1232.99	214.37	.00
Within Groups	672.92	117	5.75		
Total	3138.92	119			

Source: Own computation 2019/2020

Yield Advantage

The result indicated that Senate and liban varies have better yield (37.99 qt/ha) and (31.75 qt/ha) when compared with local check.

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

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

Table 5: Summary of yield performance in study areas

Varieties	Average yield qt/ha	Yield difference qt/ha	Yield advantage over the local check (%)
Senate	37.99	11.01	41.17
Liban	31.75	4.84	17.98
Local	26.91		

Economic Analysis of bread wheat production

The followed table describes the financial costs and returns of the improved bread wheat varieties across two demonstration sites for 2019/2020 production year the calculation used 4000 birr as farm gate price for a quintal of bread wheat grain. Thus the profit per hectare gained from Sennate variety were 126,902 and 136,142 ETB at Afgug and Dursitu Bilisuma kebeles respectively .Whereas Liban profit were at 100,662 and 112,502ETB at Afgug and Dursitu Bilisuma kebeles

Table 6: Financial analysis for Bread Wheat varieties across the districts

Financial analysis						
Location: Jarso(Afgug)				Location: Metta(Dursitu Bilisuma)		
Parameters	Varieties			Varieties		
	Sennate	Liban	Local	Sennate	Liban	Local
Yield qt/ha(Y)	36.83	30.27	25.47	39.14	33.23	28.35
Price(P) per quintal	4000	4000	4000	4000	4000	4000
Total Revenue (TR)=TR=Y*P	147,320	121,080	101,880	156,560	132,920	113,400
Variable costs						
Seed cost	6000	6000	6000	6000	6000	6000
Fertilizer cost	1,418	1,418	1,418	1,418	1,418	1,418
Labor cost	7,000	7,000	7,000	7,000	7,000	7,000
Total Variable costs(TVC)	14,418	14,418	14,418	14,418	14,418	14,418
Fixed costs						
Cost of land	6,000	6,000	6,000	6,000	6,000	6,000
Total fixed costs (TFC)	6,000	6,000	6,000	6,000	6,000	6,000
Total cost (TC) =TVC+TFC	20,418	20,418	20,418	20,418	20,418	20,418
Gross Margin (GM) = TR - TVC	132,902	106,662	87,462	142,142	118,502	98,982
Profit=GM-TFC	126,902	100,662	81,462	136,142	112,502	92,982

Results of Knowledge Test

A simple knowledge test items were developed based on the contents of training and production package practices and knowledge level of participant farmers regarding improved bread wheat production technologies was measured before and after implementation. Score of 1 is given for correct answers and 0 for incorrect answers. As one can observe from the table 7 below, the percentage of respondents for correct answers is increased after intervention. As a result, the percentage of respondents for incorrect answers is decreased.

Table 7.Percentage of Respondents for each knowledge Items (N=30)

No	Knowledge Items	Respondent Percentage			
		Before		After	
		Correct	Incorrect	Correct	Incorrect
1	The Name of improved Variety Wheat used	53.3	46.7	66.7	33.3
2	Ploughing frequency	63.3	36.7	70	30
3	The recommended seeding rate of improved bread wheat	36.7	63.3	53.3	46.7
4	The Maturity date of Bread wheat	43.3	56.7	46.3	53.3
5	The symptom of disease that affect bread wheat	50	50	56.7	43.3
6	The disease tolerant varieties	53.3	46.7	73.3	26.7
7	The chemicals used for bread wheat disease	50	50	50	50
8	The season that wheat disease severely occurred	30	70	43.3	56.7
9	Yield per hectare of improved bread wheat	40	60	71	29
10	Market price of bread wheat	66.7	33.3	66.7	33.3
11	Exact Source of improved bread wheat	43.3	56.7	56.7	43.3

Source: Own computation 2019/2020

The mean score for knowledge test before intervention and after intervention is 5.3 and 6.4 respectively. The result of paired-sample t-test indicates a significant difference between the mean score for knowledge test before intervention and after intervention at 1% significant level. This implies an improvement of farmers' knowledge regarding the improved bread wheat technologies due to technological intervention.

Table 8. Results of paired-sample t-test for knowledge test before and after intervention

	Mean	**St.Dev**	**t-value**
Total score before	**5.3**	**1.36**	**6.44*** **
Total score After	**6.4**	**1.37**	

Note: ***: refers to significance at 1% level, respectively

Source: Own computation 2019/2020

Farmers' Opinion/Perception

Farmers' in the study area selected the best performing improved bread wheat varieties by using their own criteria. The opinion of these farmers on varietal preference was collected from participants during variety demonstration. The major criteria used by farmers were tillering capacity, seed per spicke disease tolerant, plant height, early maturing, yield, seed quality and uniformity. Therefore, most farmers selected senate variety to reuse on their farm for the future. The following table describes farmers' selection criteria and their perception (feedback) toward the varieties

Table.9 Ranks of the varieties based on farmers' selection criteria

Varieties	**Farmers rank**	**Reasons**
Senate	1st	High tillering capacity, seed per spike medium disease tolerant, high plant height, early maturing, high yield, good seed quality, uniform
Liban	2nd	High tillering capacity, seed per spike medium disease tolerant, midium plant height, early maturing, good yield, medium seed quality, uniform
Local	3rd	low tillering capacity, seed per spike medium disease tolerant, short plant height, early maturing, low yield, low seed quality, not uniform

Conclusion and Recommendation

The result showed yield of improved varieties statistically significant difference over the local check. Field day was organized and farmers visit the demonstration plots and select the best varieties based on their own listed criteria.In general, tillering capacity, seed per spike, disease tolerant, plant height, early maturing, yield, seed size and uniformity. The overall harvested mean yield of senate, liban and local was 37.98 qt/ha, 31.75 and 26.91 qt/ha respectively. Agronomic data result shows that Senate and Liban varieties were selected as compared to the standard local check variety. Senate and Liban were farmers' 1st and 2nd preferred bread wheat varieties respectively in Jarso and Metta districts. Therefore, since senate has been preferred by farmers and gave good grain yield. Senate improved bread wheat variety should be promoted to a wider scale at Jarso and Metta districts for pre-scaling up. Effective and efficient delivery of technical advices and support to farmers is highly

required to improve wheat production and productivity help us in making our research demand-driven and enhance wheat production and productivity.

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Pre-extension Demonstration and Evaluation of Donkey drawn Multi-Purpose Cart in Gola Oda District of East Hararghe Zone

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Abstract

Pre-extension demonstration of donkey drawn cart with the objectives of promoting and popularize donkey drawn cart technology and to create awareness, improving farmers knowledge and skills through training. Two FREGs having 40 farmers per kebele were established at Jiddo Misra and Dima Misra. Training on which a total of 81 participants part were organized at Jiddo Misra and Dima Misra of Gola Oda district. 81.5% of the participants were farmers out of which 18.1% female farmers participated on the training. The use of donkeys for pulling carts enables larger quantities of goods to be transported and also helps farmers to earn income by hiring it out. The participants in the technology demonstration activities preferred this technology than the traditional one as single donkey can draw up to five quintals at once.

Key words: *Demonstration, Donkey Drawn Cart, Technology Multi-Purpose, Gola Oda District*

Introduction

Around the world, in much of development work, transport above everything is the ultimate enabler since it unlocks growth potentials, creates jobs, and brings wealth to local communities. Transport in the rural areas relates principally to basic needs and is carried out mostly on foot or with the aid of intermediate means of transport (World Bank, 2010; Tamene and Megento, 2017). Rural transport-related issues such as access to markets, health care, fuel wood, water, grinding mill and other basic facilities play an important.

Sustainable development in agriculture can be achieved by use of mechanization in agriculture. Mechanization can help in increasing the production by timely farm operation, reducing losses, reducing the cost of operations. It also ensures better management of costly inputs and enhances the productivity of natural resources. It also reduces drudgery in farm operations. Mechanization of different farm operations can increase the agricultural productivity by more work in less time, efficient use of inputs, by producing quality product, improving the safety of the farmers, reducing the loss of produce and drudgery of farmers and improving comforts of farmers(Waghmare Ajay Annasaheb .B.2017)

Women smallholder farmers living in remote areas spend longer hours collecting water or processing food than women living in areas better endowed with infrastructure and this appears to be a significant constraint on their meaningful participation in productive economic sectors like agriculture (FAO, 2010; Gebre-Selassie and Bekele, 2010).

In much of rural Ethiopia, travel and transport takes place along footpaths, walking and back loading, shoulder loading or head loading are the major means of travel and transport. Animal drawn carts are available only in very few rural communities. The introductions of animal drawn carts are important because the farmers in the study area use donkey and human back to transport agricultural products and to fetch water.

Objectives

- To create awareness among farmers, developmental agents, subject matter specialists and other participant stakeholders on use Donkey Drawn Multi-purpose Cart technology the area.
- To build farmers' knowledge and skill of production and management of the enterprise
- To strengthen linkage among stakeholders

Materials and Methods

Description of the Study Area

Gola Oda is one of the District in the Oromia Region of Ethiopia. It was part of former Gola Odana Meyumuluke District what was divided for Gola Oda and Meyu muluke District. Part of the East Hararghe Zone, Gola Odana Meyumuluke is bordered on the south by the Shebelle River which separates it from the Bale Zone, on the southwest by the Galetti River which separates it from the West Hararghe Zone, on the northwest by Malka Balo, on the north by Bedeno, on the northeast by Girawa, on the east by Fedis, and on the southeast by the Erer River which separates it from the Somali Region. Latitude: 8° 24' 59.99" N Longitude: 41° 29' 59.99" E

The altitude of this Districts ranges from 500 to 1930 meters above sea level; Mountain Sebero is the highest point. Rivers include the Ramis and Deneba. A survey of the land in this District shows that 3.5% is arable or cultivable, 7.6% pasture, 22.1%forest, and the remaining 66.8% is considered degraded, built-up or otherwise unusable. There are no identified important cash crops.

Site and Farmers Selection

Farmers were selected based on their interest, innovation and interest he/she has in cost-sharing, willingness to share experiences for other farmers. Farmers' selection was under taken in collaboration with DA's, District experts (SME) and multidisciplinary Researchers. Forty Farmers were selected for pre-extension demonstration of Animal drawn multi-purpose cart purposively.

One district and a total of two PAs from a district were selected purposively in collaboration with experts and DAs from the respective offices of agriculture and rural development. The site were selected based on the slope, appropriateness of land for the technology and access to the road for day to day monitoring and farmer's interest/tendency on the technology. The target farmers were selected based on their interest on technology, willingness to share the experience for the members as well as non-members and activeness/innovative. Therefore, according to the above criteria, One FREG per kebele with farmers consisting of 40 members were established that should be based on gender focus at least 30% of the composition members were women. In establishing FRG members in each one district a total of 2 FREGs that is total of 80 farmers were grouped in two FREGs.

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

District	PAs	No. of trial farmers
Gola Oda	Jiddo Misra	40
	Dima Misra	40
	Total	80

Method of data collection

Observation: It is the gathering of primary data by investigator's own direct field observation/measurements. Individual interview: Collecting individual's ideas towards the technology. Focus Group Discussion (FGD): for the way forwarding and the desirable change before and after implementation of this project for analyzing the performances of all responsibility shared among participants. Check list- for feedback of farmers and stake-holders collection on specific information .Data sheet- performance and the efficiency of donkey drawn cart.A total number of both female and male farmers participated in training, number of farmers that get access to these technology and cost of production of the cart were recorded.

Data analysis

Quantitative data were summarized using descriptive statistics (percent, mean and standard deviation), while the qualitative data collected using group discussion and field observation and oral histories were analyze using narrative explanation and argument. Finally data from different sources were triangulate to get reliable information.

Technology evaluation and demonstration methods/technique

The evaluation and demonstration of the trials were followed a process demonstration approach by involving FREGs, development agents and experts at on technically applicability of donkey dra. The activity was jointly monitored by FRGs, researchers, experts and development agents.

Results and Discussion

Training of farmers and other stalk holders

Multidisciplinary research team; crop, extension and socio-economic research team and other stakeholders (Offices of Agriculture and Natural Resource) actively participated by sharing their experience and knowledge and journalists for the sake of publicity of the work done Development agents, experts and farmers were participated on the training given on the use of donkey drawn cart.

Table 2: number of participants during the training at research site

		Gola Oda		
No.	Participants	Male	Female	Total
1	Farmers	54	12	66
2	DAs	7	1	8
3	District experts	6	1	7
	Total	**67**	**14**	**81**

Among the training participant stakeholders, 81.5% were farmers. From those farmers, 22.2 % were female farmers' participant.

Table.3 Multipurpose donkey-drawn cart

Parameter	**Multipurpose**
Donkey-drawn cart Capacity	4–5 quintal
Overall size–width x height x length (m)	1.3 x 0.9 x 1.3
Beam length (m)	1.3
Total cost (purchasing)	Birr 15,000
Strength of parts	Stronger
Complexity of manufacturing	more complex
Comfort for donkey	comfortable
Comfort for loading and unloading	comfortable

Farmers' Opinion/Perception

Farmers' in the study area selected donkey drawn cart by using their own criteria. Farmers set these criteria after having know-how about the technology. The opinion of those farmers on varietal preference was collected from participants during the technology donkey drawn cart can carry five quintal at time, efficient use of time ,efficient use of energy, reduce work load, reduce frequency of going and turning, concentrate effort.

Table 4: Ranks of the technology based on farmers' selection criteria**.**

Crop varieties	Farmers rank	Reasons
Donkey Drawn Cart	1st	Can carry five quintal at time, efficient use of time ,efficient use of energy, reduce work load, reduce frequency of going and turning, concentrate effort
Donkey	2nd	Can carry one quintal at a time, not efficient in usin of time ,not efficient in using of energy, increase work load the same activities, maximize frequency of going and turning, dilute effort in doing the same activities

Conclusion and Recommendation

Donkey drawn cart play significant socio-economic roles in terms of income generation, employment opportunities and improvement of livelihoods of many smallholder farmers and their families the study was conducted in two purposively selected Kebele of Gola Oda district because of their appropriateness for the technology being demonstrated in terms of the good slope of the land they have. FREGs having 40 members on average with around 30% female and 70% male was established. Farmers of Gola Oda district living around good roads are not using donkey-drawn carts for transporting construction materials such as sand, gravel and stone and for transporting their produce (grain, straw, fire wood etc.) from the field to their homes and to the market. In Gola Oda district there is plenty of animal power which is not yet properly utilized. Donkey drawn Multi-purpose Carts carry five quintals and donkey carry on one quintal at a time. Demonstrating the multipurpose donkey drawn-cart more fully is a part of the solution to transport problems of agricultural produce in the Gola Oda District.

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Pre-extension Demonstration of Ground nut Technology in Babile and Fedis Districts of East Hararghe Zone

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Abstract

*Three groundnut varieties namely Shulamiz,Bable-2 and local check were demonstrated with its full packages on 10*10m^2 on ten trial farmers field at Fadis and Babile Districts for two consecutive years (2019-2020) with the objectives of promoting and popularize improved groundnut varieties. Two FRGs having 30 farmers were established at both District. The average yield performances of the shulamiz, Babile-2 and local were 12.02, 12.02 and 7.6 quintals/ha at Bishan Babile and 11.68, 10.44 and 7.6quintal/ha at Ballina Arba respectively. The net benefit that were obtained from Shulamiz, Babile-2 and local were 29,892, 24,312, 11,892 ETB at Balina Arba and 31, 422, 31,422, 11,532ETB at Bishan babile respectively. Accordingly, the yield advantage of Shulamiz and Babile-2 variety over the local check were 55.1% and 46.98% over local check respectively.Finally it is better to promote Shulamiz varieties more fully on the larger scales for scale up.*

Key words: *Demonstration, ground nut, Shulamiz, Babile-2, local check, yield, Fadis and Babile*

Introduction

Groundnut (*Arachis hypogaea* L.) is the sixth most important oilseed crop in the world. It contains 48-50% oil and 26-28% protein and is a rich source of dietary fiber, minerals, and vitamins. Groundnut was grown on nearly 25.45 million hactar worldwide with the total production of 45.23 million tons and an average yield of 1.777 tons/ha (FAOSTAT, 2015). Groundnut has several uses .It is the principal source of digestible protein (25 to 34%), cooking oil (44 to 56%), and vitamins like thiamine, riboflavin, and niacin. In many countries, groundnut cake and haulms (straw stems) are used as livestock feed (University of Georgia, 2007).

In Ethiopia groundnut is grown and covered nearly about 40,000 hectares of arable land per annum and the major growing areas were; Eastern Hararghe, Metekel Zone, and Eastern Wellega but currently this figure was doubled. Groundnut production being expanded due to its high market value and resistance to drought (EIAR, 2010).The groundnut plant has the ability to survive in areas of low rainfall (arid and semi-arid regions) because it is a legume and it increases soil fertility by fixing nitrogen in the soil.

It requires fewer inputs than many other crops, giving a high return per unit of land, and hence is appropriate for small-scale farmers, including women (Okello, 2010).Groundnut production can also be a way for women to earn income and participate in the cash economy. Women account for 70–80% of household food production in sub-Saharan Africa, growing crops to sell in the market, as well as preparing it for their families (Caliskan, S., Arslan, M., and Arioglu, H. (2008).Therefore, this activity initiated with the objective of demonstrating and evaluating the best performing improved groundnut varieties to the target area

Objectives

- To evaluate the productivity and profitability of ground nut verities under farmers' condition.
- To create awareness among farmers, developmental agents, subject matter specialists and other participant stakeholders on improved groundnut production technologies in the area.
- To build farmers' knowledge and skill of production and management of the enterprise
- To strengthen linkage among stakeholders

Materials and Methods

Site and farmer selection

Fadis and Babile were purposively be selected. Kebeles were selected purposively based on the potentiality, appropriateness of the area by considering lodging, slop's landscape, access to road, suit for repeatable monitoring and evaluation in progress of sowing to harvesting. Ballina Arba from Fadis district and Bishan Babile from Babile were selected purposively. Farmers were selected purposively based on their interest, innovation he/she has, land provision for this pre-extension demonstration, interest in cost-sharing, willingness to share experiences for other farmers, and studying their profile with the participation of DAs and community leaders.

The selected farmers were grouped in form of Farmers Research Group (FRG) with the member of 15 farmers per Kebeles in consideration of gender issues (women, men and youth). In the establishment of FRG in the study areas total of 2 FRGs from one Kebele 15 farmers and a total of 30 farmers were grouped in 2 FRG. In the FRG 5 farmers were trial farmers (3 male trial farmers and 2 female trial farmers) and 10 farmers worked with trial farmers.

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

District	Kebeles	No. of trial farmers	FTCs	Area covered
Fadis	B/Arba	5	1	10mx 10m for each plots
Babile	Bishan Babile	5	-	
	Total	10	1	

Research design

Two improved treatment Groundnut varieties (Shulamis and Babile-2) one local check, were replicated across five trial farmers per Kebeles. Two improved and one local check were sown on 10 farmers land. Each variety planted on the Plot Size: 10mx10m, Seeding rate 100 kg/ha, Spacing 40cm*10cm (between row and plant), Fertilizer rate: DAP 100kg/ha and Maturity Date 123-135

Data Collection

Both quantitative and qualitative data were collected through personal field observation, individual interview, Focus Group Discussion by using checklist and data sheet tools. Types of collected quantitative data were number of farmers participated in FRG, yield performance, economic analysis and number of stakeholders participated on the training.

While qualitative data were farmers' Knowledge/ perceptions towards the new technology and ranked using Matrix ranking.

Data analysis

The collected quantitative data were analysed using simple descriptive statistics (mean, frequency and percentage), independent Samples t-test to compare the mean of one sample with the mean of another samples to see if there is a statistically significant difference between the two, while the qualitative were analysed using narrative explanation and argument.

Results and Discussion

Yield performance of the demonstrated varieties

The following table describes the yield performances of the demonstrated groundnut varieties across the study site. The yield performance of the improved varieties (Shulamiz, Babile-2 and local) were 11.68, 10.44 and 7.68 qt/ha at Balina Arba, 12.02, 12.02 and 7.60 qt/ha at Bishan Babile, respectively. The average yield performance of Shulamiz and Babile-2 were higher than local at and statistically significant difference at 1% probability level

Table 2: Yield performance of improved ground nut varieties across districts

PA	Varieties	N	Std. Deviation	Mean (qt/ha)	Maximum	Minimum
Ballina Arba	Shulamiz	5	1.25	11.68	13.10	10.00
	Babile-2	5	1.85	10.44	12.40	8.20
	Local	5	.50	7.68	8.30	7.10
Bishan Babile	Shulamiz	5	1.04	12.02	13.40	10.60
	Babile-2	5	.32	12.02	12.30	11.50
	Local	5	.43	7.60	8.10	7.10
Total		**10**	**2.16**	**10.24**	**13.40**	**7.10**

Table.3 ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	103.32	2	51.66	42.02	.00
Within Groups	33.19	27	1.22		
Total	**136.51**	**29**			

Yield Advantage

The result indicated that Shulamiz and Babile-2 variety have better yield (11.85 and 11.23 qt/ha) when compared with local check 7.64qt/ha) respectively. The yield advantage advantage of the Shulamiz and Babile-2 variety over the local was 55.1 and 46.98 % under farmer condition.

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

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

Table 4: Summary of yield performance in study areas

Varieties	Average yield qt/ha	Yield difference qt/ha	Yield advantage over the local check (%)
Shulamiz	11.85	4.21	55.1
Babile-2	11.23	3.59	46.98
Local	7.64		

Economic Analysis

The followed table describes the financial costs and returns of the improved ground nut varieties across two demonstration sites for 2019/20 production year.The calculation used 4500 birr as farm gate price for a quintal of ground nut grain. Thus the profit per hectare gained from shulamiz variety were 29,892 and 31,422 ETB at Balina Arba and Bishaan Babile kebeles respectively .Whereas Babile-2 profit were at 24,312 and 31,422 ETB Balina Arba and Bishaan Babile kebeles

Table 5: Financial analysis for ground nut varieties across the districts

Financial analysis						
Location: Fadis(Balina Arba)				Location: Bishan Babile		
Parameters	Varieties			Varieties		
	Shulamiz	Babile-2	Local	Shulamiz	Babile-2	Local
Yield qt/ha(Y)	11.68	10.44	7.68	12.02	12.02	7.6
Price(P) per quintal	4500	4500	4500	4500	4500	4500
TotalRevenue (TR)=TR=Y*P	52,560	46,980	34,560	54,090	54,090	34,200
Variable costs						
Seed cost	4500	4500	4500	4500	4500	4500
Fertilizer cost	1418	1418	1418	1418	1418	1418
Labor cost	12750	12750	12750	12750	12750	12750
Total Variable costs(TVC)	18,668	18,668	18,668	18,668	18,668	18,668
Fixed costs						
Cost of land	4000	4000	4000	4000	4000	4000
Total fixed costs (TFC)	4000	4000	4000	4000	4000	4000
Total cost (TC) =TVC+TFC	22,668	22,668	22,668	22,668	22,668	22,668
Gross Margin (GM) = TR - TVC	33,892	28,312	15,892	35,422	35,422	15,532
Profit=GM-TFC	29,892	24,312	11,892	31,422	31,422	11,532

Farmers' Opinion/Perception

Farmers' in the study areas selected the best performing improved groundnut varieties by using their own criteria. . The major criteria used by farmers used were grain yield, disease tolerance, large seed size, high number of pod per plant, drought tolerant. Based on the above criteria's; farmers evaluated the varieties and ranked Shulamiz followed by Babile-2. Therefore, most farmers selected both improved groundnut varieties to reuse on their farm for the future. The following table describes farmers' selection criteria and their perception (feedback) toward the varieties.

Table.6 Ranks of the varieties based on farmers' selection criteria

Varieties	Farmers rank	Reasons
Shulamiz	1st	High grain yield, disease tolerance, large seed size, high number of pod per plant, drought tolerant, uniformity,
Babile-2	2nd	High grain yield, disease tolerance, medium seed size, high number of pod per plant, drought tolerant, uniformity
Local	3rd	low grain yield, disease tolerance, small seed size, medium number of pod per plant, drought tolerant, not uniform

Conclusion and Recommendation

Farmers perceive new technologies that have an advantage over local one. Shulamiz and Babile-2 were identified by researchers and farmers as high yielding. In general, high grain yield, disease tolerance, large seed size, high number of pod per plant, drought tolerant and uniformity were the best selection criteria identified by the evaluators. The overall harvested mean yield of Shulamiz, Babile-2 and local were 11.85 qt/ha, 11.23 qt/ha and 7.64 qt/ha, respectively. Shulamiz and Babile-2 with yield advantage of 55.1% 46.98 respectively. Bearing farmer selection criteria in mind, scaling-up of the two ground nut verities better to scale up for further promotion and hence income from ground nut for the resource poor farmers in Fadis and Babile.

Hence, Shulamiz was found as the best ground nut variety followed by babile-2 variety as it produces a higher yield. The yield under demonstration was higher than the local check and the use of research recommended ground nut varieties can reduce the technology gap to a considerable extent.

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Pre-Extension Demonstration and Evaluation of Improved Leucaena varieties in Fadis and Babile District of East Haraghe Zone,

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Abstract

Pre-extension demonstration and evaluation of leucaena varieties with the objectives of promoting and popularize improved leucaena varieties and to create awareness and improve stakeholders participation. Two improved leucaena varieties (L.phalida 14203 and L.leucocephala 14198) were replicated on plot of 10mx20m per farmer.A total of sixty (60) trial farmers. The farmers were selected from two potential leucaena growing kebeles of Babile and Fedis one kebele from each District. Two FRGs having 30 farmers were established at each kebele. Training was organized for 35 participants at Fedis District.The yield performance of the improved varieties(L.phalida 14203 and L.leucocephala 14198) were 9.66 and 8.3 ton/ha at Bishan Babile of Babile District and 10.46 and 8.78 ton/ha at Riski kebele of Fedis District respectively. Accordingly, the yield advantage of the L.phalida 14203 variety over the L.leucocephala 14198 were 17.79 % under farmer condition L.phalida 14203 recommended to scale up because of yield and farmers prefer it.

Key words: *Leucaena, Varieties, Yield, Demonstration, Fedis and Babile*

Introduction

The Ethiopian livestock sector has considerable economic and social importance at household and national levels and provides significant export earnings. The sector contributes 15 to 17% of gross domestic product (GDP) and 35 to 49% of agricultural GDP and 37 to 87% of the household incomes (Behnke and Metaferia, 201 1; Gebremariam *et al*., 2010). The productivity of the sector, however, is low owing to a number of constraints, among which feed shortage both in quality and quantity is very crucial.

In Ethiopia, ruminant feeds are obtained mainly from native pastures and crop residues. The contribution of the former, however, is diminishing from time to time due to poor management and continued expansion of crop farming. This is resulting in the increasing role of crop residues which are generally of poor quality justifying the need for exploring alternative options for the improvement of forage (Diriba.G.2014).

Leucaena is the most productive and most suitable forage legume, no other forage plant can put the same weight on stock over so long a period of the year, its leaf is high in protein and easily digested by ruminants; Cattle preferred leucaena to the most other forages, making for high intake and subsequent weight gains. Leucaena does not cause bloat ,high palatability ,it has deep roots can extract water from the soil to the depth of 3-5m thus preventing rising water tables that can bring salt the soil surface and it reduces cattle methane production by 20-40% (mla ,2006)

The low adoption rate of forage technologies has traditionally been linked to limited knowledge of farmers, lack of competent and sustainable technical support and the low priority attached to promotion of forage technologies and shortage of planting materials (de Haan *et al.*, 2006; Ergano *et al.*, 2010)

Consequently, technology transfer attempts in the past focused on addressing these problems, mainly through a top-down technology transfer model. But this model is now proved to be inadequate in enhancing the adoption of forage technologies owing to its supply driven nature and its little consideration to the various sources of knowledge (Hall *et al*., 2006).

Thus, this project aimed at Demonstrating and evaluating Leucaena varieties at farmers' field there by disseminating the selected technologies to the end users based on farmers' selection criteria. These in turn increase the source of alternative forage crops that has high demand and nutritious (high protein contents), easily digestible and increase the weight of livestock to supplement the crop residue

Objectives

- ✓ To evaluate the productivity and profitability of leucaena varieties under farmers condition.
- ✓ To create awareness among farmers, developmental agents, subject matter specialists and other participant stakeholders on improved leucaena production technologies.
- ✓ To build farmers' knowledge and skill of production and management of the enterprise
- ✓ To strengthen linkage among stakeholders

Materials and Methods

Study Area Description

Fedis district has latitude between 8°22' and 9°14' north and longitude between 42°02' and 42°19' east, in middle and low land areas: altitude range is from 1200 – 1600m.a.s.l meters, with a prevalence of low lands. The area receives average annual rain fall of 400 - 804 mm; 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. Agriculture is mainly rain-fed. The cropping system is classified as intensive with cereal mono-cropping mainly sorghum and maize. Similar to areas in the Horn of Africa, two rainy seasons characterize the Fedis district's climate: the first, named Belg, is the shortest one and takes place between March and May, while the second and most important, named Meher, is between July and October. The rainfall distribution during the year is then bi-modal, with a dry spell period during the months of June and July, depending on its duration, may affect crop growth. The *Meher* (Main) season is the most important one; when the intensity of farm practices and production increase. Babille is bordered on the south and east by the Somali Region, on the west by Fedis, and on the north by Gursum; the Fafen River defines a portion of Babille's eastern border. The administrative center of this District is Babille. The altitude of this woreda ranges from 950 to 2000 meters above sea level; Ambelber and Sarbadin are amongst the highest points. Erer soil texture classes are sand (72%), silt (20%) and clay (15%) .

Site and farmers selection

Babile and Fadis Districts were purposively be selected based on the potentiality, accessibility to road, suit for repeatable monitoring and evaluation in progress of planting to maturity. Accordingly, the project was carried out in major leucaena -producing districts of East Hararghe (Babile and Fadis) during main season. For this study, two potential kebele per district were selected in collaboration with experts from the respective offices of agriculture and rural development.

Farmers were selected purposively based on their interest, innovation he/she has, land provision for this pre-extension demonstration, interest in cost-sharing, willingness to share experiences for other farmers, and studying their profile with the participation of DAs and community leaders. The selected farmers were grouped in the form of Farmers Research Group (FRG) with the member of 15 farmers per kebeles in consideration of gender issues (women, men and youth). A total of 4 FRGs were established that is two from Babile and Fadis each. 15 farmers/FRG and a total of 60 farmers were grouped in 4 FRGs.

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

District	PAs	No. of trial farmers	FTCs
Fadis	Riski	30	1
Babile	Erer	30	-
Total		60	1

Research design

Two improved treatments (L.phalida 14203 and Lecophela varieties were replicated across ten trial farmers per PAs. Three improved were sown on 20 farmers land. Simple plot design design (10m*20m) of land from individual trial farmer for each experiments/ varieties were used. Spacing 1.5m*1m (Between row and plant) respectively. Five trial farmers per kebeles were used as replication of the varieties.

Data collection

Yield obtained(farmer/variety/ha) from each varieties or agronomic data (yield data of biomass ,planting/maturing date), farmers variety preference criteria number of farmers participated and benefited from project with consideration of women, men and youth, cost expensed(operational expenses) and benefit obtained(net benefit), stakeholders responsibility sharing performances, feedback of our beneficiaries from the project.

Data sheet- for agronomic data (Bio mass yield data, planting/maturing date), cost-benefit data, Focus Group Discussion (FGD) for the way forwarding and the desirable change before and after implementation of this project for analyzing the performances of all responsibility shared among participants.

Method of Data Analysis

Simple descriptive statistics (frequency, mean, standard deviation, and cross tabulation), qualitative and quantitative data analysis methods, SPSS version 20 was used to analyze biomass yield and farmers' assessment/feedback. Economic analyses were used to analysis cost benefit data. Besides, field days and regular monitoring and evaluation of the activities were undertaken with the concerned stakeholders .The collected quantitative data were analysed using simple descriptive statistics (Mean, Frequency and Percentage), iindependent Samples T-test to compare the mean of one sample with the mean of another samples to see if there is a statistically significant difference between the two, while the qualitative were analysed narrative explanation and argument.

Results and Discussion

Training of farmers and other stalk holders

Multidisciplinary research team; Natural resource, extension and socio-economic research team and other stakeholders (Offices of Agriculture and Natural Resource) actively participated by sharing their experience and knowledge and journalists for the sake of publicity of the work done Development agents, experts and farmers were participated on the training given on leucaena production and management.

Table 2: Type of profession and number of participants on the training at Riski

		Riski		
No.	Participants	Male	Female	Total
1	Farmers	25	4	29
2	DAs	3	-	3
3	District experts	2	1	3
	Total	30	5	35

Among the training participant stakeholders, 82.8 % were farmers. From those farmers, 13.8 % were female farmers' participant.

Yield performance of the demonstrated varieties

The following table describes the yield performances of the demonstrated leucaena varieties across the study site. The yield performance of the improved varieties (L.phalida 14203 and L.leucocephala 14198) were 9.66 and 8.3 ton/ha at Bishan Babile and 10.46 and 8.78 ton/ha at Riski respectively. The average yield performance of L.phalida 14203 was higher than L.leucocephala 14198

Table 3: Yield performance of improved leucaena varieties across districts

PA	Varieties	Std. Deviation	Mean (ton/ha)	Maximum	Minimum
Bishan babile	L.phalida 14203	1.31	9.66	11.40	8.00
	L.leucocephala 14198	0.84	8.30	9.10	7.10
Riski	L.phalida 14203	1.44	10.46	11.90	8.80
	L.leucocephala 14198	.54	8.78	9.20	7.90
Total		1.32	9.30	11.9	7.10

Yield Advantage

The result indicated that L.phalida 14203 variety has better yield (10.06 ton/ha) when compared with L.leucocephala 14198 check (8.54 ton/ha). Accordingly, the yield advantage of the L.phalida 14203 variety over the L.leucocephala 14198 was 17.79 % under farmer condition.

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

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

Table 4: Summary of yield performance in study areas

Varieties	Average yield ton/ha	Yield difference ton/ha	Yield advantage over the local check (%)
L.phalida 14203	10.06	1.52	17.79
L.leucocephala 14198	8.54		

Farmers' Opinion/Perception

Farmers' in the study area selected the best performing improved L.phalida 14203 varieties by using their own criteria. Farmers set these criteria after having know-how about the variety and using those criteria they could select the varieties at harvest time. The opinion of those farmers on varietal preference was collected from participants during variety demonstration. The major criteria used by farmers were fodder quality, palatable, better feed, fuel wood, shade/shelter, soil fertility improvement, soil erosion control farmers evaluated the varieties and ranked L.phalida 14203 followed by L.leucocephala 14198 .

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

Crop varieties	Ranks	Reasons
L.phalida 14203	1st	High fodder quality, Highly Palatable ,Better Feed , Fuel wood ,Good shade/shelter, Soil fertility improvement, Soil erosion control
L. leucocephala	2nd	Low fodder quality, Medium Palatable ,Good Feed , Fuel wood ,Good shade/shelter, Soil fertility improvement, Soil erosion control

Conclusion and Recommendation

Farmers in Fedis and Babile district of East Hararghe Zone haven't been practicing Leucaenae for a long time after Pre-extension demonstration undertaken farmers realize the importance of Leucaenae .The survival rate of demonstrated Leucaenae was 66.7% and the 33.3% attacked wild life.Leucaenae phalida 14203 high fodder quality, highly Palatability by livestock, better feed than Leucaenae leucocephala and both are used fuel wood ,shade/shelter, soil fertility improvement and soil erosion control. Hence it is better to scale-up Leucaenae phalida 14203 on wider area.

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Pre-extension Demonstration and Evaluation of Mid land Sorghum Technology in Metta District of East Hararghe Zone

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Abstract

Pre-extension demonstration and evaluation of early maturing sorghum varieties were conducted in 2019-2020 with the objectives of promoting and popularize improved midland sorghum technologies and to create awareness and enhance stakeholder's participation. A total of 10 trial farmers were selected from two potential sorghum growing kebeles of Metta District. Two FRGs having 30 farmers were established. Two improved sorghum varieties (Dibaba and Adele) and with local check were planted on the plot of 10mx10m per trial farmers. A total of 67 participants were attended training organized at Metta District. The midland Sorghum varieties were evaluated based on their early maturity, yield, disease tolerance, seed color, seed quality, biomass, and stalk length and food test. The ANOVA results show that yield performance of the improved varieties (Dibaba, Adele and local) showed 37.73, 34.39 and 24.10 qt/ha at Dursitu bilisuma of Metta district respectively. The average yield performance of Dibaba was higher than Adele at 5% probability level and at 1% probability level than local check. As a result Dibaba variety was preferred well by farmers' selection criteria.

Key words: *Sorghum, Demonstration, Dibaba, Adele and Metta*

Introduction

Sorghum (*Sorghum bicolor*) is the fifth largest most important cereal in the world agricultural economy, after wheat, maize, rice and barley, and the second (after maize) in sub-Saharan Africa. In 2013, the global area cropped with sorghum was 42.3 million hectares and the worldwide production was 61.5 million metric tons; the USA, Nigeria, Mexico, India and Ethiopia are the main producers (FAOSTAT, 2014). It grows in a wide range of agro ecologies most importantly in the drought prone parts where other crops can least survive and food insecurity is rampant (Adugna.A, 2007) which make sorghum preferable by farmers in drought prone areas due to its tolerance to drought and harsh environments. Sorghum is an essential to diets of poor people in the semi-arid tropics where droughts cause frequent failures of other crops. Eastern Ethiopia is generally characterized by different agro-ecology where different sorghum varieties are cultivated in highland, mid-highland and lowland parts. It is produced not only for its grains but also for its use as a source of animal feed, fuel wood and construction material. It is grown mainly under rain fed condition (Tegene.S, 2013).

Together with millet, sorghum represents a main source of energy and protein for about one billion people in the semi-arid region of tropics and it is part of the staple diet of more than 300 million people in developing countries, representing their major source of energy and nutrients (Taylor, J.R.N, 2003). Sorghum is a basic staple food for many rural communities, especially in drought prone areas, characterized by shallow and heavy clay soils; thus, it is a subsistence food crop for many food insecure people (DuPlessis, J.2008)

Besides providing calories, sorghum has actual nutritional value in principle, because of its content of protein, vitamins, fat-soluble (D, E and K) and of B group (except for B12), as well as minerals, such as iron, phosphorus and zinc. In particular, a recent study classifies sorghum genotypes as source of vitamin E but highlight how the analyzed genotypes showed low contents of carotenoids (De Cardoso, L.M, 2015). In composition, sorghum grain compares favorably with some other cereals: it has a similar protein content to wheat but higher than maize and rice, while the essential amino acid composition of sorghum is comparable to maize or wheat due to the limited content of threonine, arginine and, especially, lysine(Henley, E.C.2010). Thus, this proposal initiated to demonstrate and promotes improved highland sorghum varieties in the study areas.

Objectives

- To evaluate yield performance of midland sorghum varieties under farmers' condition
- To create awareness on importance of improved midland sorghum production technologies
- To develop knowledge and skill of farmers and other stalk holder have on midland sorghum technologies
- To collect feedback on demonstrated midland sorghum varieties

Materials and Methods

Description of the Study Area

This study was conducted in Metta District of the Eastern Hararghe Zone, Oromia National Regional State (ONRS). According to the report of (CSA) (2008).Meta District is located in East Hararghe zone of Oromia region. It is bordered to the southwest by Deder District, to the northwest by Goro Gutu District, to the north by the Somali regional state, to the northeast by Kersa District, and to the southeast by Bedeno District. The administrative capital of the District is Chelenko.The District is characterized by valleys in pocket areas, and rugged topography with many hills. There are some permanent rivers in t District. Notable among these is the river that supplies water to the town of Chelenko. Besides, there are many perennial springs originating from below the mountains and crossing the valleys. One lake is also found. Groundwater resources are always there. Mixed crop production and livestock rearing characterize the farming system of the District. The major crops produced in the District include sorghum, maize, wheat, and haricot bean, vegetables of different kinds and fruit trees. Although there is no meteorological station for recording rainfall, the rainfall pattern in the District is bimodal.

Site and farmers selection

Metta was selected purposively based on the potentiality, appropriateness of the area by considering slop land scape and accessibility, suit for repeatable monitoring and evaluation. Thus Dursitu bilisuma kebele from Metta farmers selected and one FTC from the kebele were also selected as demonstration site to reach other farmers that visit FTC. Farmers were selected by studying their profile with the participation of Development Agents and community leaders. The selection was done purposively based on farmers' interest, land provision for this activity, interest in cost-sharing and willingness to share experiences for other farmers. The selected farmers were grouped in a form of Farmers Research Group (FRG) with the member of 15 farmers per kebeles in consideration of gender issues (women, men and youth). .Within one FRG five members were trial farmers (three male trial farmers and two female trial farmers) and the rest ten farmer work with trial farmers. Two FRGs

(2FRG/ kebele) from one 15 farmers and a total of 30 farmers were organized at Metta district.

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

District	PAs	No. of trial farmers	Area covered
Metta	Dursitu Bilisuma	10	10mx 10m for each plots
	Total	10	

Research design

Two improved treatment of high land sorghum varieties (Dibaba and Addelle) and one local check, were replicated across ten trial farmers per kebeles. 10m*10m plot size of land from individual trial farmer were used for each experiment/ varieties. Each variety planted at the plot size: 10mx10m, seeding rate 10 kg/ha, spacing 75cm*25cm (Between row and plant), fertilizer rate: NPS 100kg/ha and Urea 50kg/ha.

Technology evaluation and demonstration methods/technique

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

Data Collection

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

Data analysis

Quantitative data was summarized using descriptive statistics (percent, mean and standard deviation), while the qualitative data collected using group discussion and field observation and oral histories were analyze using narrative explanation and argument. Moreover, for significance checking t-test were used for this activity. Finally data from different sources were triangulate to get reliable information.

Results and Discussion

Training of farmers and other stalk holders

Training was organized to participating farmers before commencing the trial Multidisciplinary researchers ; crop, extension and socio-economic discipline and other stakeholders (Offices of Agriculture and Natural Resource) actively participated by sharing their experience and knowledge about sorghum production, management, post-harvest handling and marketing and journalists for the sake of publicity of the work done.

Table 2: Type of profession and number of participants on the training at Dursitu Bilisuma

		Dursitu Bilisuma		
No.	Participants	Male	Female	Total
1	Farmers	33	15	48
2	DAs	10	3	13
3	District expert	6	0	6
	Total	39	18	67

Source: Own computation 2019/2020

Among the training participant stakeholders, 71.6% were farmers. From those farmers, 31.2% are female farmers. During the training 45 leaflets and 30 small manuals on the technology that are organized in Afaan Oromoo and English languages were distributed. More over different questions, opinions and suggestions were raised and reacted from the concerned bodies. Most farmers showed high interest towards improved sorghum technology production because of better yield and earned income by selling it for different stakeholders (neighbors' farmers and Non-Government Organizations). Generally, all farmers were very interested to have the technology for their future production. Therefore, all concerned bodies were shared their responsibility for the future intervention and wider reach out of the technology.

Table 3: Type of profession and number of participants on the Mini-field day at Dursitu Bilisuma

		Dursitu Bilisuma		
No.	Participants	Male	Female	Total
1	Farmers	32	13	45
2	DAs	2	0	2
3	District experts	3	0	3
	Total	37	13	50

Source: Own computation 2019/2020

Agronomic and yield performance

The following table describes the yield performances of the demonstrated sorghum varieties across the study site. The yield performance of the improved varieties (Dibaba, Adele and local) were 37.73, 34.39 and 24.10 qt/ha at Dursitu bilisuma respectively. The yield performance of the improved varieties (Dibaba, Adele and local) showed 37.73, 34.39 and 24.10 qt/ha at Dursitu bilisuma of Metta district respectively.

Table 4.Yield performance of improved sorghum at Dursitu Bilisuma on Farmers land

PA	**Varieties**	**N**	Std. Deviation	**Mean (qt/ha)**	**Maximum**	**Minimum**
D/Bilisuma	Adele	10	1.21	34.39	35.70	33.00
	Dibaba	10	1.41	37.73	38.40	35.70
	Local	10	.88	24.10	25.30	22.50
	Total	10	6.01	32.07	39.40	22.50

Table.5 ANOVA

Between Groups	**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
Within Groups					
	1009.38	2	504.69	356.25	.000
	38.25	27	1.41		
Total	1047.63	29			

Yield Advantage

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

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

Table. 6 Yield Advantage

Varieties	**Average yield qt/ha**	**Yield difference qt/ha**	**Yield advantage over the local check (%)**
Adele	34.39	10.29	42.69
Dibaba	37.73	13.63	56.55
Local	24.10		

Economic Analysis of sorghum production

The followed table describes the financial costs and returns of the improved sorghum varieties across two demonstration sites for 2019/20 production year the calculation used 2000 birr as farm gate price for a quintal of sorghum grain. Thus the profit per hectare gained from Adele and Dibaba varieties were 62,692 and 56,012 ETB at dursitu bilisuma kebeles respectively.

Table 7: Financial analysis for Sorghum varieties across the districts

Financial analysis			
Location: Meta(Dursitu Bilisuma)			
Parameters	Varieties		
	Dibaba	Adele	Local
Yield qt/ha(Y)	37.73	34.39	24.10
Price(P) per quintal	2000	2000	2000
Total Revenue (TR)=TR=Y*P	75,460	68,780	48,200
Variable costs			
Seed cost	200	200	200
Fertilizer cost	1,418	1,418	1,418
Labor cost	7,150	7,150	7,150
Total Variable costs(TVC)	8,768	8,768	8,768
Fixed costs			
Cost of land	4,000	4,000	4,000
Total fixed costs (TFC)	4,000	4,000	4,000
Total cost (TC) =TVC+TFC	12,768	12,768	12,768
Gross Margin (GM) = TR - TVC	66,692	60,012	38,432
Profit=GM-TFC	62,692	56,012	35,432

Results of Knowledge Test

A simple knowledge test items were developed based on the contents of training and production package practices and knowledge level of participant farmers regarding improved sorghum production technologies was measured before and after implementation. Score of 1 is given for correct answers and 0 for incorrect answers. As one can observe from the table 8 below, the percentage of respondents for correct answers is increased after intervention. As a result, the percentage of respondents for incorrect answers is decreased.

Table 8.Percentage of Respondents for each knowledge Items

No	Test items	Respondents' percentages			
		Before		After	
		Correct	Incorrect	Correct	Incorrect
1	The Name of improved Variety sorghum used	53.3	46.7	73.3	26.3
2	Ploughing frequency	63.3	36.7	76.7	23.3
3	The recommended seeding rate of improved sorghum	43.3	56.7	63.3	36.7
4	The Maturity date of sorghum	43.3	56.7	56.7	43.3
5	The symptom of disease that affect sorghum	56.7	43.3	66.7	33.3
6	The disease tolerant varieties	60	40	66.7	33.3
7	The chemicals used for sorghum disease	46.7	53.3	60	40
8	The season that sorghum severely occurred	30	70	33.3	66.7
9	Yield per hectare of improved sorghum	40	60	63.3	36.7
10	Market price of sorghum	30	70	70	30
11	Exact Source of improved sorghum seed	43.3	56.7	53.3	46.7

Source: from own computed data (2021**)**

The mean score for knowledge test before intervention and after intervention is 5.4 and 6.7 respectively. The result of paired-sample t-test indicates a significant difference between the mean score for knowledge test before intervention and after intervention at 1% significant level. This implies an improvement of farmers' knowledge regarding the improved sorghum technologies due to technological intervention.

Table 9. Results of paired-sample t-test for knowledge test

	Mean	**St.Dev**	**t-value**
Total score before	**5.4**	**1.43**	**4.34*** **
Total score After	**6.73**	**1.36**	

Note: ***: refers to significance at 1% level, respectively

Source: computed from own data (2021)

Farmers' Opinion/Perception

Farmers' in the study area selected the best performing improved sorghum varieties by using their own criteria. Farmers set these criteria after having know-how about the variety and using those criteria they could select the varieties at harvest time. The opinion of those farmers on varietal preference was collected from participants during variety demonstration. The major criteria used by farmers were early mature, yield, disease tolerance, seed color, seed performance throughout growing stage, palatability of stalk as feed, good nutritional value and food test .Therefore, most farmers selected both improved sorghum varieties to reuse on their farm for the future. The following table describes farmers' selection criteria and their perception (feedback) toward the varieties

Table.10 Ranks of the varieties based on farmers' selection criteria

Varieties	Farmers rank	Reasons
Dibaba	1st	Early mature, high grain yield, disease tolerance, red seed color, good seed quality, very good performance , palatability of stalk, very good in injera test,elastic injera(easily pick able from eele).
Adele	2nd	Early mature, high grain yield, disease tolerance, white seed color, seed size, very good performance, palatability of stalk , very good in injera test, elastic injera(easily pick able from eele).
Local	3rd	late mature, low yield, disease tolerance, good seed color, small seed size, low performance, palatability of stalk feed,good injera test, elastic injera(easily pick able from Eele).

Conclusion and Recommendation

In the study areas, sorghum production is dominantly experienced with traditional farming and use of local varieties by substance smallholder farmers. Using improved sorghum varieties and management practices increases sorghum yield and also reduces the maturity period of sorghum. Early maturity has an advantage for farmers to produce. On the other side, during farmers' evaluation, palatability of sorghum Stover for animals was preferred by farmers. In the study area, sorghum Stover is usually used as a major livestock feed source during the dry season. The overall harvested mean yield of Dibaba, Adele and local variety was 37.73 qt/ha, 34.39 qt/ha and 24.10qt/ha respectively. The average yield performance of Dibaba higher than Adele at 5% probability level and at 1% probability level than local check. As a result Dibaba variety preferred well and better to promote it on wider area and number of farmers In general, the improved sorghum varieties Dibaba and Adele had higher yield advantage of 56.55 %, 42.69 and social acceptable than local one. Both Dibaba and Adele varieties was selected and recommended for pre-scaling up activity on wider plot (at least 0.125ha per trial farmer) for popularization. Strengthening the linkage among stakeholders is paramount to achieve the desired goal.

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Pre-Extension Demonstration and Evaluation of Improved Onion Technology in Fadis and Babile Districts of East Haraghe Zone

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Abstract

*Pre extension demonstration of onion varieties was conducted at Fadis and Babile districts of East Hararghe Zone one FRG from one kebele was established and 10 trial farmers. Both varieties sown on 10*10 plot size of demonstration plots with full package technology. The yield performance of the improved varieties (Red Bombay and local) were 22.86, 18.74ton/ha at Erer and 22.00, 17.92 ton/ha Ballina Arba Kebele respectively. The result showed that there is statistically significant difference at 1% probability level between red Bombay and local variety and also Red Bombay has 22.37% yield advantage over local check. Therefore, it is batter to promote and scale-up on wider area and reach large number of farmers.*

Key words: *Demonstration, Red Bombay, onion, yield, name of local check onion, FRG*

Introduction

Onion (*Allium cepa L.*) is one of the bulb crops belonging to the family Alliaceae. It is considerably important in the daily Ethiopian diet. All the plant parts are edible, but the bulbs and the lower stems sections are the most popular as seasonings or as vegetables in stews. Onion prefers well-drained sandy loam with a high content of organic matter. It is considered as one of the most important vegetable crops produced on large scale in Ethiopia. It also occupies an economically important place among vegetables in the country. The total area under production reaches 15,628 hectares and the production is estimated to be over1, 488,549 quintals (MoARD, 2009). The area under onion is increasing from time to time mainly due to its high profitability per unit area and ease of production and the increases in small scale irrigation areas (Olani .N, Fikre. M.2010). Increasing onion production contributes to commercialization of the rural economy and creates many off-farm jobs. For the supply of such seeds, the informal sector is playing significant role in reaching large number of farmers.

The optimum altitude range for Onion production is between 700 and 2200 m.a.s.l. and the optimum growing temperature lies between 15 ^{o}C and 23 ^{o}C (MoARD, 2009). It receives average annual rain fall of 670.24 - 804.06 mm. The minimum and maximum temperature of the area is 20 – 25°C and 30 – 35°C, respectively and its altitude ranges from 1200 – 1600masl Fedis Agricultural research Center. Onion is valued for its distinct pungency or mild flavour and form of essential ingredients of many dishes. It is consumed universally in small quantities and used in many home almost daily, primarily for flavouring of dishes, sauces, soup, and sandwiches in many countries of the world. Onion also contains Vitamin B, Vitamin C, carbohydrate and small percent of proteins (Lemma *et al*., 2004).

The result of Adaptation trial done by Fadis Agricultural Research Center showed that Melkam gave maximum bulb yield 294.64 Qt/ha which means double of the standard check (132.58qt/ha) followed by Bombay Red 224.55qt/ha and Nasik Red 206.69qt/ha, respectively. Thus, Melkam showed good field performance and attractive bulb size and bulb

color. However, Nasik has good quality. The objective of this study is to evaluate and demonstrate Nasik and Bombay Red Onion varieties in Babile and fadis. This project aimed at alleviating the problems of low quality Onion obtained from informal seed sectors and ensures the benefits to be obtained from improved Onion varieties**.**

Specific Objectives

- ✓ To evaluate the productivity and profitability of technology under farmers condition.
- ✓ To create awareness among farmers, developmental agents, subject matter specialists and other participant stakeholders on improved onion production technologies.
- ✓ To build farmers' knowledge and skill of production and management of the enterprise
- ✓ To strengthen linkage among stakeholders

Materials and Methods

The study of area description

This pre-extension demonstration of onion was conducted selected districts of Fadis and Babile Districts of East Haraghe Zone. Fedis district has latitude between 8°22' and 9°14' north and longitude between 42°02' and 42°19' east, in middle and low land areas: altitude range is from 1200 – 1600m.a.s.l meters, with a prevalence of low lands. The area receives average annual rain fall of 400 - 804 mm. The minimum and maximum temperature of the area is 20 – 25ºC and 30 – 35ºC, 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 etc.

Babile is located on distance of 31 kms from Harar in the direction of county's Eastern part.It is bordered by Gursum in Northern, Fedis in south, sumale region in eastern, Harari region and Fedis in western and Jarso in North west district. Erer ibada and Ibada Gemechu are located on distance of 33 km from Harari region and Erer Ibada located at 09° 10' 41.5'' north of latitude, 042° 15' 27.3'' east of longitude and elevation 1274m a.s.l. The physical property of soil in the study area is sandy loam (majority of the soil in the study area is sandy and equal proportion of silt and clay known as sandy loam).The climatic condition of this area is almost dry land. It has bimodal nature of rain fall. The socio-economic character of the population in the study area depends on subsistence agriculture. These study area are potential for production of horticultural crops both at main (rainy) season and off season (Belg).

Site and Farmers Selection

Fadis and Babile districts were purposively selected. Erer Ibada and Ballina Arba kebele were selected purposively based on the potentiality, appropriateness of the area by considering lodging, slop's land escape, access to road, suit for repeatable monitoring and evaluation in progress of sowing to harvesting. One kebele Balina Arba and Erer Ibada were selected from Fedis and Babile, respectively. The selected farmers were grouped in the form of Farmers Research Group (FRG) with the member of 15 (three male trial farmers and two female trial farmers) and 10 farmers work with trial farmers.

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

District	PAs	No. of trial and follower farmers	Area covered
Fadis	Balina Araba	5	10mx 10m for each plots
Babile	Erer	5	
	Total	10	

Technology evaluation and demonstration methods/technique

The evaluation and demonstration of the trials were conducted on farmers' fields to create awareness about onion production. The evaluation and demonstration of the trials were followed process demonstration approach by involving FRGs, development agents and experts at different growth stage of the crop. The activity was jointly monitored by FRGs, researchers, experts and development agents.

Experimental design

One improved treatments Onion (Red Bombay) variety and one local check, replication-replicate across five trial farmers per kebeles. One improved and one local check were sown on 10 trial farmers land.10m*10m plot size of land used from individual trial farmer for each varieties. Each variety planted at the spacing of 20cm between rows and 10cm between plants (10cm* 10cm). Fertilizer rate depends on the soil fertility of an area 100 kg NPS all applied at transplanting and 150 kg Urea in split, half transplanting and the other half at after a month of emergency 30-45 days after planting is recommended and seed rate 4kg/ha.

Data Collection

Qualitative data were collected through personal field observation, individual interview, and focus group discussion by using checklist; and quantitative data were collected by sheet tools.

Data analysis

The collected quantitative data were analysed using simple descriptive statistics (Mean, Frequency and Percentage), iindependent Samples t-test to compare the mean of one sample with the mean of another samples to see if there is a statistically significant difference between the two, while the qualitative were analysed narrative explanation and argument.

Results and Discussion

Agronomic and yield performance

The following table describes the yield performances of the demonstrated Red bombay and local, onion varieties across the study site. The yield performance of the improved varieties Red Bombay and local were 22.86, 18.74, 22.00 and 17.92ton/ha at Ballina Arba and Erer Kebele respectively.

Table 2.Yield performance of improved varieties across districts

Kebele	Varieties	No	Std. Deviation	Mean (ton/ha)	Maximum	Minimum
Erer	Red Bombay	5	.66	22.86	23.40	21.70
	Local	5	.68	18.74	19.70	17.90
Ballina Arba	Red Bombay	5	.44	22.00	22.60	21.50
	Local	5	.63	17.92	18.70	17.10
	Total	10	2.22	20.38	23.40	17.10

The average yield performance of Red Bombay is higher than local at Ballina arba and Erer.
Independent t-test

Table.3 Sample t-test for mean analysis

	Test for equal variances		t-test for equality of means				
	F	Sig.	T	df	Sig.(2-tailed)	Mean difference	Std. Error Differences
Equal variances assumed	.054	.818	12.539	18	.000	4.10	.32

Statistically significant difference 1% probability level

Yield Advantage

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

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

Table.4.Yield Advantage

Varieties	Average yield ton/ha	Yielddifference ton/ha	Yield advantage over the local check (%)
Red Bombay	22.43	4.1	22.37
Local	18.33		

Economic Analysis

Table 5: Financial analysis for Onion varieties across the districts

Financial analysis				
Location: Babile(Erer)			Location: Bishan Bahe	
Parameters	Varieties		Varieties	
	Red Bombay	Local	Red Bombay	Local
Yield qt/ha(Y)	228.6	187.4	220	179.2
Price(P) per quintal	1500	1500	1500	1500
Total Revenue (TR)=TR=Y*P	342,900	281,100	330,000	268,800
Variable costs				
Seed cost	12,800	12,800	12,800	12,800
Fertilizer cost	1,418	1,418	1,418	1,418
Labor cost	35,000	35,000	35,000	35,000
Fuel Cost	10,000	10,000	10,000	10,000
Total Variable costs(TVC)	59,218	59,218	59,218	59,218
Fixed costs				
Cost of land	8000	8000	8000	8000
Total fixed costs (TFC)	8000	8000	8000	8000
Total cost (TC) =TVC+TFC	67,218	67,218	67,218	67,218
Gross Margin (GM) = TR - TVC	283,682	221,882	270,782	209,582
Profit=GM-TFC	275,682	213,882	262,782	201,582

Results of Knowledge Test

A simple knowledge test items were developed based on the contents of training and production package practices and knowledge level of participant farmers regarding improved onion production technologies was measured before and after implementation. Score of 1 is given for correct answers and 0 for incorrect answers. As one can observe from the table 6 below, the percentage of respondents for correct answers is increased after intervention. As a result, the percentage of respondents for incorrect answers is decreased.

Table.6.Percentage of Respondents for each knowledge Items

No	**Test items**	**Respondents' percentages**			
		Before		**After**	
		Correct	**Incorrect**	**Correct**	**Incorrect**
1	The Name of improved onion variety used	37	63	55.6	44.4
2	Ploughing frequency for onion	48.1	51.9	59.3	40.7
3	The recommended spacing of improved onion	44.4	55.6	48.1	51.9
4	Transplanting date of onion	40.7	59.3	51.9	48.1
5	The recommended seeding rate of improved onion	55.6	44.4	63	37
6	The Maturity date of onion	33.3	66.7	40.7	59.3
7	The symptom of disease that affect onion	51.9	48.1	51.9	48.1
8	The disease tolerant varieties	40.7	59.3	44.4	55.6
9	The chemical application frequency of onion	29.6	70.4	33.3	66.7
10	The chemical used for onion	25.9	74.1	37	63
11	Yield per hectare of improved onion	48.1	51.9	48.1	51.9
12	Market price of onion	37	63	40.7	59.3
13	Exact Source of improved onion seed	44.6	55.4	66.7	33.3

Source: from own computed data (2020**)**

The mean score for knowledge test before intervention and after intervention is 5.3 and 6.4 respectively. The result of paired-sample t-test indicates a significant difference between the mean score for knowledge test before intervention and after intervention at 1% significant level. This implies an improvement of farmers' knowledge regarding the improved onion technologies due to technological intervention.

Table 7. Results of paired-sample t-test for knowledge test

	Mean	**St.Dev**	**t-value**
Total score before	**5.3**	**1.69**	**4.34**
Total score After	**6.4**	**2.11**	

Note: ***: refers to significance at 1% level, respectively

Source: computed from own data (2020)

Farmers' Opinion/Perception

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

Table.8 Ranks of the varieties based on farmers' selection criteria

Varieties	**Farmers rank**	**Reasons**
Red Bombay	1st	Medium maturity, High Yield, diseases tolerance ,Dark green leaf color ,medium bulb size, flat Glob bulb shape, light red bulb skin color and seed set
Local	2nd	Medium maturity ,Low yield, low diseases tolerance , green leaf color ,low bulb size, flat Glob bulb shape, red bulb skin color and seed set

Discussion

The trial farmers in the two locations are aware of the physical characteristics and field performance of all varieties used in the double cropping practices. The major variety selection criteria of farmers in the two locations were almost similar.

Conclusion and Recommendation

Generally, the yield of the improved varieties (Bombay Red and local) were 22.86 and 18.74ton/ha at Erer, 22 and 17.92 ton/ha at Balina arba, respectively. The average yield performance of Bombay Red and local at both location statistically significant difference at 1% across the location.It was recommended that, it is better to disseminate disease and pest resistant and high yielder varieties through scaling up to enhance dissemination . Based on its maturity, yield, diseases tolerance ,dark green leaf color ,medium bulb size, flat Glob bulb shape, light red bulb skin color bombay red varieties was recommended for further scaling up

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Pre-scaling up of improved Fababean Technologies in Jarso and Karsa Districts of East Hararghe Zone

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Abstract

Pre- scaling up of Dosha was conducted at the Jarso and Metta districts in 2019-2020 year to increase farmers' capacity in production and management practices of faba bean with the objectives of scale-up and increase the productivity of improved faba bean variety. A total of 80 farmers were involved in the pre-scaling up of fababean Dosha variety was used on plot size of 0.125ha of land of host farmers.One kebele from each districts were selected purposively based on their potential for faba bean production. From each kebele 40 farmers were selected for the activity making it a total of 80 farmers for the two years. Depending on the capacity of farmers 25kg-50kg of faba bean was given for the selected farmers. 10ha were covered by the crop during the production years. The yield performance of the varieties was 33.64 qt/ha and 30.35 qt/ha at Jarso and Kersa respectively. Further dissemination faba bean is expected from seed multipliers in producing quality seed and addressing potential area and informal farmer to farmer seed dissemination with the facilitation of bureau of Agriculture and natural resource.

Key Words: Fababean, Improved Variety,Yield, Pre-scaling up, Dosha

Introduction

Faba bean (*Vicia faba* L.) is believed to be originated in the Near East and is one of the earliest domesticated legumes after chickpea and pea. China has been the main producing country, followed by Ethiopia, Egypt, Italy and Morocco (Biruk Bereda 2009). As the faba bean is familiar in Ethiopian feeding culture, the majority of the seed produced would be consumed domestically and only a smaller percentage of the crop is delivered to the export market. However, still this small portion of export volume put Ethiopia among the top broad bean exporting countries of the world (Biruk Bereda 2009). Amhara and Oromia regions are the major faba bean producing regions. Within the regions some zones such as West Shoa, North Shoa, South Wello and East Gojjam are identified as major production areas of faba bean (Biruk Bereda 2009).

It is the first among pulse crops cultivated in Ethiopia and leading protein source for the rural people and used to make various traditional dishes. According to Central Statistics Agency of Ethiopia faba bean accounted for 31.4% (CSA, 2015). However, the productivity of the crops under smallholder farmers is not more than 1.89 t ha-1 (CSA, 2015) cultivated land with an average national productivity of 1.5 tons ha-1. Ethiopia is considered as the secondary center of diversity and also one of the nine major agro-geographical production regions. The growing importance of faba bean as an export crop in Ethiopia has led to a renewed interest by farmers to increase the area under production (Samuel S, Fininsa C, 2008).

Faba bean is a protein-rich leguminous crop cultivated and consumed as human food in Ethiopia. Its straw is also used as animal feed during feed shortage. Furthermore, 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).Since Fabean has high market price that brings high returns to the farmers. 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 diseases, the pre scaling up of improved faba bean technologies is important to promote improved technology dissemination.

Objectives

- To create wider awareness on the selected improved fababean technologies in the target districts
- To improve the production and productivity of fababean growing farmers found in the targeted districts
- To improve farmers' income
- To strengthen stakeholders participation and linkages and collaboration

Materials and Methods

Description of the Study Areas

Kersa is one of the Districts in the East Hararghe Zone of the Oromia Region of Ethiopia. It is named after a river that flows through it, the Kersa. The Districts is bordered on the south by Bedeno, on the west by Meta, on the north by Dire Dawa, on the northeast by Haro Maya, and on the southeast by Kurfa Chele. The administrative center of the Districts is kerasa other towns include Lange. The altitude of this Districts ranges from 1400 to 3200 meters above sea level. Rivers include the Weter, Langae and Goro; other bodies of water include the seasonal Lake Adele. A survey of the land (released in 1995/96) shows that 28.5% is arable or cultivable, 2.3% pasture, 6.2% forest, and the remaining 56.3% is considered built-up, degraded or otherwise unusable.Khat, fruits and vegetables are important cash crops. Coffee is also an important cash crop; over 50 square kilometers are planted with this crop. Jarso is bordered on the south by the Harari Region, on the west by Kombolcha, on the north by the city of Dire Dawa, on the east by the Somali Region, and on the southeast by Gursum. The administrative center of this woreda is Ejersa Goro. The altitude of this Districts ranges from 1050 to 3030 meters above sea level;Mountain Gara Sirirta, Aybera, Kilisa and Bekekalu are amongst the highest peaks. Rivers include the Gideya. A survey of the land in Jarso (reported in 1995/96) shows that 19.3% is arable or cultivable, 1.7% pasture, 21.6% forest, and the remaining 57.4% is considered degraded or otherwise unusable. Khat, fruits and vegetables are important cash crops.

Farmers' Selection

Farmers were selected based on their interest, innovation he/she has, land provision for this pre-scaling up, interest in cost-sharing, willingness to share experiences for other farmers.Farmers' selection were under taken in collaboration with DA's, Districts experts (SME) and multidisciplinary Researchers. 80 Farmers were selected for pre-scaling up of improved Fababean varieties (Dosha) purposively.

Site Selection

Two Kebeles(Afgug form Jarso and Tola from Kersa) were selected purposively based on the potentiality, appropriateness of the area by considering lodging, slop's land scape, access to road, suit for (clustering, repeatable monitoring and evaluation in progress of sowing to harvesting) . One potential Kebeles per district were selected purposively. At least need 0.125 ha of land from individual farmer were allocated in a cluster approach. Therefore, 0.125 ha

(80* 0.125) 10 ha of land were covered with this technology (Dosha) 40 farmers from Tola Kebele and 40 Farmers from Afgug kebele were selected.

Research Design

One improved fababean (Dosha) variety on 0.125ha of land per farmers in a clustered approach was be used. Spacing 40cm*20cm (between row and plant) respectively. Thirty trial farmers per kebeles were used as replication of the varieties. Seed rate134 kg/ha and fertilizer rate DAP 100kg/ha and no need of Urea.

Information sharing and ways of communication

Training, field and exchange visit field day, preparing pamphlet, brochures, manuals, and posters, and proceedings, and publications on international journals.

Methods of Data Collection

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

Data analysis

Quantitative data was summarized using descriptive statistics (percent, mean and standard deviation), while the qualitative data collected using group discussion and field observation and oral histories were analyze using narrative explanation and argument. Moreover, for significance checking t-test was used for this activity. Finally data from different sources were triangulate to get reliable information.

Result and Discussion

Training provided for stakeholders

Multidisciplinary Fadis agricultural research center researchers were participated in training delivering. The team members involved in the training deliver was research-extension, socio-economic and crop agronomics. The training was given on improved fababean production, market information and experience sharing and technology transfer approaches.

Table 2: Type of profession and number of participants on the training at Jarso

		Afgug		
No.	Participants	Male	Female	Total
1	Farmers	30	12	42
2	DAs	12	3	15
3	District experts	4	1	5
	Total	46	16	62

Source: Own computation 2019/2020

Among the training participant stakeholders, 67.7 % were farmers. This showed that most of the training participants were farmers. From those farmers, 28.5 % are female farmers' participant.

Table3: Yield performance of fababean Across the Districts

Kebele	Varieties	Mean	Std. Deviation	Maximum	Minimum
Afgug	Dosha	33.64	1.70	35.60	29.30
Kersa Tola	Dosha	30.35	2.03	33.20	24.80
Total		32.00	2.49	35.60	24.80

The yield performances of the demonstrated varieties across the the districts. The grain yield performance of the improved fababean variety (Dosha) was 33.64 qt/ha, 30.35 qt/ha at Jarso and Kersa respectively.

Exit strategy

The mandate of Fedis Agricultural Research Center is starting from technology generation or adaptation to demonstration and up to pre-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 Fadis agricultural research center is Office of Agriculture and Natural resource of the district 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. This is to keep that the extension system linkage among those organizations and to enhance the continuity of technology for wider coverage until the better new technology option developed. To realize this, Fadis agricultural research center and the respective district of Offices of Agriculture and Natural Resource has discussed on how to keep the continuity of the technology and wider scaling up to the larger peoples and then agreed to promote the technology by Offices of Agriculture and Natural Resource of the respective district and with the facilitation of Fadis agricultural research center in technical and close supervision.

Conclusion and Recommendation

A multidisciplinary team and participatory technology transfer are essential for sustainable technology transfer and to help many farmers to have access to technologies in a short time. The dissemination of disease-resistant and high yielding varieties through the participatory approach on farmers' field is essential for the improvement of production and productivity of Fababean. The establishment of local institutions and Seed producer and marketing cooperatives is essential for successive technology transfer. Creating market linkage for both seed and grains production will improve the utilization of the introduced technologies.

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Pre-scaling up of improved beekeeping technology in Ejersa-lafo and Toke-Kutaye Districts, West Shewa Zone of Oromia Region, Ethiopia

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Abstract

The study aimed to enhance the income of beekeeper from beekeeping technology through increasing production and productivity of beekeeping and also to enhance technology dissemination in Ejersa-lafo and Toke-kutaye Districts in West Shewa Zone. This activity was conducted at the communal apiary sites of FRGs. Purposive sampling method was used to select beekeepers and study areas. In this regards, FRG approach used thereby members experience working together through pooling their resources for common benefits and reduce transaction cost of dealing with beekeeping individually. Quantitative data and qualitative data were collected from primary and secondary sources. Forty beekeepers were directly benefited from the technology. Fundamental tasks like basic beekeeping training, regular FRG strengthening, training focused on team development, resources management, marketing and record keeping was done to successfully implement group activities. As a result, beekeepers had increased income through gradual bee colonies increment due to benefits derived from the sector. On average, honey productivity increased from 6kg to 20.3 kg and the groups able to acquired ETB 159,947 from honey production. Moreover, copy beekeepers also acquired beekeeping skills to utilize the benefits of honey production from FRG members. This also helped to disseminate beekeeping technologies across wider kebeles. Furthermore, group saving habit developed to further expand the scope of their income diversification. To maintain the sustainability of the activity, smooth linkage which focused on how to maintain group function was established with Woreda agriculture and natural resources office as exit point.

Keywords: Beekeeping, technology, beekeeper, FRG, pre-scaling up

Introduction

Apiculture serves as means of income diversification for beekeepers in potential rural areas. Beekeeping in Ethiopia is a promising non-farm activity which contributes to the incomes of households and the economy of nation through export earnings (Sisay, 2015). It also provides an employment opportunity for the household. The contributions of beekeeping in poverty reduction, sustainable development and natural resources conservation have been recognized and well emphasized by the Ethiopian government.

Compared to the potential of the country, contribution of beekeeping is far below anticipated. This could be attributed to many factors among which low production and productivity of beekeeping and poor marketing of honeybee product are the major ones. This is because existing beekeeping activity is more traditional which is difficult to manage bee colonies and produce required honey quantity and quality. The maximum honey yield obtained from traditional beehives is on average below 7kg per hive (Beyene and David, 2007).

Moreover, poor management skills of beekeepers also expected to reduce production and productivity of the subsector. Another limitation of beekeeping success is honeybee pest's problem like ants and wax moth. Pests cause a great loss on honeybee and bee products. In West Shewa Zone alone, 44.2% honeybee colonies attacked by ants per year which causes loss of 8% of honey yield and 15.5% of honeybee colonies which is estimated to 3.84 million Birr per annum (Desalegn B, 2007). Therefore, using of appropriate controlling method is important. Wax moths are also one of the most important pests that destroy the bees' wax combs where the bees can store pollen, honey and lay eggs for their normal activity (Dessalegn B, 2001). Further, study indicated that about 56% -75% of the wax moth infested honeybee colonies absconded and the rest dwindled (Amssalu and Desalegna, 2001). The study reported that effective wax moth control management practices proved to reduce the infestation level by 82.3%.

Adopting improved technologies and improved management practices would greatly improve the yields and quality of honey (Wilson, 2006). To improve the production and productivity of beekeeping improved bee technologies were disseminated to few beekeepers at few places. Nevertheless, the level of beekeeping still remains in traditional system. This indicates that the efforts made to exploit the potential apicultural resources of the country are not satisfactory. For this the technologies are not reached to significant number of beneficiaries in different potential parts of the country. Hence, the productivity and production of honeybee and the income generated from the sub-sector are still low and needs to be scaled-up to the wider areas.

Ejersa-lafo and Toke-kutaye districts are potential in beekeeping but due to various constraints beekeepers in these districts in particular and the region in general could not obtain satisfactory results in the subsector. The major limited success is due to poor information on the realities of beekeeping and a very less organized technology introduction and adoption. However, if the candidate technologies are promoted, they can greatly improve the income of beekeepers and contribute to the national economy. Therefore, recommended candidate beekeeping technology introduced to increase production and productivity of beekeeping in the study areas.

Specific objectives

- To improve beekeeper's knowledge and skills on improved beekeeping management practices,
- To increase the production and productivity of the beekeeping,
- To create awareness for wider dissemination of the technology

Methodology

Description of the study areas

The study was conducted from 2010 to 2013 E.C. in West Shewa Zone of Oromia Region, in Ejersa-lafo and Tokke-kutaye which are located at 70 and 126 kms West of Addis Ababa on the way from Addis Ababa to Nekemte, respectively. Ambo is the administrative center of the Zone. Geographically, Ejersa-lafo district is located between 9^0 0" 0" to 9^0 50' 0"N latitude and 38^0 12' 30" to 38^0 17 30" E longitude and altitude ranges between 2000 to 3288 meters above sea level (CSA, 2007). Agro-ecologically, Ejersa-lafo is divided in to highland (74%) and mildland (26%) agro-ecologies. On the other hand, Toke-kutaye is located between latitude 8^0 52' 27.2" N and longitude 37^0 48'22.7" E and altitude of 2,101 meters above sea

level. The mean average temperature of the Ejersa-lafo is 16^0c and the minimum and maximum temperature is 5.4^oc and 26.1^oc respectively (Holeta Research Center, Dendi station, 2019). The annual rainfall is 750 -1170 mm (Shime, 2014). The mean annual temperature of Tokke-kutaye is ranges between 22° C and the rain fall ranges between 900-1300mm (Yazachew E and Kasahun D, 2011). Ejersa-lafo has a total area of 32, 365 hectare (Ejersa-lafo Agriculture and Natural Resources Office, 2019). The total populations of Toke-kutaye district was 119,999, of which 59, 789 were male and 60, 201 were female; 87% of their population were rural dwellers, respectively (CSA, 2007).

The main crops cultivated in the Districts are: teff, barley, wheat, maize, sorghum, chickpea, bean, pea, lentil and haricot bean. The major livestock reared in the Districts are: cattle, horses, donkey, goats, sheep, mules and poultry. They also engage in beekeeping activities parallel to the above activities. Generally, mixed crop and livestock farming system is the mode of agriculture practice in the districts (DAO, 2016).

Site and Beekeeper Selection

For this study, Ejersa-lafo and Toke-kutaye districts were chosen purposively on the assumption of their potentiality in beekeeping production, unaddressed areas and close follow up. At the beginning, memorandum of understanding was signed with Zone and district livestock resource development agency to introduce the objectives of the activity and expected out puts as well as assign roles and responsibilities. Selection of the site and beekeepers was carried out in close consultation with the respective district livestock resource development agency.

With limited resources, 20 beekeepers were captured in the project under one FRG at each district (Table 1). The selection of target beekeepers was based on their willingness to participate in FRG, own bee colony, and contribute to the successful implementation of the project. Following stakeholder's commitment to implement the activity, one communal apiary site each site was established based on convenience of the site as center for learning and disseminate the technology.

The recommended improved beekeeping technologies candidates introduced in the area were movable frame bee hives, improved bee forage development, ant-control, seasonal colony management practices (swarm control, colony transferring, harvest ripen honey, disease and pest management, supplementary feeding, etc, and honey product quality handling techniques. As a starting point, ten bee colonies were transferred onto moveable frame hive at each site.

Table 5. Summary of beeekeeper FRG members in the study areas

Location	Category			bee Colony	Number of FRG
	M	F	Total		
Ejersa-lafo	20	0	20	10	1
Toke-kutaye	18	2	20	10	1
Total	38	2	40	20	2

Sources of Data and Method of Data Collection

Both quantitative and qualitative data was collected from primary source and secondary sources. The primary data was designed to capture information on over all bee hives apiary management practices, post honey harvest handling and awareness on the recommended technology package. Data collection sheet was contained both open and close-ended questions to answer the specific objectives. In addition, secondary information was collected from T/kutaye and E/lafo livestock resources development agency, published and unpublished sources to support primary. On the top of these personnel observations and FGD were used to complement the discussion of the findings.

Methods of Data Analysis

Quantitative data collected on beekeeping production and productivity status, number of people acquired improved beekeeping knowledge and skills and beekeeper awareness were analyzed using descriptive statistics such as percentage, mean, and summarized using tables. SPSS computer software package (version 21) was used to compute raw data. On the other hand, qualitative data gathered using FGD and personal observation was interpreted using narration and on spot analysis.

Results and Discussion

This part presented improved beekeeping technology, production and productivity of beekeeping and awareness of beekeeper on the technology.

Beekeeping training for Beekeepers FRGs and Experts in the Study Areas

Prior to project implementation, baseline data of the beekeeping FRG members were assessed and identified**.** Accordingly, lack of knowledge to utilize movable frame hive, bee colony transferring from traditional onto improved bee hives, active and dearth period management practices, post-harvest honey handling techniques, lack of access to bee protective cloths and tools as well as market problems were identified. In order to make theoretical parts more understandable to the trainees, pictorial facts were displayed using power point, poster, flip charts, video shows and success experiences on improved beekeeping. The following basic beekeeping training topics were delivered through establishing facilities and training materials for the trainees:

- Introduction to beekeeping practices in Ethiopia;
- Bee botany and ecology, and apiary site improvement;
- Bee health; improved bee management;
- Bee products and quality improvement;
- Bee products and marketing;
- How to start beekeeping enterprise for income generation;
- Chefeka hive construction practical, beekeeping skill development (colony transferring, processing crude honey and beeswax, pure beeswax foundation sheet making and fixing onto frame hives.

Table 6. Number of Training Participants

S/N	Title	Duration	Beekeepers			Bee expert			Das		
		M	M	F	Total	M	F	Total	M	F	Total
1	Basic beekeeping	5	68	12	80	3	2	5	6	3	9
2	Refreshment	3	38	2	40	2	2	4	2	1	3

In order to make FRG members grasp ideal beekeeping technology, 40 beekeepers provided with training twice which ranges from three to five days. Moreover, DAs and bee experts attended the training to back up beekeeping knowledge and skills to provide required services to the beekeeping community in the areas (Table 2). Furthermore, refreshment training was organized for trainees to further internalize beekeeping technology skills. So that trainees becoming beekeeping technicians in their community and confident enough to conduct beekeeping technology independently after project terminated.

Honey Yield and Revenue from Communal Bee Colonies

With traditional beekeeping practices, productivity of honeybee is quite low per (5-6 kg on average) hive but intermediate hives can yield more (10-15 kg on average) but less than frame hive (15-20kg on average). In this study, honey yield obtained from established common bee colonies was used to compute the results. On average hive productivity was increased from 6kg to 20.3 kg per movable frame bee hive due to taking up of improved beekeeping management practices in the areas. Honey yield on average which ranges from 14 to 21kg per beehive was harvested from pre-scaling up sites at Ejersa-lafo and Toke-kutaye districts, respectively (Table 3). Higher Mean honey yield from moveable frame hives was recorded at Toke-kutaye (Table 3).

Table 3. Honey yield and income from communal bee colonies of beekeeping FRGs

Location	hive number	Mean honey yield across year				Income gain across year			
		2010	2011	2012	2013	2010	2011	2012	2013
E/lafo	15	-	-	14	19.6	-	-	57, 750	78,375
T/kutaye	9	16.75	18	18.5	21	41, 456	44, 550	45, 788	51, 975
	24	-	-	16.25	20.3				**159, 947**

*Unit kg estimated to 250-300 birr

Regarding the benefit, beekeeping FRGs was benefited from honey sold. On average ETBirr 159, 947 obtained by target groups due to introduced technology in the areas. It implies that taking up of beekeeping technology has a tendency to increase the annual income of household during interim period. On the other hand, totally FRG generated ETBir 136,125 and 183,769 at Ejersa-lafo and Toke-kutaye sites, respectively. This is indispensible common revenue they could not have individually from beekeeping. 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). Higher revenue obtained at Toke-kutaye site as consecutively honey obtained during the year 2010 through 2013 E.C unlike Ejersa-lafo site where satisfactory honey yield obtained only in 2013 E.C after one year extension.

Technology Pre-scaling up Approach and Exit Strategy

It was obligatory that each FRG members had likely to have at least two hives at their back yard besides common bee colonies just after the second year of project implementation. As a result, 45% and 55% of FRG members have utilized chefeka and moveable frame hives utilized at their own home at both pre-scaling up, respectively. On the other hand, 30% and 15% of FRG members have used chefeka hives individually at Ejersa-lafo and Toke-kutaye districts, respectively. Higher number of FRG members adopted box hive (35%) at Toke-kutaye site compared to Ejersa-lafo (Table 3). Absolutely, the benefits derived and beekeeping skills acquired from being in beekeeping FRG increased their interest to adopt improved beekeeping at their home and able to maximize income from beekeeping than before.

Table 4. Adoption of improved bee hives by FRG members at their backyard

Location	N	Chefeka	Movable hive	Revenue	
		per cent	per cent	total honey yield	income in ETBirr
E/lafo	20	12 (30%)	8(20%)	121	21,175
T/kutaye	20	6 (15%)	14(35%)	144	25,200
Total	40	18(45%)	22(55%)	265	46375

*One kg honey was estimated to 250-300 Birr

To further disseminate the introduced technologies into surrounding community 40 non FRG beekeepers and three DAs from adjacent kebeles were provided with basic training by senior researchers (Table 2). Furthermore, non-target beekeepers were invited to observe communal apiary site of FRGs to know bee colonies transferring from traditional onto improved bee hives, apiary management, internal inspection to control bee enemies and swarming, honey harvesting and processing activities at different times. This kind of experience sharing provides non-target beekeepers with tangible beekeeping knowledge and skills.

First and for most, FRG groups were profoundly equipped with required improved beekeeping knowledge and skills and graduated them to become beekeeping technician to serve the community. Most importantly, Farmers Research Groups have by law to regulate the group's norms. Accordingly FRG members meet monthly to discuss, contribute monthly saving, reporting and so far. Each FRG has bank account to deposit revenue obtained from sale of honey and monthly saving. On spot analysis result shows that some FRG members can collect relevant information on the trial and capable to locate sources of information. Group members report that "Being involved in FRG enables build social relationship and pursue wider concerns, initiates new scene under organized collective action. It further create conducive conditions to cooperate and share experience and skill within FRGs as well as the tendency to have close link and intimate collaboration with research, extension, and others who have adequate information.

Training focused on business skill development, entrepreneurship, group governance and recordkeeping was organized to keep group function smoothly. It provided groups committees with business skills, ability to seek for existing opportunity, administrative skills, mobilize resource, and resource management skills as well as problem solving skills as training was supported by hands-on activity. Moreover, as exit strategy, the responsibility to provide the producer group with technical support and follow up was handed over to the respective Woreda concerned bodies.

Beekeeper's awareness on the practical management of improved beekeeping

Awareness on the beekeeping technologies and its benefit helps the beekeeper to learn more about the technologies and motivates the beekeepers towards adopting the technology. The relative advantage of movable frame hive over traditional bee hive is known but its application was guest to beekeepers in the areas. Qualitative questions were provided to beekeeping FRGs to identify whether or not they have adequate awareness towards improved beekeeping technology for surplus honey production and annual income generation.

The study show that FRG members were aware that forage determines the amount of honey yield obtained provided that other factors are suitable for honey production. It implies that beekeepers have good knowledge with respect to pollen and nectar production as sources of food for honey production. In order to make sure that they are confident enough aware of swarm preparation reason and harvest ripen honey, practical questions provided to members to have their response. Accordingly all of members have good knowledge in colony inspection to abort extra queen cells and/ or increase hive volume and identify ripen or unripe honey. This implies that beekeepers are conscious of the exact period of swarm occurrence, bee colony transferring and honey harvesting. The result members have good skills in colony transferring from traditional beehives onto improved hives while only 17% show below expectation. Moreover, FRG members have good knowledge of honey extraction and identify and manage disease and pests (ants, wax moths, and ant-control) that reduce honey production, respectively. None of the beekeepers show inadequate knows how in recommended improved beekeeping practices. The majority of them reported that such kind of beekeeping knowledge was absent in the community at all. Generally, the results show that beekeepers have increased awareness with respect to the provided improved beekeeping.

Problems faced during pre-scaling up Activity

A related problem with the extension service is the high mobility/ turnover of DAs and SMS. SMSs and DAs quit their position after they had gained experience in the field. Serious shortage of operational budget is another problem that affects the extension activities. The essence of pre-scaling up is to address more beneficiaries at instance with productive technology. Besides, improved beekeeping needs essential materials to operate routine activities. These problems coupled with inflation, it's difficult to attain the proposed goals. Related with the budget constraint is the serious shortage of training, experience sharing, etc.

Conclusion and Recommendation

In the process of pre-scaling up technology, yield is a prominent determinant factor for the decision of popularizing the technology. In the study area, the average honey yield increased from 7kg to 17.88 kg per hive. On the other hand beneficiaries able to acquired ETB 23,185 from honey production on average as a result of adoption of improved beekeeping management practices. It can be concluded that yield per hive at beekeeper's level increased as a result of adoption of beekeeping package together with strong follow up.

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 and wider dissemination of the technology. Above all FRG members have though understanding on the introduced improved beekeeping management package. Therefore, livestock resource development office of respective districts should give strong attention to further dissemination of technology package and improve delivery of extension service given to the beekeepers.

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Pre Extension Demonstration of Horizontal animal feed mixer machine in Western Oromia

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Abstract

The study was conducted in Jimma Zone of Oromia Regional State, Ethiopia. The objective of the study was to evaluate the engine operated horizontal animal feed mixer machine performance under the farmers' condition at the study area. Three sites were selected as hosting centers for the popularization of the technology at different sites namely Ganji Chala, Suse, and Serbo selected from three districts (Nada, Goma and Kersa) purposively. Total of 40 farmers (9 Female, 31 Male) and, 7 agricultural workers (SMS and DAs), 9 others (Kebele Administrators and Researchers) have attended the mini field day. The evaluation result showed that the machine saved farmers' labor and time having average mixing efficiency of 85.11% with good performance compared to the local mixing method. Likewise, participant farmers' perception responses showed that 74.28% replied the manual animal feed mixer machine had good mixing capacity and the rest 25.71% ranked it to the medium performance. Yet no respondent responded for its poor level of mixing capacity. Hence, most of the farmers have positively perceived the manually operated animal feed mixer machine based on its performance. Regarding the machine affordability, 57.14% respondents replied that it showed medium level however it was still commented for further improvement for more efficiency.

Keywords*: Mixer, Animal Feed, engine operated, Capacity, Efficiency, Affordability.*

Introduction

Livestock is an integral part of the agriculture and the contribution of live animals and their products to the agricultural economy accounts for 40%, excluding the values of draught power, manure and transport of people and products (Winrock International, 1992). Ethiopia holds the largest livestock population in Africa. In the Ethiopian highlands, natural pasture can produce 6 tons DM/ha but when continuously grazed it yields only 2.5 tons DM/ha (Jutzi *et al*., 1987). According to (Lulseged, 1985), native pasture land in the Ethiopian highlands have been estimated to be 73 million hectares supporting about 24 million livestock units (LU) in the same area. These figures indicate that native pastures are an important feed source.

In spite of this fact, seasonal feed deficiencies cause loss of weight that was gained during more favorable periods. Fodder conservation to help eliminate seasonal feed-supply fluctuations is rarely practiced. Several studies have been conducted on fodder production and use in Ethiopia, both by national and international research organizations. However, the focus of the studies was limited to the agronomic and nutritional characteristics of feed resources, and animal responses to types of feeds and feeding practices (Bediye et al., 2001).

Food is one of the most important basic needs of animals like the hogs in order to survive. That is why food and machinery are related in terms of food production, preparation and other processes. Traditionally, small scale hog, cattle and poultry raiser like the researcher, used manual or hand to mix the crushed feed. Venturing into medium scale production, machineries is needed for the purposed of mixing an ingredients to turn into feeding of the animals. Machine is a well-known structure consisting of frame works with various moving parts for doing the job easier, faster and more quality output (Cajindos, 2014).

Different types of machinery needed for the production of various types of feeds include; grinders, mixers, elevators and conveyors, mixer, extruders, cookers, driers, fat sprayers and steam boilers (New, 1987). The mixing operation in particular, is of great importance, since it is the means through which two or more ingredients that form the feed are interspersed in space with one another for the purpose of achieving a homogenous mixture capable of meeting the nutritional requirements of the target livestock (Balami, *et al*., 2013).

A satisfactory mixing process produces a uniform feed in a minimum time with a minimum cost of overhead, power, and labour. Some variation between samples should be expected, but an ideal mixture would be one with minimal variation in composition (Lindley, 1991). There is usually an optimal mix time, which must be determined experimentally.

Often, mixing times are determined by using an easy-to-analyze component, such as salt, but care must be taken that the results apply to the material of most interest, since it may have different particle size and density than salt does. The horizontal animal feed mixing machine is very important being easy to operate and gives sufficient feed mixed output.

A mixing performance of up to 85.11 % was attained being safe to use and efficient. It was cost effective because the design and fabrication were done locally. Livestock is one of given attention by side of government mainly for micro-financing enterprises which depends on the livestock Agro-industries. In south western Oromia (Jimma, Bunno Bedele) there are many micro-enterprises which evolved on livestock production. But these micro enterprises have no feed mixer machine for their animal feeding to increase their products.

Therefore, demonstration of this machine in the study area was conducted to facilitate mixing of feed constituents and save the working time.

Objectives of the study

- To create awareness on horizontal animal feed mixer to household farmers and privet individuals in the study area
- To evaluate the machine under farmers condition
- To asses feedbacks about improved animal feed mixer machine from farmers and other key stake holders

Materials and Methods

Materials: The horizontal animal feed mixer was produced in the JAERC production workshop.

Methodology

Three districts were selected from Jimma zone randomly and from each district two Kebeles were selected purposively based on animal production potential. From each selected site a group of 10-15 hosting farmers were selected purposively with respective Kebele DA's for the technology demonstration. Mini field day was arranged at the selected sites.

Data collected

Quantitative data on the machine performance based in terms of time and labor consumed in Man-hr per kg/hr.
Qualitative data on mainly feedback and comments from participant farmer's perception

Method of data analysis:

The quantitative data collected on the technical performance through interview, observation and group discussion and analyzed by using descriptive statistics and the perception by using Likert scale ranking method in three levels.

Result and Discussion

Both Practical and theoretical training were given for the participant farmers, Subject Matter Specialists (SMS) and Development Agents (DAs) at selected Kebele level on the operation and maintenance of the engine operated animal feed mixer machine to create awareness. Accordingly a total of 47 farmers, 4 DAs and 3 Subject Matter Specialists were participated in training.

Table1. Training given to farmers, DAs & SMS

No	**Location**		**Training Participants**				
			Farmers		**Others**		**Total**
	District	**Kebele**	**Adult**	**Youth**	**DAs**	**SMS**	
1	Nada	Ganji chala	11	5	1	1	**18**
2	Goma	Suse	9	4	1	1	**15**
3	Kersa	Sarbo	16	2	2	1	**21**
		Total	**36**	**11**	**4**	**3**	**54**

On-farm evaluation of engine operated horizontal animal feed mixer machine

Table2.Performance of engine operated animal feed mixer machine under farmer management

Woreda	**Kebele**	**Replication**	**Mixing time(min)**	**Mixing performance (%)**	**Empting time(sec)**
Nada	Ganji Chala	1	10	84.61	210
		2	10	85.76	230
		3	10	84.10	190
		Average	**10**	**84.82**	**210**
Goma	Suse	1	10	82.37	200
		2	10	86.54	207
		3	10	85.55	210
		Average	**10**	**84.80**	**205.66**
Kersa	Sarbo	1	10	86.25	220
		2	10	86.20	215
		3	10	84.70	180
		Average	**10**	**85.72**	**205**
	Total	**Average**	**10**	**85.11**	**206.89**

The performance evaluation of the technology was made based on the attributes recognized as important showed that average mixing efficiency (85.11%) and empting time (sec) as it has good performance. Hence, the above table indicated that the manual animal feed mixer has good mixing efficiency that preferred by the participant farmers.

Demonstration of the improved engine operated horizontal animal feed mixer machine

Mini-field days conducted

Table3. Participants on mini field day

No	Location		Participants of field days									
			Farmers				DAs & SMS		Others Stalk-holder		Total	
			Adult		Youth							
	District	Kebele	M	F	M	F	M	F	M	F	M	F
1	Nada	Gandi Chala	6	2	4	1	1	1	1	1	12	6
2	Goma	Suse	8	0	3	3	2	1	3	1	16	5
3	Kersa	Sarbo	7	1	3	2	2	0	1	2	13	5
	Total		21	3	10	6	5	2	5	4	41	16

In view of that, 40 farmers (9 Female, 31 Male), 7 agricultural workers (SMS and DAs), 9 others (Kebele Administrators and Researchers) have attended the mini field days.

Farmers' perception on the technology attributes

Table4. Farmers' perception on engine operated horizontal animal feed mixer machine

No	Description	Response level	No. of respondents=35	Percentage (%)
1	Mixing capacity	High	26	74.29
		Medium	9	25.71
		Low	-	-
2	Ease of operation and maintenance	Simple	20	57.14
		Not Simple	15	42.85
3	Affordability	High	5	14.29
		Medium	20	57.14
		Low	10	28.57

The evaluation result showed that the machine saved farmers' labor and time having average mixing efficiency of 85.11% with good performance. Likewise, participant farmers' perception responses showed that 74.28% replied the manual animal feed mixer machine had good mixing capacity and the rest 25.71% ranked it to the medium performance. Yet no respondent responded for its low level of mixing capacity. Hence, most of the farmers have positively perceived the manually operated animal feed mixer machine based on its performance. Regarding the machine affordability, 57.14% respondents replied that it showed medium level however it was still commented for further improvement for more efficiency.

Conclusion and Recommendation

Conclusion

- The engine operated horizontal animal feed mixer machine saved farmers' labor and time having average mixing efficiency of 85.11% with good performance compared to the local mixing method.
- The participant farmers' perception responses showed that 74.28% replied the manual animal feed mixer machine had good mixing capacity and the rest 25.71% ranked it to the medium performance. Yet no respondent responded for its poor level of mixing capacity.
- Hence, most of the farmers have perceived positively the animal feed mixer machine based on its performance

Recommendation

- The machine is recommended for use by small and medium stock raisers as it is important than vertical feed mixing machine aspect of operation and low cost of machine.

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Pre-extension demonstration and evaluation of Engine operated Rice Thresher in South Western Oromia

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Abstract

The study was conducted in Jimma and Buno Bedele Zones of Oromia Regional State, Ethiopia. The objective of the study was to create awareness, enhance knowledge and skill and get feedbacks on Engine Operated Rice Thresher for household farmers and privet individuals. Three sites (Kishe, Gasera and Chewaka) were selected as hosting centers for the popularization of the technology in two districts (Shebe and Chewaka) for the study. Training was given to farmers, DAs and SMS. Total of 97 farmer (29 Female, 68 Male) households attended the field demonstration at different sites involving men and women participation. The evaluation result showed that the machine saved farmers' labor and time having average threshing capacity 2.34 kg/min with efficiency of 96.44 that it performed the threshing activity in a better way than the local methods with relatively less percentage of the product loss 0.1. More than fifty participant farmers' perception showed that the machine threshing capacity and efficiency was good with tolerable grain loss. While no respondent ranked it to poor level for these criteria. Thus, most of the farmers have positively perceived to the machine on its threshing capacity, efficiency and the grain loss.

***Keywords**: Rice, Demonstration, Thresher, Engine Operated, Efficiency, Grain Loss, Capacity.*

Introduction

Threshing is vital part of post-harvest activities for cereals and legumes crop. In many developing countries, threshing is mainly carried out by traditional methods and few threshing machines (Ouezou Y.A.et al., 2009). The traditional methods of threshing rice are pounding in mortar with pestle, beating with clubs on the floor, rubbing on the floor, beating gently with clubs in jute bags and threading under the feet of man or hooves of animals.

In Ethiopia, the most common method employed by farmers, to thresh crop is spreading the crop over a prepared floor and beating it with a stick repeatedly. The other widely used method of threshing is trampling by animals. In both cases, a circular plot of land, locally called 'Ogdi, 4-6 meters in diameter is cleared from grasses on which the harvested crop (wheat, barley or rice) is spread for beating or trampling to thresh.

Unlike what is observed in mechanized farms where mowing and threshing could be undertaken simultaneously, grain harvesting by Ethiopian farmers takes place manually and involves hand mowing of crops using sickles and later threshing by letting a group of animals trampling upon it (Abebe H. Gabriel and Bekele H. 2006). Several days could elapse before mowed crops are threshed; i.e., crops stay piled for some time either around homestead or in situ before threshing. Mainly rural women and children that put a lot of additional job burden on them can carry out all these activities.

In general, in many developing countries, labor intensiveness, low grain quality and widepread use of simple farm tools that result in low productivity and high post-harvest losses are the common features occur. Now days, rice has become one of the major cereal crop produced in Jimma zone following maize, teff, sorghum, and wheat mainly the Gera, Gomma, Shebe Sombo, Limu-Kosa, and Limu-Saka districts are major rice growing areas covering 2018 hectares with 49736 quintals of rice production (JZADO, 2010). The Chewaka districtof Buno-Bedele zone is also well known for rice production.

Therefore, the improved engine operated rice thresher machine was introduced in the study area to overcome the above problems and increase the production of rice through demonstration activities.

Objectives of the study:

- To create awareness on rice thresher for household farmers and private individuals
- To evaluate the performance of the engine operated rice thresher
- To assess feedback on the technology

Materials and Methods

Materials

The sample Engine Operated Rice Thresher was produced in the JAERC production workshop.

Methods

The sample rice thresher was manufactured and two potential rice crop producer districts (one from Jimma and one from Buno-Bedele zones) were selected purposively. The demonstration was carried out on purposively selected sites by considering two Kebeles from Shebee district of Jimma Zone and one additional potential rice crop producer Kebele from Chewaka district of Buno Bedele zones. The specific sites identified in collaboration with agricultural experts and DAs from the selected Kebeles based on crop production potential. The demonstration of rice thresher was conducted on target rice growing farmers and private producers' farm field.

Field Evaluation

The threshing activity was carried out by feeding unrushed grain in to the machine. The engine speed was adjusted as per the rice threshing fitness required.

Data collected: - Quantitative data like threshing capacity (kg/hr), threshing efficiency (%), & Breakage percentage (%) of the machine performance

Qualitative data on perception through: interview and FGD, to get feedback and comments from participant farmers

Method of data analysis:

The quantitative data collected on the technical performance and analyzed by using descriptive statistics while the qualitative on perception collected through interview, observation and group discussion analyzed by using three level Likert scale ranking and narrative method

Result and Discussion

Both theoretical and practical training was given for 29 participant farmers, 4 Subject Matter Specialists (SMS) and 6 Development Agents (DAs) on the modified rice thresher machine operation and maintenance.

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Table 1: Training given to farmers, DAs & SMS on Rice Thresher Technology

No	**Training Site**		**Farmers**				**Das**		**SMS**		**Total**
			Adult		**Youth**						
	District	Kebele	M	F	M	F	M	F	M	F	
1	Shebe	Kishee	4	0	5	1	1	1	1	1	14
2	Shebe	Gasara	4	1	4	1	2	0	1	0	13
3	Chewaka	Chewaka	3	1	3	2	2	0	1	0	12
		Total	11	2	12	4	5	1	3	1	39

On-farm Performance Evaluation

Table 2: Average performance of the rice thresher (efficiency, breakage and threshing capacity)

No.	**Rep.**	**Threshing efficiency (%)**	**Breakage percentage (%)**	**Threshing capacity (kg/hr)**
1	Rep	Threshing Efficient (%)	Threshing capacity (kg/min)	Breakage (%)
	K1	95.21	2.55	0.1
	K2	96.33	2.25	0.08
	K3	97.55	2.66	0.09
2	**Av**	**96.33**	**2.48**	**0.09**
	G1	96.33	2.45	0.1
	G2	9533	2.20	0.11
	G3	97.66	2.31	0.09
3	**Av**	**96.44**	**2.32**	**0.10**
	C1	96.26	2.30	0.1
	C2	96.55	2.14	0.12
	C3	96.84	2.22	0.11
	Av.	**96.55**	**2.22**	**0.11**
Grand total		**96.44**	**2.34**	**0.1**

The letters C, G & K, indicate the thresher evaluated at three different sites.

On farm evaluation of the technology was made in team work with participant farmers, SMS and DAs. The thresher was evaluated based on the attributes recognized as important showed that average threshing efficiency (%), breakage percentage (%) and threshing capacity (kg/min) of 96.44, 0.1 and 2.34 values, respectively as it has good performance compared to the local threshing method.

Thus, the above table indicates that Jimma modified rice thresher have good threshing efficiency and capacity with minimum breakage as preferred by the participant farmers.

Demonstration

Farmer to farmer learning was used to promote the technology simply by arranging threshing program at the host farmer's farm site.

The demonstration was done through organizing mini field day. The farmers' feedback after the demonstration of rice thresher technology were collected based on evaluation criteria jointly set by researchers and farmers like grain damage, optimum output capacity, and threshing efficiency.

Demonstration of the improved Engine Operated Rice Thresher

Table 3: Participants on mini field day

No	Location		Participants of field days											
			Farmers				SMS		DAs		Stake Holders		Total	
			Adult		Youth									
	District	Kebele	M	F	M	F	M	F	M	F	M	F	M	F
1	Shebe	Kishe	12	3	8	4	1	-	1	0	1	-	23	7
2	Shebe	Gasara	9	6	13	5	1	-	2	1	1	-	26	12
3	Chewaka	Chewaka	11	3	15	8	-	1	2	1	1	1	29	14
	Total		**32**	**12**	**36**	**17**	**2**	**1**	**5**	**2**	**3**	**1**	**78**	**33**

Mini-field days were organized at different sites (Kishe, Gasera and chewaka) which was attended by different stakeholders. In view of that, 97 farmers (29 Female, 68 Male), 3 SMS, 7 DAs, and 4 Administrators (Kebele Level residents) have attended the mini field days.

Farmers' perception on the technology attributes

Data on technical operation and perception aspects were collected and analyzed as well. feedback during and after demonstration to analyze farmers' opinion about the thresher on some of the rice attributes threshing efficiency (%), Breakage percentage (%) and threshing capacity (kg/min) obtained were described in table below.

Table4. Farmers' Perception on engine operated rice thresher

The thresher attributes and its acceptance degree by farmers	Scale measurement	Participant Respondents	
		Frequency	Percentage
Criteria		(Fr)	(%)
Threshing capacity (kg/min).	High	16	53.34
	Medium	14	46.66
	Low	-	-
Threshing efficiency (%),	High	20	66.66
	Medium	10	33.34
	Low	-	-
Breakage percentage (%)	High	-	-
	Medium	5	16.67
	Low	25	83.33

Among the total respondents, 53.34% replied that the Jimma modified rice thresher machine had high threshing capacity and the rest 46.66% ranked it to the medium performance. Yet no respondent responded for its low level of threshing capacity. This shows that most of the farmers have positively perceived to this machine on its capacity.

Moreover, the respondent farmers were also perceived the machine for its good threshing efficiency. More participants (66.66%) replied that it has high efficiency and the rest 33.34% viewed it medium while no respondents perceived as poor performance for the three criteria. The machine is also preferred for its own strength and drawbacks at the farmers' field. Farmers just liked it in its minimum seed breakage, easy to operate and simple to transport.
Generally, the feedback data showed that the farmers have positively perceived the machine simply by observing its threshing efficiency (%), breakage percentage (%) and threshing capacity (kg/min) of 95.5, 0.09 and 173.06 values, respectively as it has high performance as to the farmers' observation.

Conclusion and Recommendation

Conclusion

- The evaluation result showed that it has high performance with average threshing efficiency, breakage and capacity of 96.44%, 0.1% and 2.34kg/min respectively.
- The rice producer farmers had appreciated the machine conveyance for their rice production activities for its good performance to tedious rice threshing method.
- They acquired skill through training for using the improved technology for rice threshing.
- The technology introduction had motivated more rice producer farmers where some have already demanded for the technology supply.

Recommendation

- The manufacturer enterprises and concerned agricultural offices required hould closely work in facilitating means for technology supply
- The concerned district administrative bodies need better organize unemployed landless young farmers through technical skill and financial support so that they can buy the machine and serve the farmers on rent bases.
- The rice thresher was liked by farmers and the research centre need train the local technicians for repair and maintenance in case damaged on operation.

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Pre Extension Demonstration of Jimma Model Manual Dry Coffee Dehuller in South Western Oromia

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Abstract

The study was conducted in Jimma Zone of Oromia Regional State, Ethiopia. The objective of the study was to demonstrate and evaluate the hand operated dry coffee dehuller performance for dry coffee under the farmers' condition at the study area. Three sites were selected as hosting centers for the popularization of the technology namly Omo Gurude, Kela, and Kolobo selected from three districts (Goma, Dedo, and Mana,) for the study. Total of 53 farmers (19 Female, 34 Male) households including10 agricultural workers (SMS and DAs), 10 others (Kebele Administrators and Researchers) attended the field demonstration at different sites involving men and women participation. The evaluation result showed that the machine saved farmers' labor and time with average capacity and efficiency and breakage of 71.80, and 70.63 and 5.80 respectively. It hulls the coffee in a better way than the local methods with relatively less percentage (5.8%) of the product loss due to breakage. The participant farmers' perception showed 67.5%, 90% and 93.5% has good hulling capacity, efficiency and forage loss whereas 32.5%, 10%and 7.5% responded to medium level respectively but no respondents ranked it poor for the three attributes. As a result, most of the farmers have positively perceived to this equipment towards its performance.

Keywords*: Demonstrate, Evaluate, Hand Operated, Dry Coffee, Dehuller.*

Introduction

Coffee ranks as one of the world's most valuable and widely traded commodity crops and is an important export product of several countries (Stoffelen *et al.*, 2008). Agriculture is the most important economic sector in Ethiopia contributing 45%, 85%, and 83% of the GDP, foreign earnings and employs of the total population respectively (CSA, 2008/2009).

Coffee ranked as the fifth most important trade commodity after wheat, cotton, maize, and rice (FAO, 2008). The coffee that is distinguished for such unique characteristics include Sidamo, Yirgachafe, Harar, Gimbi, Jimma and Limmu coffee types (Anwar, 2010).

Jimma Zone is one of coffee growing zones in the Oromia Regional State currently covering total area of 105,140 hectares by coffee including small-scale farmers' holdings as well as both state and private owned plantations (JZARDO, 2008). Out of the 40–55 thousand tons of coffee annually produced in the Zone about 28-35thousand tons is sent to the central market, while the remaining is locally consumed (Alemayehu et al., 2008).

Even though coffee has long history of production and favorable climatic conditions in Ethiopia, coffee quality is declining from time to time due to several improper pre and post-harvest management practices mainly associated with poor agronomic practices like lack of stumping, pruning and weeding (Tena, 2008).

Local dehulling coffee usually done by rural women involves pounding the dry grain in a mortar with a pestle need to reduce post-harvest losses, labour cost and high energy input and generally encourage coffee production in quality and quantity calls for application of mechanical methods to coffee production **(**Weinberg et al., 2001).

There were different manual operated dehullers are there in Ethiopia such as Bako made manual coffee dehuller and Harar made coffee dehuller but all dehullers were not effective while Jimma model manual operated coffee huller becomes outstanding performer in each step (Gutu B.,2011).
As the mechanism of coffee processing is direct related to the coffee quality, Jimma Agricultural Engineering Research Center developed the manual operated coffee dehuller to increase quality and decrease labour required as well as postharvest losses that demonstrated to small coffee producer farmers for local market and home consumption purposes.

Objectives

- ✓ To create awareness about use of the manual operated coffee dehuller.
- ✓ To Evaluate the performance of the manual operated coffee dehuller
- ✓ To collect feedbacks from the participant farmers and other stakeholders

Methodology

Three districts from Jimma Zone were selected. Four Kebeles purposively selected from those districts of the zone based on coffee potential. From these Kebeles, a group which has 10-15 members of farmers composed of male, female and youth were organized at the selected sites that technical evaluation, demonstration and popularization of manual operated coffee dehuller made by distributing sample prototypes to each farmer research groups. Finally, the feedback data was collected on user farmers' perception on the technology.

Data collected:

Quantitative data like dehulling capacity (kg/hr), efficiency (%), & Breakage percentage (%) of the machine performance

Qualitative data on perception through: interview and FGD, to get feedback and comments from participant farmers

Method of data analysis:

The quantitative data collected on the technical performance and analyzed by using descriptive statistics while the qualitative on perception collected through interview, observation and group discussion analyzed by using three level Likert scale ranking and narrative method

Result and Discussion

Training Farmers, SMS and DAs

Both practical and theoretical trainings were given for the participant farmers, Subject Matter Specialists (SMS) and Development Agents (DAs) at the selected Kebele level on the operation and maintenance of the hand operated dry coffee dehuller machine to create awareness before actual demonstration carry out at large. Accordingly, 39 farmers, 5 DAs and 4 Subject Matter Specialists were participated in training.

Table1. Training given to farmers, DAs & SMS

No	Location		Training Participants				
			Farmers		Others		Total
	District	Kebele	Adult	Youth	DAs	SMS	
1	Goma	Oomo Gurude	6	3	1	1	11
3	Mana	Kella Gudda	8	2	1	1	12
		Kenteri	6	5	1	1	13
4	Dedo	Sombo	5	4	2	1	12
		Total	25	14	5	4	48

On-farm Evaluation of Jimma model manual dry coffee dehuller

Table2. Average performance of hand operated dry coffee dehuller

Site	Sample(g)	Time(sec)	un pulped(g)	Broken(g)	Capacity(kg/hr)	Efficiency (%)	Breakage (%)
Omo gurude	3000	173	1000.00	211.11	62.43	75.00	7.04
Omo gurude	3000	134	1058.33	166.67	80.60	73.54	5.56
Omo gurude	3000	144	1208.33	111.11	75.00	69.79	3.70
Average	**3000.00**	**150.33**	**1088.89**	**162.96**	**72.67**	**72.78**	**5.43**
Kela guda	3000	150	1391.67	111.11	72.00	65.21	3.70
Kela guda	3000	147	1166.67	166.67	73.47	70.83	5.56
Kela guda	3000	140	1375.00	266.67	77.14	65.63	8.89
Average	**3000.00**	**145.67**	**1311.11**	**181.48**	**74.20**	**67.22**	**6.05**
Waro kolobo	3000	160	1208.33	166.67	67.50	69.79	5.56
Waro kolobo	3000	156	1000.00	244.44	69.23	75.00	8.15
Waro kolobo	3000	157	1166.67	122.22	68.79	70.83	4.07
Average	**3000**	**157.67**	**1125.00**	**177.78**	**68.51**	**71.88**	**5.93**
Average	**3000**	**151.22**	**1175.00**	**174.07**	**71.80**	**70.63**	**5.80**

Field day conducted

Table 3 participants on field day

No	Location		Participants of field days									
			Farmers				DAs & SMS		Others Stalk-holder		Total	
			Adult		Youth							
	District	Kebele	M	F	M	F	M	F	M	F	M	F
1	Goma	Omo Gurude	4	2	3	2	2	0	3	0	12	4
2	Mana	Kela Guda	7	3	4	1	2	1	1	1	14	6
		Kenteri	4	3	5	1	2	1	2	1	13	6
3	Dedo	Waro Kolobo	5	4	2	3	2	0	2	0	11	7
	Total		20	12	14	7	8	2	8	2	50	23

In view of that, 53 farmers (19 Female, 34 Male), 10 agricultural workers (SMS and DAs), 10 others (Kebele Administrators and Researchers) have attended the mini field days.

Farmers' perception on the technology attributes

Table4. Farmers' perception on manual dry coffee dehuller

Attributes used for acceptance degree	scale measurement	Participants on dry coffee dehuller (No=40)	
		Frequency	Percentage %
Pulping capacity (kg/hr)	High	27	67.5
	Medium	13	32.5
	Low	-	-
Efficiency %	High	36	90
	Medium	4	10
	Low	-	-
Breakage/loss (%)	High	-	-
	Medium	3	7.5
	Low	37	92.5

The participant farmers' perception showed 67.5%, 90% and 93.5% has high hulling capacity, efficiency and forage loss whereas 32.5%, 10%and 7.5% responded to medium level respectively but no respondents ranked it low for the three attributes. As a result, most of the farmers have positively perceived to this equipment towards its performance.

Conclusion and Recommendation

Conclusion

- Manual Dry Coffee Dehuller machine has average capacity, efficiency and breakage of 71.80, and 70.63 and 5.80 respectively. It hulls the coffee in a better way than the local methods with relatively less percentage (5.8%) of the product loss due to breakage.
- The farmers' perception showed 67.5%, 90% and 93.5% has good hulling capacity, efficiency and forage loss whereas 32.5%, 10%and 7.5% responded to medium level respectively but no respondents ranked it low for the three attributes.
- Accordingly, most of the farmers have positively perceived to this equipment on the way to its performance.

Recommendation

- The stakeholders found at different level and the technical manufacturers have to intimately work in assisting technology provision.
- Trainings and advices needed to coffee producer farmers and technology manufacturers which strengthen linkage between then so as to avail the technology as necessary.
- The improved manual dry coffee dehuller machine can serve small and medium coffee producer farmers and engine operated was required by large scale coffee producers for more capacity.

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Pre-extension Demonstration and Evaluation of engine operated Faba Bean Thresher (Bako Model) technology in Jimma Zone

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Abstract
The study was conducted in Jimma Zone of Oromia Regional State, Ethiopia. The objective of the study was to demonstrate and evaluate the engine operated faba bean thresher performance under the farmers' condition for faba bean threshing at the study area. Four sites were selected as hosting centers for the popularization of the technology at different sites namely Toli Beyem, Bidiru, Sito and Ilala selected from two districts (Dedo, and Nada,) for the study. Total of 89 farmers (25 Female, 64 Male) households including 7 agricultural workers (SMS and DAs), 12 others (Kebele Administrators and Researchers) have attended the field demonstration at different sites. The evaluation result showed that the machine average threshing capacity was 0.146 kg/sec where as its cleaning efficiency for the test at the selected site was 90.75% and the machine performed the threshing activity in a better way than the local methods with almost no product loss for faba beam crop. The participant farmers' perception showed 68.75%, 84.37% and 93.75% has good threshing capacity, efficiency and crop loss whereas 31.25%, 15.63% and 6.25% responded to medium level respectively while no respondents ranked it has poor performance in threshing. As a result, most of the farmers have positively perceived to this equipment towards its performance.

Keywords: Thresher, faba bean, engine operated Capacity, Cleaning Efficiency, Grain Damage, Crops.

Introduction

The Central Statistical Agency (2014) reported that faba bean is planted to 4.34% , of the grain crop area with an annual production of about 99.17 quintals, 3.94% of the total grain production and yield of 18.42 q/ha in Ethiopia. Faba bean has various merits in the economy of the farming communities in the highlands of Ethiopia and serves as a source of food and feed and a valuable and cheap source of protein.

Faba bean is produced different regions of Ethiopia though its productivity is affected by many factors including lack of post-harvest technologies for threshing (IFPRI, 2010). Its threshing method is traditional mainly beating with stick and animal trampling leaving up to 30% of the crop on ground and contaminates the remainder with animal waste reducing the crop quality through highly tedious, inefficient, and time consuming action.

In Jimma zone, the faba bean production covers a total area of 32-35 hectares of land (JZADOR, 2018). To overcome the problem of traditional threshing methods, the improved thresher demonstration was conducted at the selected districts of Jimma Zone.

Objectives of the study:

- To create awareness on faba bean threshing to household farmers and private individuals
- To evaluate the machine performance under farmers condition
- To assess bout the machine from farmers and other key stakeholders

Methodology

Two potential crop producer districts selected purposively from Jimma Zone. 2 kebele per district were selected. Demonstration was conducted in purposively selected sites by considering male and female participants in collaboration with district agricultural experts and DAs.

Data collected

Quantitative data on the machine performance in capacity, efficiency and breakage
Qualitative data farmers' opinion about machines performance (capacity, efficiency and breakage)

Method of data analysis:

The quantitative data collected on the technical performance and analyzed by using descriptive statistics while the qualitative on perception collected through interview, observation and group discussion analyzed by using three level Likert scale ranking and narrative method

Result and Discussion

Trainings were given for the participant farmers, Subject Matter Specialists (SMS) and Development Agents (DAs) at the selected Kebele level on the operation and maintenance of the engine operated faba bean thresher machine to create awareness before actual demonstration carry out at large. Accordingly, 45 farmers, 7 DAs and 4 Subject Matter Specialists were participated in training.

Table1. Training given to farmers, DAs & SMS

No	Location		Training Participants				
			Farmers		Others		Total
	District	Kebele	Adult	Youth	DAs	SMS	
1	Nada	Toli Beyem	4	6	2	1	13
2		Bidiru	5	4	2	1	12
	Dedo	Ilala	6	6	1	1	14
		Sito	8	6	2	1	17
	Total		23	22	7	4	56

On-farm evaluation of improved faba bean thresher

The performance of the machine was evaluated at two different sites in terms of threshing capacity (kg/hr.) percentage of cleaning efficiency, and damage using the following equation:

Threshing capacity (kg/sec) =qt/tm

Where qt=mass of threshed grain

Tm =time of threshing operation

Accordantly, threshing capacity is identified by using the maximum total output data obtained at two sites (6.5kg and 6.79kg) as the followings:

Threshing Capacity (TC)

$TC(1) = \frac{6.5\text{KG}}{43\text{SEC}}$ =6.5kg/ (43sec) …TC=0.151kg/sec (Site 1)

$TC(2) = \frac{6.79\text{KG}}{48\text{SEC}}$ =6.79kg/ (48sec) …TC=0.141kg/sec (Site 2)

Thus, the average capacity at both sites is (0.151kg/sec +0.141kg/sec)/2 which is 0.146 kg/sec

Table2. Average performance of faba bean thresher under the farmers' management

Feeding Rate (x)	**Speed**	**Replicate**	**Broken (x)**	**Un-threshed(x)**	**Cleaned**	**Total output (x)**	**Straw**	**Loss (x)**	**Time (x)**
F1=8kg	L=423RPM	R1	0kg	0kg	3.88kg	6kg	1.12kg	0kg	56sec
		R2	0kg	0kg				0kg	
		R3	0kg	0kg				0kg	
Site 1	**M=587RPM**	R1	0kg	0kg	**4kg**	**6.5kg**	**2.5kg**	**0kg**	**43sec**
		R2	0kg	0kg				0kg	
		R3	0kg	0kg				0kg	
	H=800RPM	R1	0kg	0kg	4.3kg	4.7kg	0.4kg	0kg	44sec
		R2	0kg	0kg				0kg	
		R3	0kg	0kg				0kg	
F2=8kg	L=423RPM	R1	0kg	0kg	3.998kg	5.21kg	1.22kg	0kg	55sec
		R2	0kg	0kg				0kg	
		R3	0kg	0kg				0kg	
Site 2	M=587RPM	R1	0kg	0kg	**4.23kg**	**6.79kg**	**2.56kg**	0kg	48sec
		R2	0kg	0kg				0kg	
		R3	0kg	0kg				0kg	
	H=800RPM	R1	0kg	0kg	4.55kg	5kg	0.45kg	0kg	46sec
		R2	0kg	0kg				0kg	
		R3	0kg	0kg				0kg	
Average	**TC**					**0.146kg/sec**			
Average	**CE**				**90.75**				

Demonstration of the improved faba bean thresher

Mini-field days conducted

Table3 Participants on field day

No	Location		Participants of mini field day									
			Farmers				DAs & SMS		Stalk-holder		Total	
			Adult		Youth							
	District	Kebele	M	F	M	F	M	F	M	F	M	F
1	Nada	Toli Beyem	8	4	5	2	1	1	2	1	16	8
		Bidiru	5	3	4	1	1	0	2	1	12	5
2	Dedo	Ilala	9	2	3	2	1	1	2	1	15	6
		Sito	10	3	6	3	2	0	3	0	21	6
	Total		32	12	18	8	5	2	9	3	64	25

In view of that, 70 farmers (20 Female, 50 Male), 7 agricultural workers (SMS and DAs), 12 others (Kebele Administrators and Researchers) have attended the mini field days.

Farmers' perception on the technology attributes

Table4. Farmers' Perception on improved faba bean thresher

Attributes used for acceptance degree	scale measurement	participants' reaction faba bean thresher (No=32)	
		Frequency	Percentage %
Threshing capacity (kg/hr)	High	22	68.75
	Medium	10	31.25
	Low	-	-
Efficiency %	High	27	84.37
	Medium	5	15.63
	Low	-	-
Loss/Damage (%)	High	30	-
	Medium	2	6.25
	Low	-	93.75

The participant farmers' perception showed 68.75%, 84.37% and 93.75% has high threshing capacity, efficiency and crop loss whereas 31.25%, 15.63% and 6.25% responded to medium level respectively while no respondents ranked it has low performance in threshing. As a result, most of the farmers have positively perceived to this equipment towards its performance.

Conclusion and Recommendation

Conclusion

- The faba bean machine has average threshing capacity of 0.146 kg/sec where as its cleaning efficiency for the test at the selected site was 90.75% and the machine performed the threshing activity in a better way than the local methods with almost no product loss for faba bean crop.
- The farmers' perception showed 68.75%, 84.37% and 93.75% has high threshing capacity, efficiency and crop loss whereas 31.25%, 15.63% and 6.25% said medium level respectively while no respondents ranked it has low performance in threshing.
- Thus, most farmers have perceived positive to the machine towards its performance.

Recommendation

- The agricultural extension workers need assist technology provision creating favorable condition for fast and easier supply mechanism.

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Pre-Extension Demonstration & Evaluation of Maize & Sorghum Stalk Chopper In Jimma

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Abstract

The study was conducted in Jimma Zone of Oromia Regional State, Ethiopia. The objective of the study was to evaluate the improved animal feed chopper performance for maize & sorghum stalks under the farmers' condition at the study area. Five sites were selected as hosting centers for the popularization of the technology at different Kebeles namely Chalte, Yedi, Kolobo, Tikur Balto and Merewa selected from three districts (Dedo, Kersa, and Nada,) for the study. Total of 97 farmers (26 Female, 71 Male), 12 agricultural workers (SMS and DAs), 13 others (Kebele Administrators and Researchers) have attended the field demonstration at different sites involving men and women participation. The result showed that the machine saved farmers' labor and time having average capacity of 3.3 kg/min and 1.3kg/min for maize and sorghum stalks showing significantly different across the crops stalk the machine perform the chopping activity in a better way than the local methods with relatively less percentage of the product for maize and sorghum stalks respectively. The participant farmers' perception showed 59%, 69% and 82% has good chopping capacity efficiency and forage loss whereas 41%, 31%and 16% responded to medium level respectively while no respondents ranked it to poor capacity for chopping the crop residues for both crops. As a result, most of the farmers have positively perceived to this equipment towards its capacity.

Keywords: Chopper, Capacity, Efficiency, Loss, Crop stalk, Residue

Introduction

Ethiopia has large livestock population, but still the demand of animal source foods for its human population is not met. This is mainly due to poor animal productivity that is compounded by inefficiencies in the input (feed, genetic material and veterinary services) and output. Among these, feed shortage in terms of quantity and quality is considered as a major factor that hinders sustainable development of the sector in Ethiopia (FAO, 2018, Getahun and Tegene, 2019).

In Ethiopia natural pasture is the primary feed resource throughout the wet season while crop residues play a substantial role during long dry season (CSA, 2017). However, as the productivity of grazing lands in most parts of Ethiopia is getting extremely low, due to various reasons, that include conversions of the natural pasture in to crop lands, some adopted improved forage varieties and the crop residues become considerable feed sources in wet and dry season in most mixed farming areas of the country (Demeke *et al*., 2017).

In contrast to the natural pasture grazing, most locally available feed sources; crop residues and locally available protein sources, such as improved forage types, legume residues, tree pods, green fodder from multi-purpose trees are fibrous and limited by their low value of voluntary intake as feed, thus, efficient utilization of these resources need correct harvesting and physical treatments to improve their palatability for livestock feeding (Jamshidpouya, *etal*., 2018).

Feed treatment and processing in basic terms can be physical treatment which primarily comprising of their size reduction that can be achieved by using hand operated or power driven cutters and choppers, but in Ethiopia, there is limited experience in treatment and processing methods for improving the nutritional value of crop residues (Abera *et al*., 2014). In Ethiopia, most farmers usually used to harvest grass and crop residues as forage and cut them into short lengths for livestock. But, as feeds' size bulkiness and fibrous nature can restrict intake by livestock, and it is common to see significant feed wastage attributed partly to selection of palatable and/or refusal of unpalatable fodder parts by animals. In this regard, studies showed that, appropriate chopping of forage to proper size of particles can improve the physical characteristic, that can stimulates rumination, boost feed intake, lower feed rejection and consequently reduce feed wastage (Devries. *etal*., 2008).

Livestock production is the most important field of agriculture in Jimma and Buno Bedelle zones of south western Ethiopia which is characterized by mixed crop livestock farming system. The small holder livestock farmers in the zone rear animals for different purposes like draught power, milk, meat, manure and for cash sources. However, different study report indicated problem of feed and feeding management resulted to low disease resistance ability, sterility and mortality of animals in western Oromia. The local farmers feed their animals by chopping maize and sorghum stalk manually that tiresome and labor intensive. Therefore, the improved engine operated animal feed chopper was introduced in the study area through demonstration activities.

Objectives

- To introduce maize and sorghum stalk chopper to small household farmers
- To evaluate the chopper performance under the farmer management
- To collect feedbacks on the technology for further improvement in the future

Methodology

The demonstration sites was selected at five Kebeles from the three districts of Kersa, Dedo and Nada in Jimma zone. One participatory FRG which consists of fifteen members were identified in each Keble Training on technology was given at the hosting farmers' site.

Data collected

Quantitative data on the machine performance in capacity, efficiency and breakage
Qualitative data farmers' opinion about machines performance (capacity, efficiency and breakage)

Method of data analysis:

The quantitative data collected on the technical performance was analyzed by using descriptive statistics while the qualitative on perception collected through interview, observation and group discussion analyzed by using three level Likert scale ranking and narrative method.

Result and Discussion

Training Farmers, SMS and DAs on maize & sorghum stalk chopper

Trainings were given for the participant farmers, Subject Matter Specialists (SMS) and Development Agents (DAs) at the selected Kebele level on the operation and maintenance of the engine operated chopper machine to create awareness before actual demonstration carried out at large.

Table1. Training farmers, DAs & SMS on the engine operated maize & sorghum stalk chopper

No	**Location**		**Training Participants**				
			Farmers		**Others**		**Total**
	District	**Kebele**	**Adult**	**Youth**	**DAs**	**SMS**	
1	Nada	Yedi	4	7	2	1	14
2	Dedo	Calte	5	4	2	1	12
		Kolobo	6	5	1	1	13
3	Kersa	Tikur Balto	5	4	2	1	12
		Merewa	4	6	1	0	11
Total			24	26	8	4	62

Accordingly, 50 farmers, 8 DAs and 4 Subject Matter Specialists were participated in training.

On-farm Evaluation of maize & sorghum stalk chopper

Table2. Average performance of maize & sorghum stalk chopper under the farmer's management

Evaluation at different site	Engine speed	Time take (min)	Stalk chopped (kg)	Capacity (kg/min)
Ma	950 rpm	3 min	15kg	5 kg/min
	950 rpm	3 min	15 kg	5 kg/min
	950 rpm	3 min	15 kg	5 kg/min
Mb	850 rpm	3 min	10 kg	3.3 kg/min
	850 rpm	3 min	10 kg	3.3 kg/min
	850 rpm	3 min	10 kg	3.3 kg/min
Mc	750 rpm	3 min	5 kg	1.7 kg/min
	750 rpm	3 min	5kg	1.7 kg/min
	750 rpm	3 min	5kg	1.7 kg/min
Av		**3 min**	**10 kg**	**3.3kg/min**
Sa	950 rpm	3 min	6 kg	2 kg/min
	950 rpm	3 min	6 kg	2 kg/min
	950 rpm	3 min	6 kg	2 kg/min
Sb	850 rpm	3 min	4 kg	1.3 kg/min
	850 rpm	3 min	4 kg	1.3 kg/min
	850 rpm	3 min	4 kg	1.3 kg/min
Sc	750 rpm	3 min	2 kg	0.7kg/min
	750 rpm	3 min	2 kg	0.7kg/min
	750 rpm	3 min	2 kg	0.7kg/min
Av		**3 min**	**4 kg**	**1.3 kg/min**

The letters a, b, c indicate the sites chopper evaluated at where as the letters M, S represents maize stalk and sorghum stalk

The result showed that the machine saved farmers' labor and time having average capacity of 3.3 kg/min and 1.3kg/min for maize and sorghum stalks showing significantly different across the crops stalk the machine perform the chopping activity in a better way than the local methods with relatively less percentage of the product for maize and sorghum stalks respectively.

Mini-field days conducted

Table3 Participants on field days

No	**Location**		**Participants of field days**									
			Farmers				**DAs & SMS**		**Others Stalk-holder**		**Total**	
			Adult		Youth							
	District	Kebele	M	F	M	F	M	F	M	F	M	F
1	Nada	Yedi	10	3	7	4	2	1	2	1	21	9
2	Dedo	Calte	9	2	7	3	2	1	2	1	20	7
	"	Kolobo	8	3	6	3	2	0	3	0	19	6
3	Kersa	Tikur Balto	2	0	7	6	2	1	2	1	13	8
	"	Merewa	4	0	4	2	1	0	1	0	10	2
	Total		33	8	38	18	9	3	10	3	83	32

In view of that, 97 farmers (26 Female, 71 Male), 12 agricultural workers (SMS and DAs), 13 others (Kebele Administrators and Researchers) have attended the mini field days.

Pictorial Representation

Farmers' perception on maize & sorghum stalk chopper attributes

Table4. Farmers' Perception on improved maize & sorghum stalk chopper

Attributes for acceptance degree	scale measurement	participants' reaction (No=32)	
		Frequency	Percentage %
Chopping capacity (kg/hr)	High	19	59
	Medium	13	41
	Low	-	-
Efficiency %	High	22	69
	Medium	10	31
	Low	-	-
Forage loss (%)	High	27	82
	Medium	5	15.6
	Low	-	84.4

The participant farmers' perception showed 59%, 69% and 82% has high chopping capacity efficiency and forage loss whereas 41%, 31%and 16% responded to medium level respectively while no respondents ranked it to low capacity for chopping the crop residues for both crops. As a result, most of the farmers have positively perceived to this equipment towards its capacity.

Conclusion and Recommendation

Conclusion

- The machine has average capacity of 3.3 kg/min and 1.3kg/min chopping maize and sorghum stalks under the farmers' management differing across crops stalk respectively.
- The farmers' perception indicated 59%, 69% and 82% has good chopping capacity efficiency and forage loss whereas 41%, 31%and 16% responded to medium level respectively while no respondents ranked it to low capacity,
- As a result, most of the farmers have perceived positive to this equipment since it saved farmers' labor for fees chopping.

Recommendation

- The concerned body should give advice and training for farmers in addition to facilitating the supply mechanism and maintenance of the machine.
- The district agriculture and natural resource should work on the sustainability of the technology in reaching the wider community.

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Pre-Extension Demonstration and Evaluation of Animal Drawn Potato Digger technology in Jimma Zone

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Abstract

The study was conducted in Jimma Zone of Oromia Regional State, Ethiopia. The objective of the study was to evaluate the improved potato digger performance under farmers' condition in the study area. Four sites were selected as hosting centers for popularization of the technology at different sites namely Toli Beyem, Ilala, Sito and Ginjo Karsa selected from three districts (Gera, Dedo, and Nada,) for the study. Total of 53 farmers (13 Female, 40 Male), 10 agricultural workers (SMS and DAs), 7 others (Kebele Administrators and Researchers) have attended the demonstration at different sites involving men and women participation. The evaluation result showed that the technology saved farmers' labor and time having average 0.1141(ha/hr), 89.40 % effective field capacity (ha/hr) and harvesting efficiency respectively. The response of 62.5%, 65.62 farmers showed high whereas 37.5%, 34.38% to medium level of capacity and efficiency respectively while 81.25 indicated low product loss. thus, most farmers perceived positive on its performance.

Keywords*: Potato, Potato digger, Capacity, Cleaning, Efficiency.*

Introduction

Potato (*Solanum tuberosum L.*) is the fourth most important food crop in the world. Potato supplements or replaces grain based diets where rice, wheat, or maize availability lessened or price rise (Camire ME *et al*, 2009). It can give stable yield under conditions where other crops might fail, suitable to grow where land is limited and labor is plentiful (Lutaladio N, Castaldi L.,2009). Its plasticity to environmental conditions and yielding capacity also make it the best crop for food and nutrition security (Kyamanywa S, Kashaija I, Getu E, Amata R, Senkesha N, & Kullaya A, 2011). Potato ranked fourth in the world in terms of the volume of production after rice (*Oryza sativa* L.), wheat (*Triticum aestivum* L.), and maize (*Zea mays* L.) (Adane H et al, 2010). It is also the most important tuber crop, ranking first in volume produced among root and tuber crops (FAO, 2010). The ability to grow potatoes in a wide range of climates and their adoption by a broad range of cultures has increased potato consumption worldwide (Ephrem, 2015).

Potato is produced mostly for local consumption and local markets in Ethiopia for example, is 0–45 kg per capita (Theisen and Thiele, 2008). Area under potato cultivation was about 51,698 ha in 2005/6 that produced 509,716 tons of tuber yields; currently, in 2014/2015, area under potato crop has increased to 67,362 ha and its productivity is about 921,832 tones in Ethiopia (FAOSTAT, 2016).

Oromia is the major potato producing region in Ethiopia that constitutes 51% of potato production (CSA, 2015). In Jimma, Dedo and Nada districts are important production pocket for vegetables increasing its yield serving the urban markets and the surroundings where large volume of potato is traded though no improved technology to dig out it that potato harvesting system cause post-harvest loss (20-25%) and physical damage due to the digging (lifting) of the tubers by hoe or local plow (CSA, 2014).

Hence, this study was conducted through evaluation and demonstration of improved potato digger to the smallholder producer farmers of the Jimma Zone to reduce the prevailing product loss.

Objectives of the study:

- To Introduce potato digger as harvesting technology to the farmers
- To evaluate potato digger under farmers management
- To collect farmers' feedbacks on the technology

Methodology

Study Site Description

Pre-extension demonstration of potato digger technologies was carried out in Dedo, Gera and Nada districts of Jimma zone based on the potential for production and accessibility by selecting four representative sites from the identified districts.

FREG approach was followed by enhancing the participation of none FREG farmers and the concerned stakeholders. Accordingly, one FREG was established in every site that consists of 10 members taking in to account all categories of farmers and gender issues.

Data collected

Quantitative data on the machine performance in capacity, efficiency and breakage
Qualitative data farmers' opinion about machines performance (capacity, efficiency and breakage)

Method of data analysis:

The quantitative data collected on the technical performance and analyzed by using descriptive statistics while the qualitative on perception collected through interview, observation and group discussion analyzed by using three level Likert scale ranking and narrative method

Result and Discussion

Training was given for the participant farmers, Subject Matter Specialists (SMS) and Development Agents (DAs) at the selected Kebele level on the operation and maintenance of the potato digger to create awareness before actual demonstration carry out at large. Accordingly, 37 farmers, 7 DAs and 4 Subject Matter Specialists were participated in training.

Table1. Training farmers, DAs & SMS on the potato digger

No	Location		Training Participants				
			Farmers		Others		Total
	District	Kebele	Adult	Youth	DAs	SMS	
1	Nada	Toli Beyem	4	4	2	1	11
2	Dedo	Ilala	5	4	2	1	12
		Sito	6	5	1	1	13
3	Gera	Ginjo Kersa	5	4	2	1	12
	Total		20	17	7	4	48

Table2. Average performance of potato digger under the farmer's management

No.	**Mean values of the plot trial**			**Overall mean value**
	Parameter	plot 1	plot 2	plot 3	Average
1	Working speed (m/s)	0.637	0.5699	0.5441	0.5838
2	Working depth (cm)	13	15	16	14.67
3	Working width (cm)	50	47	52	49.67
4	Field efficiency (%)	82.44	89.36	84.04	85.28
5	Effective time (min)	1	0.9833	0.8667	0.95
6	Effective field capacity (ha/hr)	0.107	0.1069	0.1084	0.1141
7	Theoretical field capacity (ha/hr)	0.136	0.142	0.132	0.1367
8	Harvesting efficiency (%)	90.49	88.68	89.04	89.403
9	Weight of potato dugout (kg/m2)	6.147	5.6105	4.823	5.5268
10	Weight of damaged potato (kg/m2)	0.135	0.1209	0.0714	0.1091
11	Weight of potato left in soil (kg/m2)	0.645	0.209	0.317	0.3903

The evaluation result showed that the technology saved farmers' labor and time having average 0.1141(ha/hr) 89.40 % effective field capacity (ha/hr) and harvesting efficiency respectively digging the potato in a better way than the local methods with relatively less percentage of the product loss.

Table3 Participants on field days

No	Location		Participants of field days									
			Farmers				DAs & SMS		Others		Total	
			Adult		Youth				Stalk-holder			
	District	Kebele	M	F	M	F	M	F	M	F	M	F
1	Nada	Toli Beyem	6	2	4	1	1	1	1	0	12	4
2	Dedo	Ilala	6	2	4	2	2	1	1	1	13	6
		Sito	4	3	5	1	2	1	2	1	13	6
3	Gera	Ginjo Kersa	7	0	4	2	2	0	1	0	14	2
	Total		23	7	17	6	7	3	5	2	52	18

Consequently, 53 farmers (13 Female, 40 Male), 10 agricultural workers (SMS and DAs), 7 others (Kebele Administrators and Researchers) have attended the mini field days.

Farmers' perception on the potato digger technology attributes

Table4. Farmers' Perception on Potato digger

Attributes used for acceptance degree	scale measurement	participants' reaction (No=32)	
		Frequency	Percentage %
Digging capacity (kg/hr)	High	20	62.5
	Medium	12	37..5
	Low	-	-
Efficiency (%)	High	21	65.62
	Medium	11	34.38
	Low	-	-
Loss/Damage (%)	High	-	-
	Medium	6	18.75
	Low	26	81.25

The participants' responses being 62.5%, 65.62 showed high whereas 37.5%, 34.38% to medium level of capacity and efficiency respectively whilst 81.25 respondents indicated low product loss. As a result, most of the farmers have perceived positively to this equipment towards its capacity.

Conclusion and Recommendation

Conclusion

- The Potato digger evaluation result showed that the technology has average capacity of 0.1141(ha/hr) and harvesting efficiency of 89.40 that saved farmers' labor and time with relatively less percentage of the product loss.
- The response of 62.5%, 65.62 farmers showed high whereas 37.5%, 34.38% to medium level of capacity and efficiency respectively while 81.25 indicated low product loss respecting the equipment's performance.

Recommendation

- The agricultural extensions need advise the farmers in using technology facilitating conditions so that the users can easily familiarized with the implement.

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Pre Extension Demonstration of Solar Beeswax Extractor in Jimma Zone of South W estern Oromia

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Abstract

The study was conducted in Jimma Zone of Oromia Regional State, Ethiopia. The objective of the study was to valuate the improved solar beeswax extractor performance under farmers' condition in the study area. Four sites were selected as hosting centers for the popularization of the technology at different sites namely Gandi calla, Omo Gurude, Suse and Kersa selected from three districts (Gera, Goma, and Kersa,) for the study. Accordingly 51 farmers (41 Female, 10Male), 7 agricultural workers (SMS and DAs), 14 others (Kebele Administrators and Researchers) have attended the demonstration at different sites involving men and women participation. The evaluation result showed that the technology saved farmers' labor and time having average of *0.546 kg from 3kg of honey combs and 18.17% extracted beeswax performing in a better way than the local methods with relatively less percentage of the product loss. The participant farmers' perception responses was 66.67% that showed the extractor has high capacity whereas 33.3% responded to medium level while no respondents ranked it to low capacity for harvesting potato. As a result, most of the farmers have perceived positive to this equipment about its capacity.*

Keywords*: Beeswax, Solar, Extractor, Performance, Capacity.*

Introduction

Ethiopia is one of the few countries in the world with a long tradition of beekeeping. The country is estimated to have the largest bee colonies in Africa with over ten million bee colonies (Honey and Wax Potential Study, SNNPR State, Regional Export Products Promotion Agency (EPPA), 2003). Ethiopia produces about 24,000 tons of honey and close to 32,000 tons of wax (Sahel, 2006).

The proportion of honey to wax produced is 1:6, therefore there appears to be a huge wastage rate of wax. It is estimated that about 25% of the total beeswax production is 'lost' due to selling of honey with the wax (not extracted). This includes the loss of beeswax that is sold to consumers with the crude honey. Honey consumers chew the honey and spit out the remaining beeswax.

According to the Central Statistics Agency (2011/12), Oromia has the largest number of beehives followed by Amhara and SNNP. Jimma and Illubabor were the areas of Oromia region with the highest number of hives (CSA, 2011/12).

The beekeeping subsector is creating job opportunities in both rural and urban areas (Mengistu, 2011). Recently, Ethiopian government is working on jobless youth and women involve in bee equipment production and beekeeping activities. Among total 4,601,806 beehives exist in Ethiopia, about 95.5% are traditional, 4.3% transitional, and 0.2% frame beehives (Beyene David p. 2007).

Apiculture in southwestern Ethiopia provides opportunity for low-income people to supplement their earnings from bee products sale like honey and beeswax at a suitable market. Since South western part of Oromia is known with natural resources specifically by forests, the honey produced from the areas is high but no sufficient improved technologies in the area.

Method of honey production and beeswax extraction of Ethiopian farmers is still very traditional (MoARD, 2006). Therefore, farmers earn less income from honey and beeswax as bees eat more honey to prepare foundation and honeycomb considered as a waste material.
To minimize these problems, solar beeswax extractor made by Jimma Agricultural Engineering Research Center demonstrated to the honey producers that helped to extract the foundation from honeycomb using the technology for the beehive use.

Objectives

- ✓ To demonstrate solar beeswax extractor technology
- ✓ To evaluate solar beeswax extractor under the farmers management
- ✓ To feedback for farther improvement on solar beeswax extractor technology

Methodology

Three districts were selected from Jimma zone. The demonstration was conducted on purposively selected sites by considering one site in a Kebele to conduct the test. The specific sites were identified in collaboration with district agricultural experts and DAs from the selected Kebeles based on honey production potential.

A total of four Kebeles purposively selected from those districts of the zone based on beehive users honey production areas involving a group of 10 members of farmers composed of male, female and youth were organized in the selected Kebele that conducted demonstration and popularization of solar beeswax extractor technology. Training was given to the FREG members and agricultural workers

Quantitative data like dehulling capacity (kg/hr), & efficiency (%) of the machine performance

Qualitative data on perception through: interview and FGD, to get feedback and comments from participant farmers

Method of data analysis:

The quantitative data collected on the technical performance and analyzed by using descriptive statistics while the qualitative on perception collected through interview, observation and group discussion analyzed by using three level Likert scale ranking and narrative method

Result and Discussion

Training Farmers, SMS and DAs on Solar beeswax extractor device

Both practical and theoretical trainings were given for the participant farmers, Subject Matter Specialists (SMS) and Development Agents (DAs) at the selected Kebele level on the operation and maintenance of the solar beeswax extractor to create awareness before actual demonstration carry out at large. Accordingly, a total of 43 farmers, 5 DAs and 3 Subject Matter Specialists were participated in training.

Table1. Training given to farmers, DAs & SMS

No	Location		Training Participants				
			Farmers		Others		Total
	District	Kebele	Adult	Youth	DAs	SMS	
1	Gera	Gandi callaa	9	2	1	1	13
2	Goma	Suse	7	3	1	1	12
		Omo Gurude	10	1	2	-	13
3	Kersa	Kersa	6	5	1	1	13
		Total	32	11	5	3	51

On-farm evaluation of the solar beeswax extractor

Table2. Average performance of solar beeswax extractor

Test sites (rep}	Input (old honey comb in kg)	output(beeswax in kg)	extraction percent
G1	3	0.54	
G2	3	0.59	
G3	3	0.525	
	Average 3	**0.55**	18.39%
O1	3	0.675	
O2	3	0.63	
O3	3	0.62	
	Average 3	**0.64**	21.39%
S1	3	0.51	
S2	3	0.508	
S3	3	0.47	
	Average 3	**0.496**	16.53%
K1	3	0.51	
K2	3	0.52	
K3	3	0.48	
	Average 3	**0.50**	16.78%
Total Average		0.546 kg	18.17%

The letters G, O, S, K indicate the extractor was evaluated at four different sites

The evaluation result showed that the technology has saved farmers' labor and time having average output of 0.546 kg from average three kg of old honey comb and 18.17% extracted beeswax performing in a better way than the local methods with less product loss.

Table 3 participants on mini field day

No	Location		Participants on mini field day									
			Farmers				DAs & SMS		Others Stalk-holder		Total	
			Adult		Youth							
	District	Kebele	M	F	M	F	M	F	M	F	M	F
1	Gera	Gandi calla	8	1	2	0	1	1	3	0	14	2
2	Goma	Omo Gurude	10	0	2	1	1	1	2	1	15	3
		Suse	5	2	3	1	1	0	4	0	13	3
3	Kersa	Kersa	9	3	2	2	2	0	3	1	16	6
	Total		32	6	9	4	5	2	12	2	58	14

Accordingly 51 farmers (41 Female, 10Male), 7 agricultural workers (SMS and DAs), 14 others (Kebele Administrators and Researchers) have attended the mini field days.

Farmers' perception on the technology attributes

Table4. Farmers' Perception on Solar beeswax extractor

No	Description	Response level	No. of respondents=33	Percentage (%)
1	Extracting capacity	High	22	66.67
		Medium	11	33.33
		Low	-	-
	Ease of operation and maintenance	Simple	29	87.87
		Not Simple	4	12.12
3	Affordability	High	20	60.6
		Medium	8	24.24
		Low	5	15.15

The participant farmers' perception responses was 66.67% that showed the extractor has high capacity whereas 33.3% responded to medium level while no respondents ranked it to low capacity for extracting honey comb. As a result, most of the farmers have perceived positive to this equipment concerning its capacity.

Conclusion and Recommendation

Conclusion

- The honeycomb extractor device has average of 0.546 kg from 3kg of honey combs and 18.17% extracted beeswax performing in a better way than the local methods with less product loss.
- The participant farmers' perception responses was 66.67% that showed the extractor has high capacity whereas 33.3% responded to medium level while no respondents ranked it to low capacity for extracting honey comb.
- As a result, most of the farmers have positively perceived to this equipment towards its efficiency.

Recommendation for the concerned bodies

- Advice and support is required to bee keepers and manufacture enterprises devising the mechanism of easily getting technology supply in needed quality and quantity

- The honeycomb extractor machine was actually thus liked by the participant farmers and the prevalence of the local repair and maintenance agents is required for stability of the technology use.

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Pre-Scaling up of Mechanical Coffee demucilager in Jimma & Buno Bedele zones

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Abstract

The study was conducted in Jimma and Buno Bedele Zones of Oromia Regional State. The objective of the study was to scale up the Mechanical Coffee Demucilager machine at the farmer's condition. Nine hosting households were taken for the study as hosting sites in two zones from six districts (Mana, Goma, Gera, Limu, Chora and Bedele). The result showed that the wet coffee demucilager machine operates with average capacity of 39, 823 kg/hr, & grain injury 0.09 while it showed 4, 286 kg/hr capacity and 1.11 injuries by conventional coffee method. The perception result showed that 83.33% respondents showed it was simple to use the machine for washing wet coffee compared to tedious local method by human labor. Similarly 73.33 % of the respondents indicated it can be repaired and maintained by local technicians if damaged while 66.67 % of the farmers responded the machine affordability by average farmers. Trainings was given to 95 participants out of whom 82 were farmers, 10 were Development Agents (DAs), and 3 were district Subject Matter Specialists (SMS). The training topics were on general aspects of operation and maintenance of the wet coffee technology with aim to improve the users' awareness. Participants from agricultural offices of the two zones and technical micro enterprises were also invited and participated during consultation meeting and training.

Key words**:** *Demusilager, wet coffee, conventional method, Capacity, Efficiency scaling up*

Introduction

Coffee is the major source of foreign currency for Ethiopia and contributes more than 35% of the total export earnings (FAO/WFP, 2008).So, it is a cornerstone in export economy of the country and it supports directly or indirectly the livelihood of some 15 million people (EEA, 2001). Jimma Zone is one of coffee growing zones in the Oromia Regional State, which has a total area of 1,093,268 hectares of land (JZARDO, 2008). Currently, the total area of land covered by coffee in the zone is about 105,140 hectares. Out of the 40–55 thousand tons of coffee annually produced in the Zone, about 28-35 thousand tons is sent to the central market, while the remaining is locally consumed (Alemayehu *et al*., 2008).

The quality problems are mainly associated with improper post-harvest processing and handling practices (Desse, 2008). Coffee washing process usually performed through scrubbing the soaked beans against the concrete floor/passages manually to remove all traces and decomposed products of the mucilage which is laborious activity (Anwar, 2010).

The mechanical demucilaging process allows the quick removal of the mucilage compared to the fermentation process. As to Ethiopian Science and Technology Agency (ESTA, 2004) using demucilager reduce human labor required for the operation, maintenance of a better coffee quality by 40%, saving foreign currency, minimizes quantity loss of coffee during demucilaging process and reduce water consumption. The average capacity & grain injury (%) by demucilager & conventional coffee washing method is 39, 823 kg/hr, 4, 286 kg/hr and 0.09, 1.11 respectively. Water consumption per kg of coffee was 0.67 Lt/kg & 2.1 Lt/kg respectively for demucilager & conventional coffee washing methods.

The research centre has conducted scaling up of the machine to reach more number of farmers with the following objectives.

Specific Objectives:

- To popularize the technology at much more wider areas through scaling up
- To create wider awareness about utilization of technology for farmers
- To collect feedback and create linkage among the stakeholders for sustainability of machine supply in future

Methodology

Description of the study area

The study was conducted in Jimma and Buno-Bedele zones of which Mana, Gera , Goma, Limu and Seka, districts were from Jimma where as Chora and Bedele districts were from Buno-Bedele zone selecting totally six districts and nine Kebeles purposively based on coffee potential and appropriate washing site availability.

Approach followed

Participatory and multidisciplinary approach was used during the pre-scale up activity. A multidisciplinary team consisting of researchers from post harvest, production technicians and agricultural research extension was established at Jimma Agricultural Engineering Research Centre (JAERC) for the implementation of activity. Besides, for better efficiency and effectiveness, integration and cooperation were used as tools for the realization of the strategy. Moreover, the approach followed included the following

Joint planning: establishment of task force at district and Kebele and establishment of FRGs at each site were done.

Capacity building training on operation and maintenance: training the participant farmers, DAs, SMS and local microenterprises members

Inputs supply for technology production and distribution: The JAERC produced the demusleger and scaled up at the specified wet coffee washing sites. Farmers were encouraged to participate in physical activities at all stages of the demusleger pre-scaling up activities.

Joint monitoring and evaluation: field visit and supervision were made regularly by extension agents at different study sites where the demusleger popularization made. Field day organized at six sites namely Mana, Gera, Goma, Limu, Chora and Bedele districts.

Technology supply & maintenance mechanism: sustainable technology delivery and maintenance system was designed. Technical enterprises and private manufacturers were invited and information of potential manufacturers was provided to farmers for future technology supply and maintenance.

The research center was closely working and has made frequent consultation with the respective stakeholder in technology promotion. The joint stakeholder analysis was made to identify potential stakeholders, the type, role, duties and responsibilities of each actor as pre-scaling up activities need different actors in partnership. District Office of Agriculture, Micro Enterprises, farmers and private investors were identified as the stakeholders.

Communication method used

Primarily individual, group, and other mass contacts of extension teaching methods were used in line with the situations during the machine pre-scaling up activity implementation.

Data collection

In this research activity, quantities data were collected mainly on training and field day participants

Were as qualitative data were concerning farmers' perceptions on ease of operation, advantage and limitation of technology by appropriated data collection methods such us field observation, interview and focused group discussion.

Method of data analysis:

The quantitative data collected on training and field day participant were analyzed by using descriptive statistics while the qualitative data on perception were analyzed by using three level Likert scale ranking method

Results and Discussion

Training

Trainings was given to 95 participants out of whom 82 were farmers, 10 were Development Agents (DAs), and 3 were district Subject Matter Specialists (SMS). The training topics were on general aspects of operation and maintenance of the wet coffee technology with aim to improve the users' awareness, attitude and adoption behavior.

Participants from agricultural offices of the two zones and technical micro enterprises were also invited and participated during consultation meeting and training.

Table1. Training given to farmers, DAs & SMS

No.	Location			Farmer		Others		Total
	Zone	District	Kebele	Adult	Youth	DAs	SMS	
1	Jimma	Mana	Kentry	8	2	1	1	12
		"	Bilida	6	4	1	0	11
		Goma	Bulbul	5	3	2	0	10
		"	Haro	6	4	1	1	12
		Gera	Kecho	5	4	1	0	10
		"	Ginjo Kersa	4	3	2	0	9
		Limu	Ambuye	6	3	1	0	10
2	Buno-	Chora	Chora	7	4	0	1	12
	Bedele	Bedele	Dabana	6	2	1	0	9
Total				53	29	10	3	95

Field day for pre-scaling up

A total of 118 participants attended the field demonstration that conducted at different sites where the machine scaling up has made at hosting farmers' farm sites. The nine district level agricultural workers or subject matter specialists, ten development agents and eleven stakeholders were participated in field day of scaling up as stated in the table below

Table2. Participants on field days

No.	Location		Participants					
			Farmers		workers		Stake	Total
	District	Kebele	Adult	Youth	DAs	SMS	holder	
1	Mana	Bilida	9	5	1	1	2	18
2	Goma	Bulbul	7	5	1	2	1	16
3	Gera	Kecho	5	4	2	1	3	15
4	"	Ginjo K.	6	7	2	2	1	18
5	Limu	Ambuye	6	8	1	1	2	18
6	Chora	Chora	6	7	2	1	1	17
7	Bedele	Dabana	7	6	1	1	1	16
	Total		46	42	10	9	11	118

Farmers' perception on the technology attributes

Assessment was made to know how farmer perceived the technology. The demicileger was liked by farmers for coffee washing using the machine than human labor. About 83.33% respondents responded it is simple to use the machine for washing wet coffee compared to tedious local method using human labor.

While only 16.67 % of the respondents stated that it needed some technical knowledge to use and make maintenances when it damages. Usually the demucileger machine was virtually easy to operate with minimum labor requirement.

Table3. Farmers response on the coffee demucileger machine (no= 30)

No	Description	Response level	No. of respondents	Percentage (%)
1	Ease of operation	Simple	25	83.33
		Not Simple	5	16.67
2	Maintenance	Easy	22	73.33
		Difficult	8	26.67
3	Affordability (for farmers)	High	8	26.67
		Medium	20	66.67
		Low	2	6.67

About 73.33 % of the respondent farmers also indicate that it is likely to repair and maintain by local technicians or by themselves when the machine damages. As far as its affordability is concerned, 66.67 % of the farmers responded that the machine price is medium that can be affordable by the average farmers and mainly easy for the model farmers.

Challenges encountered:

Some hosting farmers and private investors distrust to show on their coffee washing site thinking as if the machine damages their coffee bean which reduces the coffee grade before they see the machine performance which they appreciate it ultimately. The laborers working on wet coffee washing sites observed felt discomfort speculating that using the machine can make them idle. Since only one sample was used to popularize at every site, it was not easy to

satisfy the demand of farmers when required for demucileger service for long time during the scaling up process at a single site as it need cover all other sites within limited duration.

Exiting strategy

As the role of the research centre in technology supplying is very much limited, the wider scale dissemination of the technology is to be undertaken by the bureau of agriculture in collaboration with manufacturer enterprises. Thus information was provided to the respective districts and zonal bureau of agriculture.

Conclusion and Recommendation

Conclusion

- The average capacity & grain injury (%) by demucilager & conventional coffee washing method is 39, 823 kg/hr, 4, 286 kg/hr and 0.09, 1.11 respectively. Water consumption per kg of coffee was 0.67 Lt/kg & 2.1 Lt/kg respectively for demucilager & conventional coffee washing methods.
- More number (83.33%) of respondents showed it is simple to use the machine for washing wet coffee compared to tedious local method by human labor.
- Similarly 73.33 % of the respondents indicated it can be repaired and maintained by local technicians if damaged while 66.67 % of the farmers responded the machine affordability by average farmers.
- Training had enhanced farmers' awareness aided by field demonstration conducted at identified sites where the demucilager scaling up has made.

Recommendation

- Though the demucilager was efficient and well accepted by the famers, it remained challenge to have sustainable supplying mechanism that need for creation of smooth linkage between the district and zonal agricultural bureau with the respective technical manufacturer enterprises.
- As the machine use the electric power for energy source, the follow up and training need be provided for the operators by the district agricultural offices so that they can be able to repair and maintain when machine and or the engine damages

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Pre-Extension Demonstration of Improved Bread Wheat Technologies in Bale Zone, Oromia National Regional State, Ethiopia

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Abstract

*Pre-extension demonstration and evaluation of improved bread wheat technologies was carried out in Bale Zone by selecting potential districts and accessible kebeles. Accordingly, the current activity was demonstrated in Sinana and Agarfa districts on five farmers' field and two FTCs. One recently released improved variety of bread wheat (Galan) was demonstrated and compared against Dambal (standard check) on plot size of 10 m * 10 m. Participatory approach was employed to demonstrate and evaluate the technologies under farmers' condition in which farmers were enhanced to set their own variety selection criteria. The yield evaluation of the demonstrated bread wheat varieties which was carried out across location indicated that 44.25 quintals were harvested from Galan variety per hectare while 39.75 quintals were obtained from Dambal variety per hectare. The result of cost benefit analysis shows that the farmer who decided to produce Galan variety can earn an additional net profit of 7,350 (ETB) per hectare in a single production season than who preferred to produce Dambal variety. Moreover, during variety evaluation and selection event, farmers gave the first rank for Galan variety due to it has higher tillering capacity, more tolerant to disease, higher number of seed/spike, larger spike length and better stem strength. Therefore, by considering the yield performance, economic return and farmers' preference, Galan variety was recommended for pre-scaling up.*

Key Words: Bread wheat, Farmers' preference, Galan variety, Participatory approach, Pre-extension demonstration

Introduction

Bread wheat (*Triticum aestivum L.*) is one of the most staple food crops in the world and is one of the most important cereal crop produced in Ethiopia. It is largely grown in the mid and highland areas of Ethiopia spanning at altitudes of 1500 to 3000 m above sea level (m.a.s.l). However, it is mainly grown between1800 to 2500 m.a.s.l in Bale, Arsi, West Arsi and Shao zones of Oromia National Regional State (SARC Profile, 2015). 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'.

In Ethiopia, during 2019/20 main cropping season out of the total cereal crop area, 10,478,218.0 hectares, 17.08% (1,789,372.23 hectares) was covered by wheat production from which 53,152,703.28 quintals were obtained with national average productivity of 29.70 quintals per hectare (CSA, 2020). Hence, wheat ranks 4th in area of production next to teff, maize and sorghum in the country. In the same cropping season 970,517.66 ha of land was covered by wheat from which 30,933,981.77 quintals were harvested with the average yield of 31.87 qt/ha in Oromia National Regional State (CSA, 2020). Among the potential wheat growing areas of the Oromia region, Bale and Arsi Zones are known for the wheat belt of the country and even referred as the highest potential agro-ecologies in Eastern Africa. In Bale Zone, 176,804.44 ha of land was covered by wheat and 6,011,573.36 quintals of grain were produced with the productivity of 34.00 qt/ha (CSA, 2020).

However, farmers experience a wide range of biotic, abiotic and socio-economic constraints. Wheat rusts, stem rust (Puccinia graminis Pers. f.sp. tritici Eriks and Hann), leaf rust (P. triticina Eriks) and stripe or yellow rust (P. striiformis Westend. f. sp. tritici) are the major biotic constraints in all wheat growing regions of the country (Hei *et al.*, 2017). As a result, commercial bread wheat varieties under production have been losing their potential to resist epidemic wheat diseases from time to time. To overcome the problem, Sinana Agricultural Research Centre (SARC) has released (in 2019) the new variety of bread wheat (**Galan**) which has relatively better resistance towards wheat rust diseases and good in yield potential. Galan has yield potential of 45 qt/ha to 60 quintal per hectare with yield advantage of 22.7% over standard check (Dambal) and 99.5% over local check (Madda Walabu), respectively.

Participatory technology evaluation under farmers' management condition may have many advantages, such as increased and stable crop productivity, faster release and rate of adoption of varieties, better understanding farmers' criteria for variety selection, enhanced biodiversity, increased cost effectiveness, facilitated farmers learning and empowerment (Sperling *et al*, 2001). Similarly, Getachew *et al.* (2008) also argued the two ways feedback between farmers and researchers is indeed vital component of high yielder and disease and pest resistant varietal development process. Consequently, pre-extension demonstration of improved bread wheat variety, Galan, was undertaken with the recommended wheat production packages and management practices so as to increase demand of farmers toward the new variety and bridge productivity gap for improved bread wheat production.

Objectives

- To evaluate the yield performance of bread wheat varieties under farmers' condition
- To evaluate the Profitability of Galan and Dambal varieties
- To collect farmers' feedbacks for further development of wheat technologies

Methodology

Description of the study area

The study area, Agarfa and Sinana districts, are found in Bale zone. Sinana district is found at a distance of 430 km to the southeast from Addis Ababa. It is mainly characterized by highland agro-ecology (90%) while the rest (10%) accounts for midland agro-ecology. The district has 20 rural kebeles and four rural towns. According to the Central Statistics Authority (Population Census, 2007), the population of Sinana district was 119,208 of which the share of male and female are 62,280 and 56,928, respectively. In the district 5% of the population is urban dwellers and 95% are rural dwellers. About 99% of the population is engaged in agriculture. The major crops grown in the district include wheat, barley, Faba bean, field pea, lentil, potato, onion, pepper and emmer wheat (SDANRO, 2017).

Similarly, Agarfa district is found at a distance of 465 km to the southeast from Addis Ababa. It has twenty kebeles and two administrative towns with a total land area of 1343 km^2 (134,300 hectares) and out of which 45% is arable land, 30% is grazing land, 12% is forest, 5% is covered by barren/degraded area, and 8% is occupied by rivers, mountains, different constructions. According to the Central Statistics Authority (Population Census, 2007), the population of the district was 104,412 out of which 53,276 are male and 51,136 is female. It is estimated that 13,760 (13.2%) are urban dwellers and 90,852 (86.8%) are rural dwellers. More than 95% of the population is engaged in agriculture. The agro-ecological zones of the district are highland (83%), midland (11%) and lowland (6%). The altitude ranges from 1250m to 3855m a.s.l. The major crops grown in the district includes wheat, barley, faba bean, field pea, maize, pepper, potato and onion (ADANRO, 2017).

Site Selection and Farmer selection

Two kebeles were selected from each district based on their accessibility and bread wheat production potential. FRG approach was employed by strengthening the formerly established FRGs by enhancing the participation of none FRG farmers, development agents, agricultural experts and kebele administrators. Accordingly, in each kebele FRG was strengthened which consists of 15-20 members by taking into account all categories of farmers (resource poor, medium and innovative/resource rich) and gender disaggregation. The FRG approach enhanced the involvement female farmers and the youth group at least 20 percent and 10 percent, respectively. The process of selecting FRG members considered farmers' willingness to be held as member, good history of compatibility with groups, genuineness and commitment to share information and knowledge to other none FRG farmers. From FRG members, hosting farmers were selected in collaboration with SMS, DAs and the members themselves in each Kebele. Accordingly, it was demonstrated and evaluated on a total of five farmers' field and two FTCs by considering each field as replication.

Field design and materials

Simple plot demonstration on 10m x 10m size of land was allotted for each variety by using the recommended spacing (20 cm between rows), seed rate (150 kg/ha) and fertilizer rate (100/100 kg/ha UREA/NPS) with split application of UREA (1/3 at planting and 2/3 at tillering time) for efficient utilization of nitrogen for plants. All NPS fertilizer was applied at planting time. An improved variety of bread wheat (Galan) was compared against with the existing farmers' variety (commercial variety) Dambal. Twice effective hand weeding were done; the first at one month after planting and the second at one months after the first weeding. Farm operations (land preparation) was carried out by hosting farmers; whereas farm activities such as land leveling, planting, first and second weeding, data collection, agro-chemical spray, harvesting and threshing were handled by SARC with close supervision of FRG member farmers.

Technology demonstration and evaluation approaches

Participatory technology demonstration and evaluation approach was employed. Accordingly, FRG members and other follower farmers were encouraged to participate during field visit and mini filed days organized at representative sites for the process of technology demonstration and evaluation. These are mechanisms used to enhance farmer-to-farmer learning and information exchange. Field visits were organized at different sites on which FRG members and agricultural experts (DAs, supervisors and SMSs) were involved in order to build knowledge and skills of the participants toward the technology. Similarly, mini-field days were organized at representative sites during variety evaluation and selection time (at maturity stage of the crop) to enhance the active participation of farmers in the process with researchers and development agents, agricultural experts and kebele administrators.

Extension Methods Used

Pre-extension demonstration of bread wheat technologies was carried out using individual and group extension methods. Accordingly, individual contact and group discussion were used as extension method during the implementation of this demonstration activity. Ponniah (2008) confirmed about the relative importance of group approach as it is a vehicle and entry points for new technologies and facilitating learning activities. Because, a successful group approach has the following characteristics; i) Strong group bond; ii) established communication pattern; iii) participatory group structure; have rules and code of conduct; iv) shared goal; v) cohesiveness; vi) manageable group size (30-50) and vii) quality leadership (Ponniah, 2008).

Types of Data Collected

Types of data collected include number of farmers who participated in mini-field days and field visits, yield data and input costs (fertilizers, seeds, labor, fungicides, herbicides, transportation and harvesting costs). Furthermore, qualitative data such as farmers' feedback about the technology and farmers' variety selection criteria were identified.

Method of Data Collection and Analysis

Field observation, measurements and Focus group discussion (FGD) were used as methods of data collection. Descriptive statistics were used to analyze the quantitative data. Cost-benefit ratio **(**income gained**)** was computed. Farmers' preferences to the demonstrated varieties were ranked using direct matrix ranking methods (Dan, 2012). Farmers' feedback toward the technology were assessed and narrated.

Result and Discussion

Yield performance of demonstrated Varieties

The yield performance of the demonstrated bread wheat varieties was carried out across location. As it is depicted in the Figure 1 below, the recent improved bread wheat variety, Galan, had maximum yield performance of 51 qt ha^{-1} at Sinana district compared to the standard check (Dambal) which gave grain yield of 47.25 qt ha^{-1}. Therefore, these bread wheat varieties were performed best at Sinana district than Agarfa district where both varieties gave lower grain yield. The overall mean across demonstrated districts accounted 44.25 qt ha^{-1} and 39.75 qt ha^{-1}, for Galan and Dambal, respectively. The figurative overall yield difference between the two bread wheat varieties (i.e Galan and Dambal) was only 4.5 quintals. This indicates both varieties are good options for farmers in terms of yield potential.

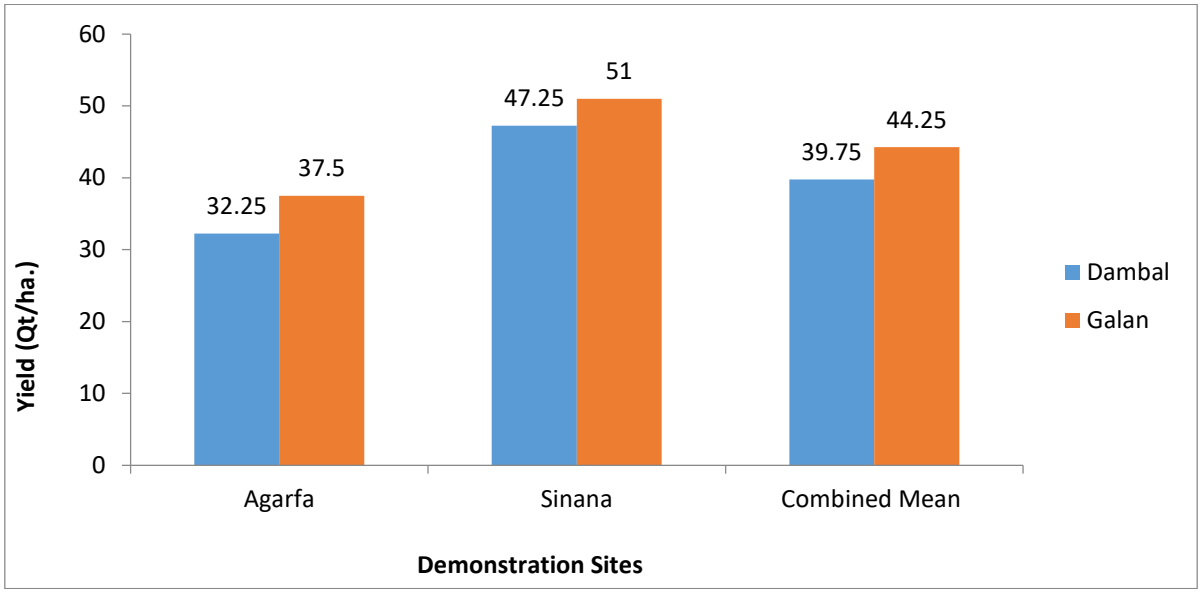

Figure 1: Yield performance of bread wheat varieties

Farmers' Preference towards the Demonstrated Varieties

To identify the farmers' preference towards the demonstrated varieties mini field days were organized in each site and focus group discussion was carried with participant farmers in order to recognize their evaluation criteria and select the variety that satisfy their criteria.

A total of 65 farmers were participated on mini-field days organized in Agarfa and Sinana districts of which 86 %of them was male participants and the rest 14% was female participants (Table 1). Similarly, 12 agricultural experts were directly involved on this extension event (mini filed day organized to facilitate technology evaluation and selection.

Table 1: Participants of Technology Evaluation and Selection

Districts	Farmers			Experts	Total
	Men	Women	Total		
Sinana	32	4	36	6	42
Agarfa	24	5	29	6	35
Total	56	9	65	12	**77**

Finally, at the end of FGD, farmers had selected Galan variety in the first stage due to it has higher tillering capacity; it is more tolerant to disease; it has higher number of seed/spike; it has larger spike length and better stem strength. The summary of farmers' preferences towards demonstrated bread wheat varieties was depicted in the following Table 2.

Table 2: The result of farmers' varietal preferences towards demonstrated bread wheat varieties

S/N	Varieties	Rank	Criteria
1	Galan	1st	- Higher tillering capacity, - More tolerant to disease, - Higher number of seed/spike, - Larger spike length and - Better stem strength.
2	Dambal	2nd	- Lower tillering capacity, - Tolerant to disease, - High number of seed/spike, - Smaller spike length.

Feedback Assessment

Farmers' feedback assessment is important for the future wheat development.

Table 3: Pair wise ranking of demonstrated bread wheat varieties

Code	Varietal Traits	Code of Varietal Traits								Frequency	Rank
		1	2	3	4	5	6	7	8		
1	Tillering Capacity		2	1	1	1	1	1	8	5	3rd
2	Disease Tolerance			2	2	2	2	2	2	7	1st
3	Seed/spike				4	3	3	3	8	3	5th
4	Spike length					4	4	4	8	4	4th
5	Stem strength						6	7	8	0	8th
6	Seed size							7	8	1	7th
7	Seed color								8	2	6th
8	Yield									6	2nd

Cost Benefit Analysis

The result of cost benefit analysis illustrated in the Table 4 below shows that the farmer who decided to produce Galan and Dambal varieties can earn the net profit of 55,993.75 (ETB) and 48,643.75 (ETB) per hectare, respectively in a single production season (Bona Season). However, those farmers who use own land, own draught power and family labor could earn an additional net profit of 24700 birr from the production of each variety.

Table 4: Financial analysis of the demonstrated bread wheat varieties

Variables	**Varieties**	
	Galan	**Dambal**
Yield obtained (qtha^{-1})	44.25	39.75
Sale price (ETB/qt)	2250	2250
Total Revenue (Price X Qt)	97,350	89,437.50
Variable Costs		
Land preparation (tractor rent)	3500	3500
Seed purchase	2850	2850
Fertilizers purchase (NPS)	1650	1650
Fertilizers purchase (UREA)	1200	1200
Cost of Chemicals (herbicide and fungicide)	5500	5500
Labor cost for chemical spray	1200	1200
Combiner rent	3318.75	2981.25
Packing, Loading and store	1327.50	1192.50
Store (bag purchase)	810	720
Total Variable Costs (ETB/ha)	21,356.25	20,793.75
Fixed costs		
Cost of Land	20,000	20,000
Total cost (TVC + TF C)	*41,356.25*	40,793.75
Gross Margin (GM)=TR-TVC	75,993.75	68,643.75
Net Profit=TR-TC or GM-TFC	55,993.75	48,643.75
Benefit-cost Ratio=Net profit/Total Cost	1.35	1.19

Conclusion and Recommendations

Pre-extension demonstration of improved agricultural technologies which enhances the active involvement of farmers and other concerned stakeholders had a better chance in meeting the actual farmers' needs and solving their critical problems through popularizing and disseminating the selected technology/ies by farmers based on the farmers' selection criteria. This pre-extension demonstration study employed two improved varieties of bread wheat (Galan and Dambal). The yield performance of these varieties over location indicated the higher overall mean yield of 44.25 quintals per hectare for Galan variety while that of Dambal was 39.75 quintals per hectare. Moreover, the result of financial analysis indicated that producing both varieties is economically profitable. Likewise, farmers who were participated during variety evaluation and selection event gave the first rank for Galan variety due to it has higher tillering capacity, more tolerant to disease, higher number of seed/spike, larger spike length and better stem strength. Furthermore, according to the farmers' selection criteria Dambal variety held the second rank due to it is less yielder, lower tillering capacity, tolerant to disease, high number of seed/spike and smaller spike length. Therefore, by considering the yield performance, economic return and farmers' preference, Galan variety was recommended for scaling up.

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Pre-extension Demonstration and Evaluation of Improved Faba bean Technologies in Bale Zone, Southeastern Ethiopia

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Abstract

Promoting improved faba bean technologies is supposed to be the best approach to break the prevailing mono cropping problem in Bale zone which mainly focused on wheat production. As a result, pre-extension demonstration of improved faba bean technologies was carried out in Sinana and Agarfa districts by selecting potential and accessible kebeles. A total of eight farmers and two FTCs were used as activity demonstration sites in which Moybon (new variety) and Aloshe (standard check) were planted on plot size of 100 m^2 using full production packages. The yield performance of demonstrated faba bean varieties over location depicts higher yield for Moybon variety with average yield of 28.54 quintals per hectare while the yield performance for Aloshe variety accounts average yield of 23.87 quintals per hectares. Besides, the task of variety evaluation and selection was undertaken by enhancing the participation of farmers and experts in which farmers were encouraged to reflect their preference to varietal attributes by setting their own varietal selection criteria in the study area. Finally, farmers selected Moybon variety by recognizing its higher number of seed/pod, better stem strength, bigger seed size, more tolerant to disease, good crop stand. Moreover, the result of cost benefit analysis revealed that producing Moybon variety is economically feasible and enables earning of 12,380.85 ETB per hectare than Aloshe variety in a single production season. Hence, Moybon variety is recommended for the pre-scaling up in wider area areas.

Key words: Faba bean, Farmers' preference, Moybon Variety, Production packages, Yield

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. Ethiopia ranks 2nd in area coverage in legume production next to china and 4th in productivity in the world (Asfaw, 1994). Faba bean has ecological and economic importance and used for food (rich in protein), income source and foreign currency (attractive market price), soil fertility restoration (NP) and food security. It is mainly used as an alternative with peas to prepare flour called 'shiro' which is used to make 'shiro wot' (a stew almost ubiquitous in Ethiopian dishes).

In Ethiopia, out of the total area allocated for grain crops in 2017/2018 main production season, 12.61% (1,598,806.51 hectares) was allotted for pulse crop production. Subsequently, faba beans, haricot beans (white), haricot beans (red), and chick peas were planted to 3.45% (about 437,106.04 hectares), 0.71% (about 89,382.68 hectares), 1.71% (about 216,803.91 hectares) and 1.91% (about 242,703.73 hectares) of the grain crop area, respectively (CSA, 2018). Hence, from the above CSA (2018) data faba bean production ranks the 1st among pulse crops in area and volume of production in the country during 2017/18 main production season.

During 2017/18 cropping season 437,106.04 ha of land was covered by faba Bean and over 9,217,615.35 quintals was harvested with the average yield of 21.09 qt/ha at national level. In the same cropping season 204,387.86 ha of land was covered by faba bean and about 4,832,016.57 quintals was harvested with the average yield of 23.64 qt/ha in Oromia National

Regional State (CSA, 2018). In Bale Zone, 15,347.32 hectares of land was covered by faba bean from which 372,559.31 quintals of grain were harvested with average productivity of 24.28 quintals pre hectare in 2016/2017 during main (Bona) production season (CSA, 2017).

Farming system in Bale Zone is characterized by mixed farming systems in which most of the crop areas were under cereal based mono-cropping (Bekele, 2011). Crop diversification can be a means to stay in sustainable crop production in the study zone. Faba bean is suggested to be the best crop to break this mono cropping which mainly focused on 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, 2015).

Nevertheless, the productivity of faba bean is far below its potential in Ethiopia due to low grain yielding potential of the indigenous cultivars and susceptibility to biotic and abiotic stresses (Zewdie *et al.*, 2008). 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, Moybon variety of faba bean was recently released in 2019 by Sinana Agricultural Research Center with yield potential of 33-40qt/ha. The yield advantage of Moybon variety over standard check (Gabalcho) is 21.78%. The two way feedback between farmers and researchers is indeed vital component of high yielder and disease and pest resistant varietal development process (Getachew *et al.*, 2008). Thus, undertaking participatory demonstration, evaluation, validation and dissemination of improved faba bean technologies with the active participation of farmers and other stakeholders for sustainable production and productivity of the crop is highly important.

Objectives

- To demonstrated and evaluate improved faba bean technologies under farmers' condition in the study area
- To evaluate the profitability of the Moybon and Aloshe varieties
- To collect farmers' feedbacks for improved development of faba bean

Methodology

Description of the Study Area

Pre-extension demonstration of improved faba bean technologies was carried out in Sinana, Agarfa and Goba districts of Bale zone. Sinana district is found at a distance of 430 km to the southeast from Addis Ababa. It is mainly characterized by highland agro-ecology (90%) while the rest (10%) accounts for midland agro-ecology. The district has 20 rural kebeles and four rural towns. According to the Central Statistics Authority (Population Census, 2007), the population of Sinana district was 119,208 of which the share of male and female are 62,280 and 56,928, respectively in the district from which 5% are urban dwellers and 95% are rural dwellers. About 99% of the population is engaged in agriculture. The land use of the district is characterized with 63% crop land, 11.78% grazing land, 7.5% covered with forest and about 0.07% barren/degraded land and 17.65% of land occupied with others (for construction, rivers, gorges and others). The major crops grown in the district include wheat, barley, Faba bean, field pea, lentil, potato, onion, pepper and emmer wheat (SDANRO, 2017).

Similarly, Agarfa district is found at a distance of 465 km to the southeast from Addis Ababa. It has twenty kebeles and two administrative towns with a total land area of 1343 km2 (134,300 hectares) and out of which 45% is arable land, 30% is grazing land, 12% is forest, 5% is covered by barren/degraded area, and 8% is occupied by rivers, mountains, different constructions. According to the Central Statistics Authority (Population Census, 2007), the population of the district was 104,412 out of which 53,276 are male and 51,136 is female. It is estimated that 13,760 (13.2%) are urban dwellers and 90,852 (86.8%) are rural dwellers. More than 95% of the population is engaged in agriculture. The agro-ecological zones of the district are highland (83%), midland (11%) and lowland (6%). The altitude ranges from 1250m to 3855m a.s.l. The major crops grown in the district includes wheat, barley, faba bean, field pea, maize, pepper, potato and onion (ADANRO, 2017).

Goba district is located in the Bale Zone of the Oromia National Regiona state, Ethiopia approximately 446 km to the southeast of Addis Ababa. It is found at 6^0 30'- 7 ^{0}N latitude and 39^0 3'- 40^0 20'E longitude with an altitude ranging between 2600-2900m above sea level. The ditrict capital is Goba town. Goba is the second largest town next to Robe in Bale zone with an estimated population of 32,025 in the year 2007 (CSA 2007). It is situated 250km linear air distance south–East of Addis Ababa.

Site Selection and Farmer Selection

The study area, Sinana, Agarfa and Goba districts, were selected purposively as demonstration sites based on the potential for faba bean production. From each district, one to two (2) faba bean growing potential kebeles were used for this demonstration activity. Accordingly, one kebele was selected from Goba district while two kebeles were selected from Sinana and Agarfa districts. Similarly, two representative hosting farmers were selected from each kebele in collaboration with the district level agricultural experts and development agents. Finally, pre-extension demonstration of improved faba bean technologies was carried out on eight farmers' field and two FTCs by considering each field as replication.

Field Design and Materials

Simple plot demonstration on 10m x 10m size of land was allotted for each variety. The recommended faba bean production packages, 40cm spacing between rows, seed rate of 180kg/ha were used. Shallow planting of 5cm depth was employed in the presence of ample soil moisture. The recommended fertilizer rate of NPS 100 kg/ha was applied at planting time. A recently released faba bean variety, *Moybon*, was demonstrated and compared against the existing farmers' variety (commercial variety) *Alloshe*. Furthermore, two times effective hand weeding was applied.

Technology Demonstration and Evaluation Approach

FRG approach was used to demonstrate and evaluate the introduced faba bean technologies under farmers' condition. Five FRGs were strengthened to undertake this trial in which 15-20 members were included in each group. FRG member farmers and other follower farmers were encouraged to participate in the process of demonstration activities as well as on different extension events organized at each site. These are the mechanisms used to enhance farmer-to-farmer learning and information exchange. Mini-field days were organized at representative sites during variety evaluation and selection time (at maturity stage of the crop) to enhance the active participation of farmers in the process with researchers, development agents, agricultural experts and kebele administrators. An inter-disciplinary team composed of an Agricultural Extensionist, Breeder, Agronomist, Weed Scientist,

Pathologist, Entomologist, Seed Scientist and Agricultural economist were involved during the implementation of this activity.

Extension Methods Used

Pre-extension demonstration of faba bean technologies was carried out using individual and group extension methods. Accordingly, individual contact and group discussion were used as extension method during the implementation of this demonstration activity. Ponniah (2008) confirmed about the relative importance of group approach as it is a vehicle and entry points for new technologies and facilitating learning activities. Because, a successful group approach has the following characteristics; i) Strong group bond; ii) established communication pattern; iii) participatory group structure; have rules and code of conduct; iv) shared goal; v) cohesiveness; vi) manageable group size (30-50) and vii) quality leadership (Ponniah, 2008).

Types of Data and Methods of Data Collection

Types of data collected include number of farmers who participated in mini-field days and field visits, yield data and input costs (fertilizers, seeds, labor, fungicides, herbicides, transportation and harvesting costs). Furthermore, qualitative data such as farmers' feedback about the technology and farmers' variety selection criteria were identified. Moreover, field observation, measurements and Focus group discussion (FGD) were used as methods of data collection.

Data analysis

Descriptive statistics were used to analyze the quantitative data. Cost-benefit ratio (income gained) was computed. Farmers' preference to varietal attributes of the demonstrated varieties were identified and ranked using pair wise and simple matrix ranking methods (Dan, 2012). Farmers' feedback toward the technology were assessed and narrated.

Result and Discussion

Yield performance of Demonstrated Faba bean Varieties

As shown in the following figure 1, the yield performance of demonstrated faba bean varieties over location depicts higher yield for the new variety Moybon with overall mean yield of 28.54 quintals per hectare. Similarly, the yield performance of Aloshe variety over location is also encouraging with average yield of 23.87 quintals per hectares. Moybon variety gave more yielder in all demonstration sites; but, it gave the maximum yield (37.50 qt ha^{-1}) at Goba district. Hence, Goba district, which is most highland area than other demonstration sites, is the area where Moybon variety can show its maximum potential if it is properly managed.

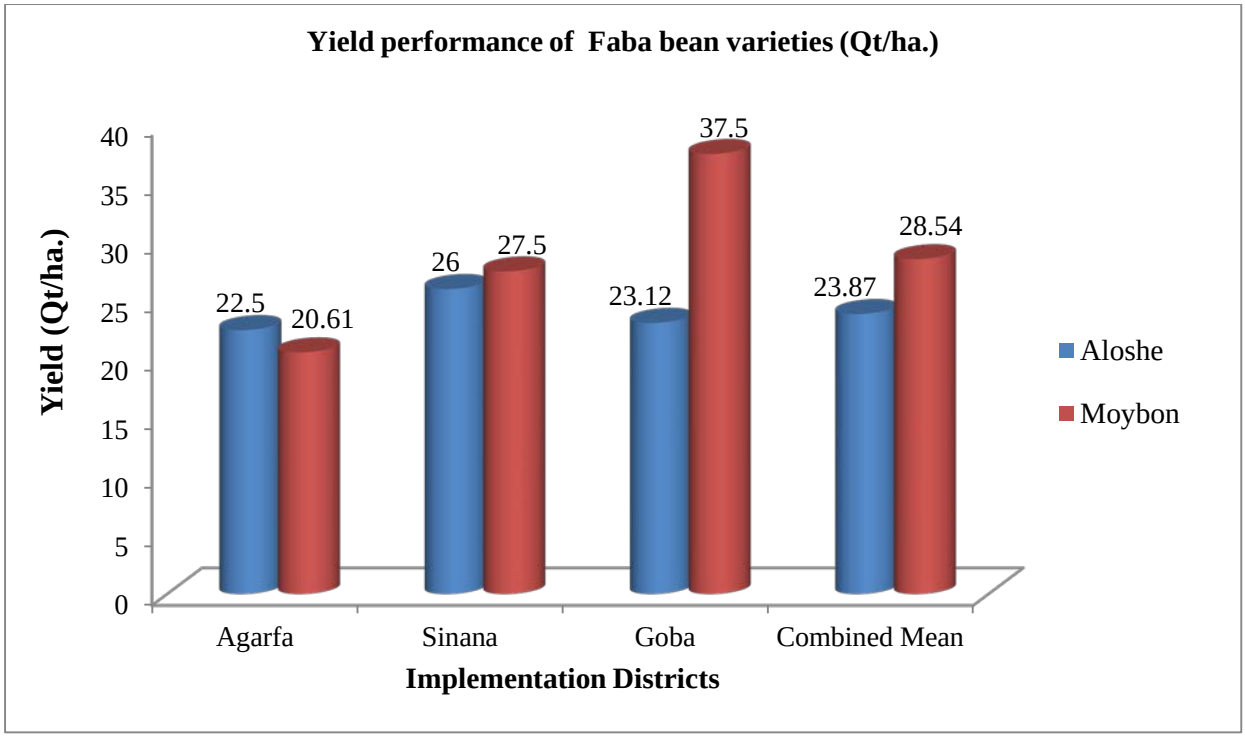

Figure 1: Yield performance of faba bean varieties

Farmers' Preference towards the Demonstrated Varieties

The task of variety evaluation and selection was undertaken by enhancing the participation of farmers and experts in which farmers were encouraged to reflect their preference to varietal attributes by setting their own varietal selection criteria in the study area. Accordingly, focus group discussions were carried out in areas where mini filed days were organized.

The summary of farmers and experts participated during mini field days organized in Goba, Sinana and Agarfa districts was illustrated in the Table 1. Accordingly, a total of 76 farmers were participated on the mini field days organized in the three districts from which 62 of them were male participants and the remaining 14 were female farmers. Likewise, 16 district level experts and development agents participated on this extension event and totally 92 participants were involved on mini field days organized in the three demonstration districts (Table 1).

Table 1: Participants of Technology Evaluation and Selection

	Farmers				
Districts	**Men**	**Women**	**Total**	**Experts**	**Total**
Goba	25	5	30	4	34
Sinana	22	4	26	6	32
Agarfa	15	5	20	6	26
Total	62	14	76	16	**92**

Finally, after active participation carried out during focus group discussion farmers selected Moybon variety in the first stage due to it has higher number of seed/pod, better stem strength, bigger seed size, more tolerant to disease, good crop stand. The summary of farmers' preferences towards the demonstrated faba bean varieties depicted in the Table 2 below.

Table 2: Farmers' varietal preferences towards the demonstrated faba bean varieties

No	Varieties	Rank	Criteria
1	Moybon	1st	Higher number of seed/pod, better stem strength, bigger seed size, more tolerant to disease, good crop stand
2	Aloshe	2nd	Lower number of seed/pod, smaller seed size, less tolerant to disease,

Cost Benefit Analysis

The result of cost benefit analysis revealed that if the farmer decided to produce Moybon and Aloshe varieties, he/she will gain the net profit of 46,253.70 (ETB) and 33,854.85 (ETB) per hectare, respectively in a single production season (Table 3). But, the farmer used own land, own draught power and family labor could earn an additional net profit of 23870 birr from the production of each variety.

Table 3: Financial analysis of the demonstrated faba bean varieties

Parameters	**Varieties**	
	Moybon	**Aloshe**
Yield obtained (Y) ($qtha^{-1}$)	28.54	23.87
Average price (P) (ETB/qt)	2700	2700
Total Revenue (TR)=Y x P	77,058	64,449
Variable Costs		
Land preparation (tractor rent)	2200	2200
Seed purchase	3200	3200
Fertilizers purchase (NPS)	1650	1650
Cost of Chemicals (herbicide and fungicide)	800	800
Cost for second hand weeding	3000	3000
Labor cost for chemical spray	720	720
Harvesting cost	1950	1950
Packing, Loading and store	856.20	716.10
Store (bag purchase)	428.10	358.05
Total Variable Costs (ETB/ha)	14,804.30	14,594.15
Fixed costs		
Cost of Land	16000	16000
Total cost (TVC + TFC)	30,804.30	30,594.15
Gross Margin (GM)=TR-TVC	62,253.70	49,854.85
Net Profit=TR-TC or GM-TFC	46,253.70	33,854.85
Benefit-cost Ratio=Net profit/Total cost	1.50	1.10

Conclusion and Recommendations

The result of yield performance of demonstrated faba bean varieties revealed the higher average overall yield for Moybon variety, 28.54 quintals per hectare while that of the standard check (Aloshe) gave 23.87 quintals per hectare. The average yield difference between these varieties is 4.67 quintals. Farmers also selected Moybon variety in the first stage by recognizing its higher number of seed/pod, better stem strength, bigger seed size, more tolerant to disease, good crop stand. They also not refused Aloshe variety and selected in the second stage. However, in the past a lot of efforts were exerted to disseminate Aloshe variety. As a result, farmers are using this variety in their production. Therefore, Moybon variety is recommended for the next research stage (pre-scaling up phase).

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Pre-extension Demonstration of Improved Linseed Technologies in Bale Zone, Oromia National Regional State, Ethiopia

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Abstract

Linseed is the main oil crop grown in *Bale highlands and it used as a cash crop for most of smallholder farmers in the zone. Pre-extension demonstration of improved linseed technologies was undertaken in Dinsho and Agarfa districts of Bale zone to enhance linseed productivity. For this activity, the new variety (Horasoba) was evaluated and compared with the commercial variety (Jitu). FRG approach was used to demonstrate these varieties and the recommended agronomic packages. Yield data, production costs, number of stakeholders participated on mini field days and farmers' varietal selection criteria were collected using measurements, key informant interview and Focus group discussion (FGD). Descriptive statistics was used to analyze quantitative data while cost benefit analysis was applied for financial analysis. Farmers' preference to varietal attributes of the demonstrated varieties was identified and narrated. The yield evaluation over location revealed that 10 quintals of Horasoba variety were harvested per hectare while 7.5 quintals were obtained from Jitu variety. Horasoba, has yield advantage of 33.33% over commercial variety. Farmers also selected Horasoba variety for its relative advantages of higher number of tiller, higher number of seed/capsule, good plant height, higher number of branch/plant, higher number of capsule/plant, better stem strength, more tolerate water to lodging. The result of cost benefit analysis also indicated that producing Horasoba variety is more economically profitable than the commercial variety. Finally, based on relative yield performance, farmers' preference and economic profitability, Horasoba variety is recommended for pre-scaling up phase to be undertaken in wider area coverage.*

Key Words: Farmers' criteria, FRG approach, Horasoba variety, Linseed, Yield performance

Introduction

Oilseed crops can be grown in all parts of Ethiopia and are currently contributing a larger share to the agrarian economy of the country. Linseed (Linum usitatissimum L.) has been a traditional crop in Ethiopia and it is the second most important oil seed crop in production after noug (Guizotia abyssinica Cass) in the higher altitudes (Adugna and Adefris, 1995). Linseed is one of the most versatile crops and suited to a wide range of soil types. It prefers dry and sunny weather with well-distributed moderate rain over the growing season (Getinet Alemaw and Nigussie Alemayehu, 1997).

Linseed is among useful crops and yields seed which is rich source of both non-edible and edible oil. The industrial oil is an important ingredient in the manufacture of paints, varnishes and linoleum (Matheson, 1976) while edible linseed oil is used for human food consumption and contains α-linolenic acid (ALA), a polyunsaturated fatty acid that is known to have nutritional and health benefits (Morris, 2005). Aside from ALA, linseed is becoming increasingly popular as a nutritional and functional food in the Western world due to its high content of health promoting substances such as ω-3 fatty acid, soluble and insoluble fibre and lignans (Morris, 2005).

In most countries, linseed is only cultivated for its seed which is processed into oil and a high protein stock feed after oil extraction. Nonetheless, it is also suitable in crop rotation programs with cereals and cereal crops following linseed produce good yields since it prevents disease build up as it is resistant to cereal diseases. Crop production in Bale Zone is characterized by mainly cereal based mono-cropping (Bekele, 2011). Crop diversification can be a means to stay in sustainable crop production in the study zones. Linseed can be used as one of the break crops for mono cropping which mainly focused on wheat production. Bread wheat grown after Pulses and Oil crops gave higher grain yield than after cereal crops with a yield advantage of 15% (Sinana ARC Profile, 2014).

During 2017/18 cropping season, Oil seeds added 6.68% (about 846,493.53 hectares) of the grain crop area and 2.79% (about 8,550,738.16 quintals) of the production to the national grain total. Neug, sesame and linseed covered 2.29% (about 290,494.94 hectares), 2.92% (about 370,141.06 hectares) and 0.62% (about 79,044.51 hectares) of the grain crop area of Ethiopia, respectively (CSA, 2018). In the same season, 79,044.51 ha of land was covered by linseed and over 882,096.51 quintals was harvested with the average yield of 11.16 qt/ha at national level. In the same cropping season 46,443.46 ha of land was covered by linseed and about 635,444.41 quintals was harvested with the average yield of 13.68 qt/ha in Oromia National Regional State (CSA, 2018).

The Bale highlands are one of the potential areas for the production of highland oil crops in Ethiopia, and linseed is the main oil crop grown in the zone. Regarding its future prospect, however, it can be envisaged that the need for large scale production of this potential oil crop is eminent, particularly with the advent of private investors, farmers' cooperatives and potential farmers so as to satisfy the ever-increasing domestic demand for oil, flourishing small scale linseed processors in the country to extract oil and moreover, ample production for export. In general, with the present national trend of agricultural diversification, linseed commands increased research interest focused on developing and releasing improved varieties in line with the cultural aspects or practices for the performance of improved cultivars. Consequently, Horasoba variety has recently released (in 2019) by Sinana Agricultural Research Centre (SARC) with yield potential of 15-21qt/ha. The yield advantage of Horasoba over standard check (Jitu) is 18.97%.

The two way feedback between farmers and researchers is indeed vital component of high yielder and disease and pest resistant varietal development process (Getachew *et al*, 2008). Participatory technology evaluation on farmers' management condition may have many advantages, such as increased and stable crop productivity, faster release and rate of adoption of varieties, better understanding farmers' criteria for variety selection, enhanced biodiversity, increased cost effectiveness, facilitated farmers learning and empowerment (Sperling et al, 2001). Thus, undertaking participatory demonstration, evaluation, validation, popularization, multiplication and dissemination of improved linseed variety (Horasoba) with the active participation of farmers (resource poor, medium and innovative/resource rich) and other stakeholders is important to familiarize the farming communities with the varieties and associated recommended full packages which in turn will facilitate the adoption process, bridge the productivity gap and sustainable production.

Objectives

- To evaluate the yield performance of improved linseed technologies under farmers' condition
- To evaluate the profitability of the demonstrated linseed varieties.
- To collect farmers' feedbacks on improved linseed technologies for further development of oil crops production.

Methodology

Site selection and Farmer Selection

Dinsho and Agarfa districts of Bale Zone were selected purposively as demonstration sites based on the potential for linseed production. One kebele was selected from Dinsho district while two kebeles were selected from Agarfa district based on production potential and road accessibility for the supervision and management of the trial. Moreover, a total of four farmers and two FTCs were selected for implementation of the trial.

Field design and materials

Simple plot demonstration on 10m x 10m size of land was allotted for each variety by using the recommended seed rate of 25kg/ha for row planting and spacing of 20 cm between rows. Planting was done by drilling in the prepared rows and shallow planting of 5cm depth was employed in the presence of ample soil moisture. The recommended fertilizer rate of 23/23 kg ha^{-1} N/P2O5 or 25/60.53 kg/ha UREA/NPS was applied at planting time. An improved variety of linseed (Horasoba) was compared against the existing commercial variety (Jitu.). Twice effective hand weeding were done; the first at one month after planting and the second at one months after the first weeding.

Technology demonstration and evaluation approaches

FRG member farmers and other follower farmers were encouraged to participate in the process of demonstration activities as well as on different extension events organized at each site. These are the mechanisms used to enhance farmer-to-farmer learning and information exchange such as trainings, field visits/tours, field days, etc. Thus, mini-field days were organized at representative sites during variety evaluation and selection time (at maturity stage of the crop) to enhance the active participation of farmers in the process with researchers and other relevant stakeholders. An inter-disciplinary team composed of an Agricultural Extensionist, Breeder, Agronomist, Weed Scientist, Pathologist, Entomologist, Seed Scientist and Agricultural economist were participated in the process of this activity.

Extension Methods Used

In extension, there are no one-size-fits-all solutions. Hence, 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 demonstration activity.

Types Data and Method of Collection

Agronomic data (yield data), input costs (fertilizers, seeds, Labor, fungicides, herbicides, transportation and harvesting costs), local market price of the out puts at harvesting time were recorded. Number of farmers participated on field visit; mini-field days, demonstration and evaluation were recorded by gender. Furthermore, farmers' feedback about the technology (farmers` perceptions/preferences and farmers' variety selection criteria) was collected using field observation, key informant interview and Focus group discussion (FGD) methods of data collection.

Data analysis

Descriptive statistics was used to analyze quantitative data. Financial analysis (income gained) was computed. Farmers' preference to varietal attributes of the demonstrated varieties were identified and ranked using direct matrix ranking methods (Dan, 2012). Farmers' feed-back toward the technology was assessed and narrated.

Result and Discussion

Yield Performance of the Varieties

In both districts the Horasoba variety gave higher yield than the standard variety. In average 10 quintals per hectare was harvested from Horasoba variety while the standard check (Jitu) variety gave average yield of 7.5 quintals per hectare. The new variety, Horasoba, has yield advantage of 33.33% over the standard check. The yield performance of demonstrated linseed varieties across locations was analyzed and illustrated in the following graph (Figure 1).

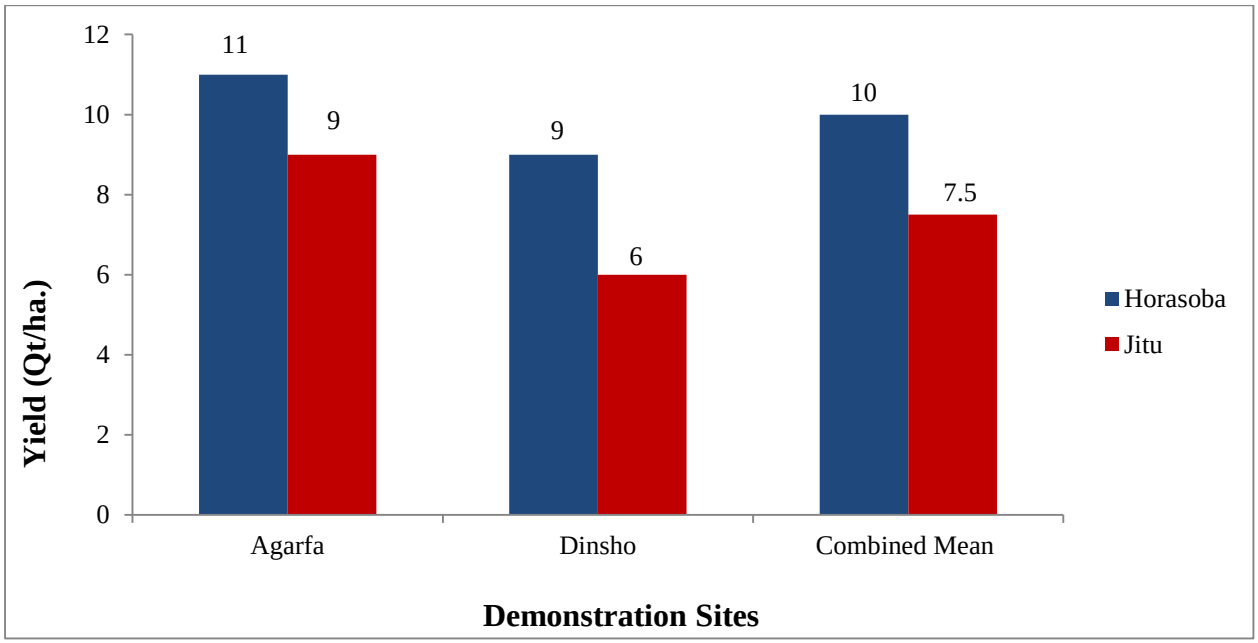

Figure 1: Yield performance of demonstrated linseed varieties

Farmers' Preferences to the Demonstrated Varieties

Farmers are considered to have subjective preferences for specific characteristics inherent in new technologies or innovations (Dawit *et al.*, 2019). These preferences are assumed to play a significant role in technology adoption. Hence, consulting the intended end users to assess which quality/ies of a particular technology they prefer is highly important. Because, farmers have a broad knowledge of their environments, crops and cropping systems which they built up their life base over many years and do experiments by their own and generate innovations, even though they lack control treatment for comparison and statistical tools to test the hypothesis (Bänziger, 2000). In this regard, the task of variety evaluation and selection was undertaken by enhancing the participation of farmers and experts in which farmers were encouraged to reflect their preference to varietal attributes by setting their own varietal selection criteria in the study area.

Accordingly, out of the total 48 farmers participated in variety evaluation and selection on mini field days organized in Dinsho and Agarfa districts, 13 (27%) of them were female participants (Table 1). Similarly, seven (7) experts were involved during variety evaluation and selection process. Generally, 55 stakeholders were participated on mini field days organized to enhance farmers' variety evaluation and selection at maturity stage of the crop.

Table 1: Participants of Technology Evaluation and Selection

	Farmers				
Districts	**Men**	**Women**	**Total**	**Experts**	**Total**
Dinsho	15	5	20	2	22
Agarfa	20	8	28	5	33
Total	35	13	48	7	**55**

Finally, after a fruitful discussion, participant farmers agreed to select Horasoba variety at the first stage for its relative advantages of higher number of tiller, higher number of seed/capsule, good plant height, higher number of branch/plant, higher number of capsule/plant, better stem strength, more tolerate water to lodging. The following Table 2 shows the rank given for linseed varieties with associated reason.

Table 2: Farmers' varietal preference

S/N	Varieties	Rank	Reasons
1	Horasoba	1st	• Higher number of tiller, higher number of seed/capsule, good plant height, higher number of branch/plant, higher number of capsule/plant, better stem strength, more tolerate water to lodging. • But, it has late maturity.
2	Jitu	2nd	• Early maturity and good uniformity. • But, it has relatively lower number of tiller, lower number of seed/capsule, lower number of branch/plant, lower number of capsule/plant and less tolerate to water lodging.

Cost Benefit Analysis

Producing the two varieties of linseed is economically feasible. As a result, a farmer who decided to produce Horasoba and Jitu varieties can earn net profit of 16,450 (ETB) and 4,937.50 (ETB) per hectare, from the former and the later, respectively in a single production season (Table 3). However, the farmer could be more profitable if he/she decided to Horasoba variety than the standard check.

Table 3: Financial analysis of the demonstrated linseed varieties

Parameters	**Varieties**	
	Horasoba	**Jitu**
Yield obtained (Y) ($qtha^{-1}$)	10	7.5
Average price (P) (ETB/qt)	4650	4650
Total Revenue (TR)=Y x P	46500	34875
Variable Costs		
Land preparation (tractor rent)	2000	2000
Seed purchase	4200	4200
Fertilizers purchase (NPS)	1700	1700
Cost for hand weeding	3000	3000
Harvesting cost	2700	2700
Packing, Loading and store	300	225
Store (bag purchase)	150	112.50
Total Variable Costs (ETB/ha)	14,050	13,937.5
Fixed costs		
Cost of Land	16000	16000
Total cost (TVC + TFC)	30,050	29,937.50
Gross Margin (GM)=TR-TVC	32,450	20,937.50
Net Profit=TR-TC or GM-TFC	16,450	4,937.50
Benefit-cost Ratio=Net profit/ Total cost	0.55	0.16

Conclusion and Recommendations

Pre-extension demonstration of improved linseed technologies was carried in Dinsho and Agarfa districts using FRG approach. A new linseed variety, Horasoba, was compared with Jitu variety (commercial variety). The yield performance of these varieties revealed that Horasoba variety better performed than the commercial variety. Accordingly, the mean yield of Horasoba and Jitu varieties over location per hectare were 10 quintals and 7.5 quintals, respectively. Similarly, farmers gave the first rank for Horasoba variety for its relative advantages of higher number of tiller, higher number of seed/capsule, good plant height, higher number of branch/plant, higher number of capsule/plant, better stem strength, more tolerate water to lodging. Moreover, the result of financial analysis shows that Horasoba variety is economically more profitable than the commercial variety. Therefore, based on relative yield performance, farmers' preference and economic feasibility, Horasoba variety is recommended for pre-scaling up.

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Pre-extension Demonstration of Improved Common Bean Technologies: The Case of Goro and Ginnir Districts of Bale and East Bale Zones

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Abstract

*Pre-extension demonstration of improved common bean technologies containing two sets (white speckled and red mottled bean) was carried out in Goro and Ginnir districts and compared separately with corresponding standard checks. Accordingly, from red mottled bean, Hundaf (new variety) was demonstrated and compared with Melka dame while the white speckled set, Duma variety, was demonstrated with the corresponding set, Doyo (standard check). A total of six (6) representative hosting farmers were used for this activity in which the two sets were planted on the same farmers' field and evaluated independently using plot size of 10 m * 10 m. Yield data, number of farmers participated on mini field days and farmers' variety selection criteria were collected using measurements and focus group discussion (FGD). The collected quantitative data were analyzed using descriptive statistics while narration was applied for qualitative data. The yield performance analysis was carried out for white speckled and red mottled common beans separately. Accordingly, from white speckled set, the average yield of new variety (Dumal) was less than the standard check (Doyo variety with significant mean difference at less 1% significance level. Similarly, from red mottled set, the mean yield of Hundaf (the new variety) was 17.6 qt/ha with standard deviation of 2.47 while the standard check gave mean yield of 16.22 qtha^{-1} with standard deviation of 3.7. Moreover, farmers had selected Hundaf variety in the first stage due it has higher pod/plant, bigger seed size, good seed color and higher number of seed/pod. The new variety from white speckled set was not selected by farmers instead they preferred the standard check. Therefore, based on the obtained yield difference and the farmers' preference, only Hundaf was suggested for further pre-scaling up.*

Key Words: Common bean, Dumal, Hundaf, Farmers' criteria and Yield performance

Introduction

Common bean (*Phaseolus vulgares L*) is the most important of the food legumes grown in tropics and sub-tropics. It is one of the lowland Pulse crops produced in hot region (Arke *et. al.*, 2016). Although the crop used for family food consumption in Ethiopia, it has been known as an export crop for long period in contributing to foreign exchange earnings. Out of the total grain crop area in the country, 12.61% (1,598,806.51 hectares) was under pulses. Faba beans, haricot beans (white), haricot beans (red), and chick peas were planted to 3.45% (about 437,106.04 hectares), 0.71% (about 89,382.68 hectares), 1.71% (about 216,803.91 hectares) and 1.91% (about 242,703.73 hectares) of the grain crop area, respectively (CSA, 2018).

During 2017/18 cropping season 89,382.68 ha and 216,803.91 of land were covered by white and red haricot beans and over 1,482,128.42 and 3,727,664.85 quintals was harvested with the average yield of 16.58 qt/ha and 17.19 at national level, respectively. In the same cropping season 41,834.37 ha and 84,060.21 of land was covered by white and red haricot beans and about 717,879.69 and 1,597,865 quintals was harvested with the average yield of 17.16 and 19.01 qt/ha in Oromia National Regional State, respectively (CSA, 2018). In

2016/17 production season, the average national yield of white and red set of common bean was 13.18 and 8.66 quintals per hectare, respectively (CSA, 2017).

However, local varieties are becoming low yielding and less profitable to subsistence farmers (Asfaw *et al.*, 2008). In line with this, the research system made a lot of efforts to address the bottleneck of farming communities and released different varieties for cultivation in the country. Besides, Sinana Agricultural Research Center (SARC) released Wabero (white), Gobu (red) and Doyo (white speckled) varieties of common bean in 2018 for mid and low land areas of Bale zone. Likewise, **Hundaf** (red mottled) and **Dumal** (white speckled) varieties of common bean were released (in 2019) by SARC with yield potential of 17-25 qt/ha and 17-23qt/ha, respectively. The yield advantage of Hundaf variety over standard check (Malka Dame) is 19.83% and that of Dumal variety over brown speckled is 19.46%.

Thus, participatory research and extension approach whereby stakeholders actively participate in decision making, implementation, utilization and dissemination of research results is crucial in addressing those problems. Therefore, undertaking participatory demonstration, evaluation, popularization and dissemination of improved common bean technologies was suggested for sustainable production and productivity.

Objectives

- To evaluate yield performance of improved common bean technologies under farmers' condition in the mid altitude areas of Bale and East Bale Zones.
- To create awareness on the importance of improved common bean technologies among farmers, DAs, SMSs and other participant stakeholders.
- To collect farmers' feedbacks on improved common bean technologies for further development of pulse production.

Methodology

Site selection and Farmer selection

Participatory demonstration and evaluation of improved common bean technologies was undertaken in Goro and Ginnir districts of Bale and East Bale zones in 2020/2021 during the main cropping season. These districts were selected purposively as demonstration sites based on the potential for common bean production. One PA was selected from Goro district while two PAs were selected from Ginnir district purposively based on road accessibility and the existing production potential. Trial farmers were selected in collaboration with agricultural experts (SMSs, DAs) and the members themselves. A total of six (6) representative host farmers were considered for this demonstration activity.

Field design and materials

Simple plot demonstration was used on which 10m x 10m size of land was allotted for each variety. Row planting was applied with the spacing of 30cm between rows and the recommended seed rate for Hundaf 110kg/ha and for Dumal 100kg/ha. Shallow planting of 5cm depth was employed in the presence of ample soil moisture. The recommended fertilizer rate of NPS 100 kg/ha was applied similarly for both varieties all during planting time. The two recently released common bean varieties, namely, Hundaf (red mottled) and Dumal (white speckled) with associated packages were demonstrated side by side and compared against with the existing standard checks Melka Dame (red mottled) and Doyo (white speckled), respectively.

Technology demonstration and evaluation approaches

FRG approach was used in which three FRGs were established consisting of 15-20 members. FRG members and follower farmers were encouraged to participate in the process of demonstration activities as well as on different extension events organized at each site. Accordingly, mini-field days were organized at representative sites during variety evaluation and selection time at maturity stage of the crop to enhance the active participation of farmers in the process with researchers and other relevant stakeholders. At each district, before leading the participants to Focused Group Discussion (**FGD)**, brief orientation was given to them on the objectives of technology evaluation and selection in research process. Then, the evaluators were grouped in to smaller manageable groups by selecting and having one group leader and secretary. Then, researchers from SARC facilitated the variety evaluation and selection carried out by the group members. Finally, each group reported their evaluation result through the respective group leader.

Extension Methods to be used

In extension, there are no one-size-fits-all solutions. Hence, appropriate participatory extension approaches such as individual contact method and group contact methods were employed during the implementation of the demonstration activity.

Data to be collected

Yield data, input costs (fertilizers, seeds, Labor, fungicides, herbicides, transportation and harvesting costs), local market price of the out puts at harvesting time were recorded. Farmers' feedback about the technology (farmers` preferences and farmers' variety selection criteria) was identified using field observation, key informant interview and Focus group discussion (FGD) methods of data collection. Number of farmers participated on field visit; mini-field days, demonstration and evaluation were recorded by gender disaggregation.

Data analysis

Descriptive statistics was used to analyze the quantitative data. Financial analysis was computed to analyze the economic profitability of the demonstrated common bean varieties. Farmers' preference to varietal attributes of the demonstrated varieties was identified and ranked using direct matrix ranking methods (Dan, 2012). Farmers' feed-back toward the technology was assessed and narrated.

Result and Discussion

Yield performance of demonstrated Varieties

The yield performance analysis was carried out for white speckled and red mottled common beans separately. Accordingly, from white speckled set, the average yield of Doyo variety was 15.18 with standard deviation of 1.26. Likewise, Dumal variety gave average yield of 10.1 quintals per hectare with the standard deviation of 1.39 (Table 1). The yield difference between the two white speckled varieties of common bean is 5.08 quintals per hectare. The mean comparison between the Doyo and Dumal varieties indicates significant yield difference at less than 1% significance level with the t-value of 6.04. Therefore, a farmer who produces Doyo variety can get an extra 5.08 quintals for each additional hectare he/she allocated for common bean production than a farmer who decided to use Dumal variety.

Table 1: Yield performance of white speckled common bean varieties

Demonstrated Varieties (White speckled Bean)	Yield Obtained qt/ha.			t-value
	Mean	Std. Deviation	Mean Difference	
Doyo	15.18	1.26	5.08	6.04***
Dumal	10.10	1.39		

Moreover, the yield performance of these white speckled common bean varieties over location is shown in the following figure. The average yield of Doyo and Dumal varieties in Ginnir district was 16 and 10.6 quintals per hectare, respectively while 14.36 and 9.6 quintals were harvested per hectare from the former and the latter varieties, respectively. Thus, relatively both varieties performed better in Ginnir district than Goro district. This suggests that Ginnir district is a potential area for white speckled common bean production.

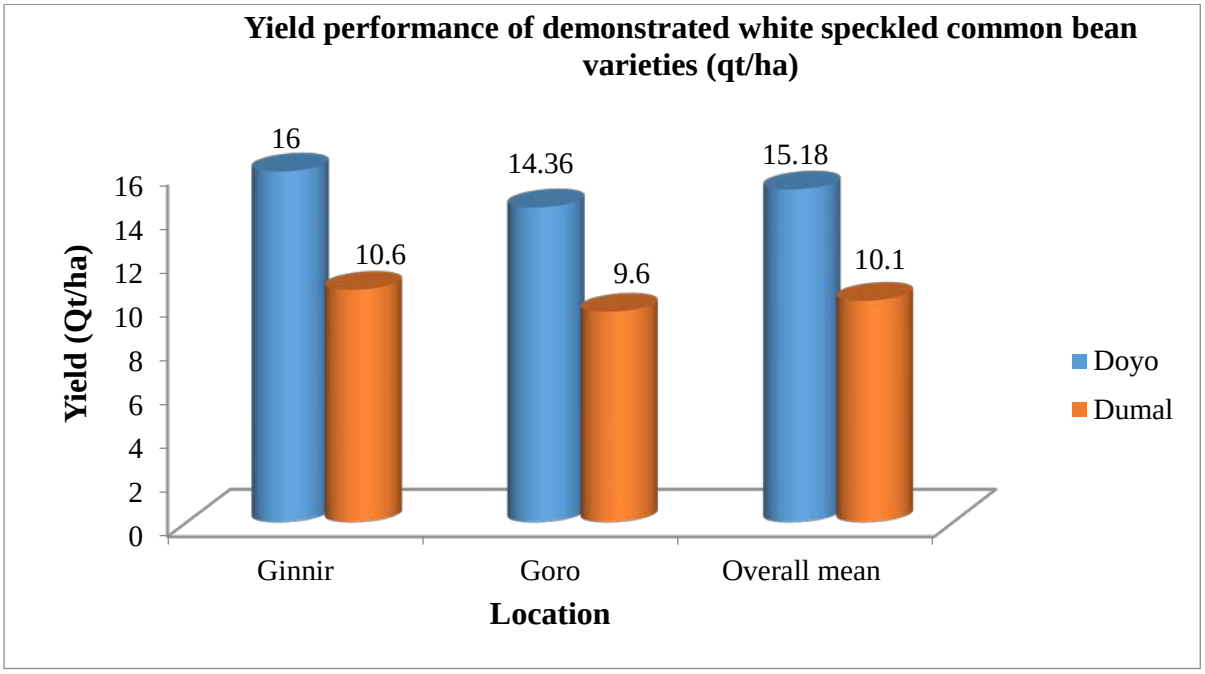

Figure 1: Yield performance of white speckled common bean varieties

Similarly, yield comparison of red mottled common bean varieties, hundaf and Melka dame, was carried out using t-test. Accordingly, the mean yield of Hundaf variety was 17.6 quintal per hectare with standard deviation of 2.47 while Melka dame gave mean yield of 16.22 quintals per Hectare with standard deviation of 3.7. However, the result of t-test reveals as there is no statistically yield difference between these two varieties.

Table 2: Yield performance of red mottled common bean varieties

Demonstrated Varieties (Red Mottled Bean)	Yield Obtained qt/ha.			t-value
	Mean	Std. Deviation	Mean Difference	
Hundaf	17.60	2.47	1.38	.69
Melka dame	16.22	3.704		

Furthermore, the yield performance of the two varieties across location indicates slight difference between Ginnir and Goro districts in which relatively the highest yield was harvested from Ginnir district for both varieties. In view of that, the mean yield of Hundaf variety in Ginnir district was 18.89 quintals per hectare while Melka dame variety gave mean yield of 17.23 quintals per hectare in the same district. On the other, hand both varieties gave smaller yield in which the average of Hundaf and Melka dame varieties was estimated to be 16.31 and 15.2 quintals per hectare, respectively.

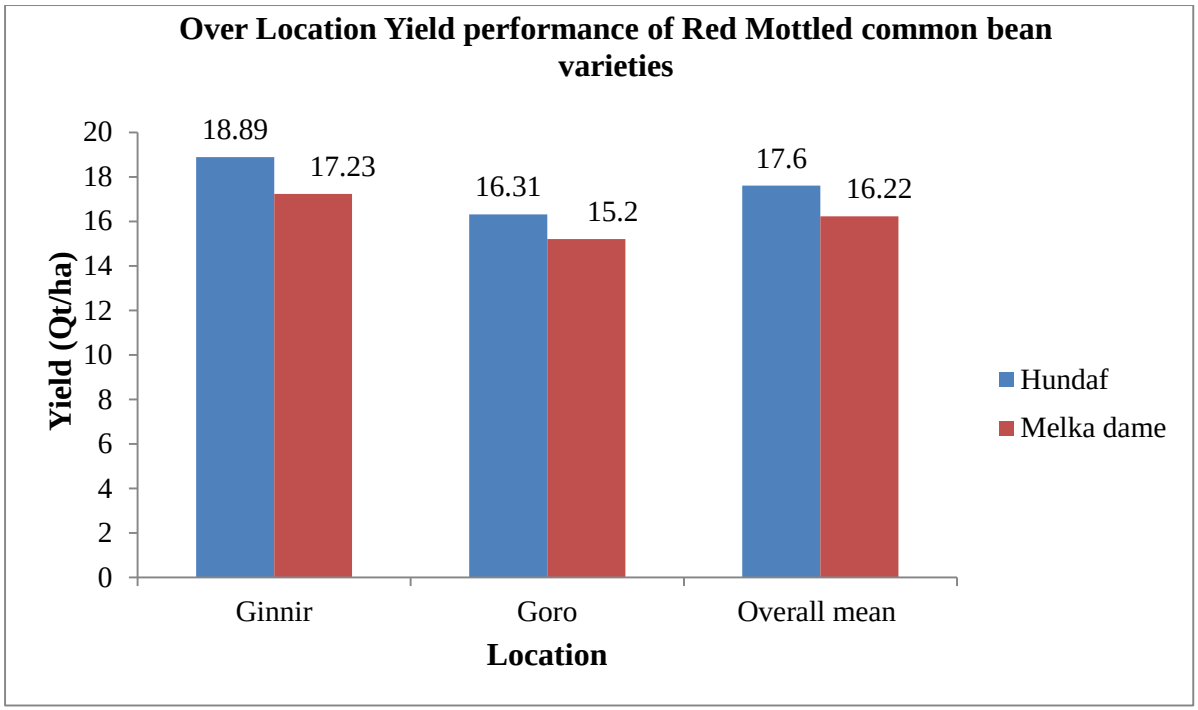

Figure 2: Yield performance of red mottled common bean varieties

Farmers' Preference

Farmers were enhanced to select the variety/ies of their interest by setting their own selection criteria during participatory variety evaluation and selection events. During focus group discussions, farmers were more inclined to yield and yield components while comparing, identifying and selecting varieties in all demonstration sites. Participatory variety evaluation and selection was arranged at mini field days organized in representative sites. FRG members, other farmers, district level agricultural experts and local agricultural experts (Development agents) were involved at mini field days.

Out of 47 participants participated on mini field days organized at representative sites, 38 of them were farmers while nine of them were agricultural experts. Accordingly, the summary of mini field day participants was illustrated in Table 3.

Table 3: Participants of Mini field days in Ginnir and Goro districts

	Farmers				
Districts	**Men**	**Women**	**Total**	**Experts**	**Total**
Ginnir	18	2	20	5	25
Goro	15	3	18	4	22
Total	33	5	38	9	**47**

For the ease of illustration, farmers' preference toward the demonstrated common bean varieties was presented separately in Table 4 and Table 5 based on their set (i.e., white speckled and red mottled sets). Accordingly, Table 4 indicates famers' preference toward the red mottled common bean varieties while Table 4 signifies farmers' preference toward the demonstrated white speckled common bean varieties.

From the red mottled set, farmers selected the new variety, Hundaf, for its higher pod/plant, bigger seed size, marketability (seed color) and higher number of seed/pod (Table 4).

Table 4: Farmers' preference toward the red mottled common bean varieties

No	Varieties	Rank	Reasons
1	Hundaf	1st	- Higher pod/plant, - Bigger seed size, - Marketability (good seed color), - Higher number of seed/pods.
2	Melka Dame	2nd	- Smaller seed size, - Less marketable, - Lower number of seed/pods.

Similarly, farmers carried out hot discussion to compare, identify and select the demonstrated white speckled common bean varieties by setting their own selection criteria. After a fruitful discussion, farmers preferred the commercial variety (Doyo) than the new variey (Dumal). They reason out that Doyo variety is relatively high yielder, more tolerant to disease, bigger seed size and has higher number of seed/pod. The farmers' preference towards the demonstrated white speckled common bean varieties along with selection criteria were summarized in Table 5.

Table 5: Farmers' preference towards the demonstrated white speckled common bean varieties

No	Varieties	Rank	Reasons
1	Doyo	1st	- High yielder, - More disease tolerance, - Bigger seed size, - Higher number of seed/pod.
2	Dumal	2nd	- Low yielder, - Less disease tolerance, - Smaller seed size, - Lower number of seed/pod.

Conclusion and Recommendations

Pre-extension demonstration of improved agricultural technologies through FRG approach is very important to create demand and build confidence toward the demonstrated varieties for wider scaling up. The demonstrated common bean varieties performed better in Ginnir district than Goro district even if the same agronomic and management practices were applied in both districts. Two new varieties from different sets were demonstrated and compared with commercial varieties of the corresponding sets. Accordingly, from the red mottled set the new variety, Hundaf, was performed better than the commercial variety (Melka dame). As a result, farmers had selected Hundaf variety in the first stage due it has higher pod/plant, bigger seed size, good seed color and higher number of seed/pods. On the contrary, the new variety from white speckled set (Dumal) performed less than Doyo in both districts and the mean yield difference between the two varieties is significant at less than 1% significance level. Similarly, farmers were also selected Doyo than the new variety according to their selection criteria. Therefore, based on the obtained yield difference and the farmers' preference, only Hundaf was suggested for further pre-scaling up.

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Pre-Extension Demonstration of Improved Dessi Type Chickpea (*Cicer Arietinum* L) Technologies in Mid Altitude of Bale and East Bale Zones

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Abstract

The activity was undertaken in Goro and Ginnir districts in 2020/2021 during the main cropping season with objective of demonstrating and evaluating improved desi type chickpea technologies under farmers' condtion. As a result, the improved variety, Melba, was compared and evaluated with Teketay variety (standard check). Six (6) representative trial farmers were selected as hosting farmer for physical implementation of this demonstration trial in which each variety was planted on a plot size of 10 m x 10 m side by side employing the recommended full packages. FRG approach was used to demonstrate and evaluate improved chickpea technologies by organizing mini field days at representative sites. Quantitative data such as yield data and number of farmers participated on mini field day and the qualitative data such as farmers' selection criteria and their feedback were collected. Descriptive statistics were used to analyze the quantitative data. Farmers' preference to varietal attributes of the demonstrated varieties was ranked using simple matrix ranking methods. The result of t-test indicated that Melba variety gave mean yield of 20.83 quintals per hectare with standard deviation of 1.76 over location while the standard check (Teketay) gave average yield of 16.75 quintals per hectare with standard deviation of 1.39. The result showed that the yield performance between the two varieties is significant at less than 5% significance level with the t-value of 4.08. Farmers also selected the improved variety Melba in the first stage because of its relative advantage over the standard check (Teketay) in terms of number of branch/plants, disease tolerance, number of seed/pod (2) and yield. Therefore, Melba variety is suggested for wider scaling up and further dissemination.

Key Words: Chickpea, demonstration, Farmers' criteria, FRG, Melba variety

Introduction

Chickpea is widely grown around the world and serves as a multi-use crop. The diverse agro-climatic conditions in Ethiopia make it very suitable for growing chickpeas. The country is also considered as the secondary center of diversity for chickpea (Anbessa and Bejiga, 2002). It is widely grown across the highlands and mid altitude areas of Ethiopia and used in rotation with several cereals like barley, teff or wheat. It also plays an important role in system productivity and sustainability of wheat production as a break crop in improving soil fertility through biological nitrogen fixation (can fix up to 60kg N/ha/year) (FAO and ICRISAT, 2015). Chickpea is considered less labor-intensive crop and its production requires less external inputs as compared to cereals.

It is an important food and cash crop for many households in Ethiopia. Out of the total grain crop area, 12.61% (1,598,806.51 hectares) was under pulses. Faba beans, haricot beans (white), haricot beans (red), and chick peas were planted to 3.45% (about 437,106.04 hectares), 0.71% (about 89,382.68 hectares), 1.71% (about 216,803.91 hectares) and 1.91% (about 242,703.73 hectares) of the grain crop area, respectively (CSA, 2018). During 2017/18 cropping season 242,703.73 ha of land was covered by chick peas and over 4,994,255.50 quintals was harvested with the average yield of 20.58 qt/ha at national level although its

potential is more than 5t/ha. In the same cropping season 92,829.49 ha of land was covered by chick peas and about 2,165,837.23 quintals were harvested with the average yield of 23.33 qt/ha in Oromia National Regional State (CSA, 2018).

The average yield of chick pea at national level is lower than its potential due to lack of improved varieties with associated recommended packages and poor cultural practices; low or no protection measures against weeds, diseases and insect pests (Bejiga et al. 1996). The usage of improved seeds with recommended agronomic and management practices is one of the most efficient ways of raising crop production, but in Ethiopia less than 10 percent of farmers use improved seeds (FAO, 2010). In line with this, the research system made a lot of efforts to address the bottleneck of farming communities and released for cultivation in the country about twenty (20) Kabuli and Dessi type chickpea varieties over the last three decades. Among these varieties, demonstration and validation results of ICARDA project revealed that Habru, Dhera, Arerti and Hora varieties (Kabuli types) and Dimtu, Teketay, Natoli and Mastewal (Dessi type) are high yielder, preferred and making an impact in mid agro-ecologies of the Eastern Shoa and Bale Zones of Oromia National Regional State, Ethiopia (Amare *et al.*, 2018).

On the other hand, less sincere efforts were initiated to disseminate these well adapted improved chick pea technologies in Bale and West Arsi zones either by private or public seed sectors. Thus, lack of access to improved chick pea varieties in mid land areas of Bale zone is the main problem that hampers production of this crop. Consequently, **Melba** variety (Dessi type) has recently released (in 2019) by SARC with yield potential of 34-38 qt/ha. The yield advantage of **Melba** over standard check (Akaki) is 16.47%. However, 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).

Therefore, participatory research and extension approach whereby stakeholders, mainly farming community actively participate in decision making and implementation from stage of problem identification through experimentation to utilization and dissemination of research results is by far crucial in addressing those problems. Thus, undertaking participatory demonstration, evaluation, validation, popularization and dissemination of improved chickpea technologies with the active participation of farmers and other stakeholders for sustainable production and productivity of the crop is paramount.

Objectives

- To evaluate the yield performance of improved chickpea technologies under farmers' condition
- To create awareness on the importance of improved chickpea technologies among farmers, DAs, SMSs and other participant stakeholders.
- To collect farmers' feedbacks on improved chickpea technologies for further development of pulse production

Methodology

Site selection and farmer selection

Participatory demonstration and evaluation of improved chickpea technologies was undertaken in Goro and Ginnir districts in 2020/2021 during the main cropping season. These districts were selected purposively as demonstration sites based on the potential for chickpea production. One operational kebele was selected from Goro district while two kebeles were selected from Ginnir district based on the existing potential for chickpea production and road accessibility. Farmers Research Group (FRG) approach was employed by enhancing the participation of none FRG farmers and the concerned stakeholders. Accordingly, in each kebele one (1) FRG was strengthened which consists of 15-20 members. From the formed FRG members in each kebele, two representative hosting farmers were selected in collaboration with SMSs, DAs and the members themselves. Accordingly, six (6) representative trial farmers were selected as hosting farmer for physical implementation of this demonstration trial

Field design and materials

Simple plot demonstration on 10m x 10m size of land was allotted for each variety. For chickpea, the spacing of 30 cm between rows and the recommended seed rate of 120 kg/ha was be used by drilling in the prepared rows. Shallow planting of 5 cm depth was employed in the presence of ample soil moisture. The fertilizer rate of NPS 100 kg/ha was applied at planting time. One recently released chickpea variety (**Melba)** was compared against Teketay (commercial variety).

Technology demonstration and evaluation approach

FRG member farmers and other follower farmers were encouraged to participate in the process of demonstration activities as well as on different extension events organized at each site. Mini-field days were organized at representative sites during variety evaluation and selection time (at maturity stage of the crop) to enhance the active participation of farmers in the process with researchers and other relevant stakeholders. Hence, before leading the participants to Focused Group Discussion (FGD), brief orientation was given to them on the objectives of technology evaluation and selection in research process. Then, the evaluators were grouped in to small manageable groups (by selecting and having one group leader and secretary). Then they oriented to set their own criteria of variety selection and finally, report the evaluation result through their respective group leader.

Extension Methods Used

In extension, there are no one-size-fits-all solutions. Hence, 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 demonstration activity.

Types of Data and Methods of Collection

Types of data collected include both quantitative and qualitative data. Accordingly, the collected quantitative data include: yield data, production costs (fertilizers, seeds, Labor, fungicides, herbicides, transportation and harvesting costs), local market price of the out puts at harvesting time, number of farmers participated on training, field visit, mini-field days. Similarly, qualitative data such as Farmers' feedback about the technology and farmers' variety selection criteria were recorded. These quantitative and qualitative data were collected using field observation, key informant interview and Focus group discussion (FGD.

Data analysis

Descriptive statistics were used to analyze the quantitative data. Farmers' preference to varietal attributes of the demonstrated varieties was ranked using pair wise and simple matrix ranking methods (Dan, 2012). Farmers' feedback toward the technology was assessed and narrated.

Result and Discussion

Yield Performance of the demonstrated varieties

Yield performance analysis was carried using t-test analysis. Accordingly, Melba variety gave average yield of 20.83 quintals per hectare with standard deviation of 1.76 while Teketay gave 16.75 quintals with standard deviation of 1.39. The result revealed significant yield difference between the demonstrated chickpea varieties at less than 5% significant level (Table 1).

Table 1: Yield difference between the demonstrated chickpea varieties

Varieties	Yield (Qt/ha)			t-value
	Mean	Std. Deviation	Mean Difference	
Melba	20.83	1.76	4.09	4.08**
Teketay	16.75	1.39		

Moreover, to consider the yield performance of the varieties in each demonstrated district the result was illustrated in the following bar-graph. Relatively, both varieties were performed better in Ginnir district than Goro district. Especially, Melba gave highest yield of 22.5 quintal per hectare in Ginnir district.

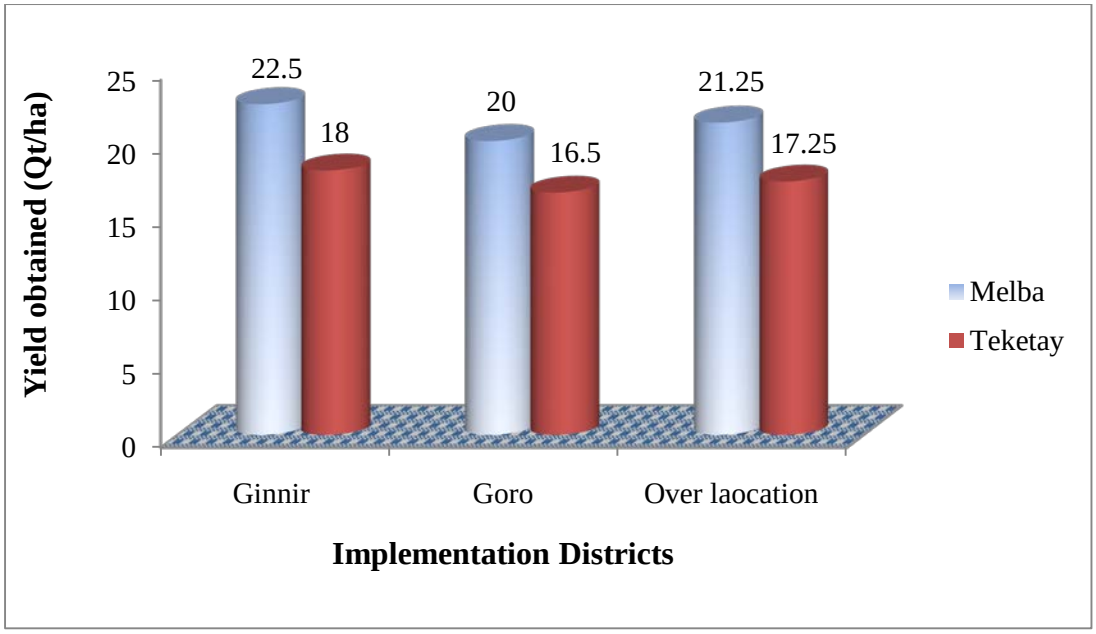

Figure 1: Yield performance of demonstrated chickpea varieties

Farmers' Preference

To identify farmers' preference participatory variety evaluation was carried out in which focus group discussions were carried out to compare and select best fit varieties based on farmers' selection criteria. About 47 participants were involved during variety evaluation and selection in two districts. Out of 47 total participants, 38 of them were farmers; of which five (4) of them were female participants and nine of them were agricultural experts. Accordingly, the summary of mini field day participants was illustrated in Table 2.

Table 2: Participants of Mini field days in Ginnir and Goro districts

	Farmers				
Districts	**Men**	**Women**	**Total**	**Experts**	**Total**
Ginnir	18	2	20	5	25
Goro	15	3	18	4	22
Total	33	5	38	9	**47**

Finally, farmers selected the improved variety Melba in the first stage; because, the variety is relatively better than the standard check (Teketay) in terms of number of branch/plant, disease tolerance, number of seed/pod (2) and yield. The result of farmers' preference towards the demonstrated chickpea varieties was summarized in the Table 3.

Table 3: Farmers' preference towards demonstrated varieties

No	Varieties	Rank	Reasons
1	Melba	1st	- Higher number of branch/plant, more tolerate disease, higher number of seed/pod (2), high yielder. - But, it has small seed size.
2	Teketay	2nd	- Bigger seed size, high yielder. But, lower number of branch/plant, less tolerant to disease, lower seed/pod (1).

Conclusion and Recommendations

A recently released desi type chickpea variety, Melba, was demonstrated against the standard check (Teketay). The result of t-test indicated that Melba variety gave mean yield of 20.83 quintal per hectare with standard deviation of 1.76 over location while teketay gave average yield of 16.75 quintals per hectare with standard deviation of 1.39. The result showed that the yield performance between the two varieties is significant at less than 5% with the t-value of 4.08. Finally, farmers had selected the improved variety Melba in the first stage; because, the variety is relatively better than the standard check (Teketay) in terms of number of branch/plant, disease tolerance, number of seed/pod (2) and yield. Therefore, Melba variety is suggested for pre-scaling up.

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Participatory Demonstration and Evaluation of Cassava Technology in Lowlands of Borana, Southern Oromia, Ethiopia

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Abstract

The activity was conducted in the Yabello district of Borana zone to evaluate the productivity and profitability of improved cassava varieties, creating awareness, improving farmers' knowledge and skill under agro pastoralists' condition. A total of 24 agro-pastoralists were involved for the two consecutive years (2019-2020). Two improved cassava (Kelo and Kule) varieties were used for this study. As these technologies are new for the pastoral community, target agro-pastoralist, Development agents (DAs), and experts of the district are well trained before the start of the demonstration. The result showed that the average total tuber yield ranges from 4.0 to 4.61 ton/ha. Under agro-pastoralist conditions, the Kelo variety gave a higher tuber yield (4.48 ton/ha) while the average yield of Kule was 4.1 ton/ha. In the study area, agro-pastoralists were given training on steps of cassava processing and utilization of cassava with the mix of wheat flour. Accordingly from cassava processed root flour with the mix of wheat Cookies, Bobolino, and Kita food types were made. Based on agro pastoralists' set selection criterion, Kelo variety was ranked first followed by Kule. Therefore, the Kelo variety should be more popularized in the study areas by all concerned bodies.

Keywords: Cassava, Food processing, and utilization, Demonstration

Introduction

Cassava (Manihot esculenta Crantz) together with maize, sugar cane, and rice constitute the most important source of energy in the tropics. Native to South America (Olsen and Schaal 2001), cassava was domesticated about 50000 years ago and has since been extensively cultivated in the tropics and sub-tropics of the continent (Bernando and Ceballos, 2012).

Cassava (Manihot esculenta Crantz) is grown by smallholder farmers in more than 100 tropical and subtropical countries. Thanks to its efficient use of water and soil nutrients, and tolerance to drought and sporadic pest attacks, cassava can produce reasonable yields, using few if any inputs, in areas with poor soils and unpredictable rainfall. The roots of cassava are very rich in carbohydrates, which makes them an important source of dietary energy. They can be consumed fresh after cooking, processed into food products, or fed to livestock. Cassava root starch can be used in a wide array of industries, from food manufacturing and pharmaceuticals to the production of plywood, paper, and bio-ethanol. In some countries, cassava is also grown for its leaves, which contain up to 25 percent protein. The global average yields have increased by almost 1.8 percent a year over the past decade, to 12.8 tons per hectare. With better crop and soil management, and higher-yielding varieties more resistant to drought, pests, and diseases, cassava could produce average root yields estimated at 23.2 tones (FAO, 2013).

Cassava was introduced into Africa from Brazil in the 16th century, can grow and produce reasonable returns even under very poor soil and climatic conditions. It has now become one of the continent's leading food crops, giving Africa a worldwide leader. (Nweke, 1992). Even if the introduction of the crop to Ethiopia is not well documented, its cultivation counted

more than a century. But, it is mainly cultivated by small resource-poor farmers on smallholding plots of land (Tesfaye et al., 2013). Moreover the bulk of its production is situated in the south, southwestern, and western parts of the country, and most of the varieties are low yieldings, bitter type, and containing high hydrogen cyanide (Anshebo *et al*., 2004).

Cassava is a potentially high yielding root crop of South American origin. It was introduced into Africa by Portuguese traders during the sixteenth century (Carter et al. 1992). No specific production skills are required to grow cassava, which tolerates drought, acidity and low soil fertility (Asher et al. 1980, Hahn et al. 1987). The potentially high yields of cassava (up to 50 tones ha-', or approximately 20 tones ha-' dry mass basis; Pakpahan et al. 1993) can guarantee farmers food from small cropped areas. In Borana lowlands NGO called Lutheran is introducing and familiarizing with Borana people on processing and consumption of the crop. Drought tolerant cassava may be an acceptable alternative crop for borana lowland.

In Borana lowlands, the cassava varieties are not well known among pastoral community. As a result, Yabello Pastoral and Dryland Agriculture research centre brought two improved cassava varieties from other research centers and has undertaken adaptation trail of cassava varieties at Miyo district of Borana zone on irrigation bases for the last years.

As indicated on the evaluation of this research activity, two improved cassava varieties, namely Kule (104/72 Nigeria red) and kelo (44/72 red) were highly performed in the study area. Therefore, this specific activity was initiated for further promotion of these varieties in the selected Yabello district of Borana zone.

Materials and Methods

Site and agro-pastoralists Selection

Yabello district and one peasant association (Qadalle) was selected purposively by the researchers in collaboration with experts and development agents (DAs) of the Yabello office of agriculture and natural resources. The site was selected based on accessibility to the road and availability of irrigation water. Two FRGs (Farmers Research Groups) were established in the PA with 12 (twelve) members and a total of 24 agro pastoralists were involved in the activity.

Research Design

The trial was undertaken on agro-pastoralists land in the selected PA. For this activity, two improved cassava varieties Kelo (44/72 red) and kule (104/72 Nigeria red) were used and planted on a plot size of 10m x 10m with 25 cutting per plot.

Training and field day organized

Training is very important tool for awareness creation and to bring improvement in filling the gap between skill, knowledge and attitude of the farmers towards new technologies. As the cassava variety is new for the pastoral community, the training was given in two phases. In the first phase, a theoretical training was given on the importance, production and productivity of cassava. In the second phase, practical training was given on the steps that should be followed in the food processing of cassava by the invited food scientists from Oromia Agricultural Research Institute. During training different professional researchers were participated and shared their knowledge and skills through PowerPoint presentation and

distribution of extension materials like leaflets and manuals. At the physiological maturity stage of the crop, a mini-field day was conducted to communicate the result to the members as well as non-members of the target group. Finally, the result was communicated through training and extension materials such as leaflet, PowerPoint and manual. In this min-field day, a total of 30 agro pastoralists, out of which 10 females and 20 males were participated.

Method of Data Collection

Both quantitative and qualitative data were collected during research implementation. The quantitative data was collected through measuring of data and using check lists format while qualitative data was collected through personal observation, interview of agro pastoralists and their feedback and focus group discussion. Yield data, farmers' preference and crop with cassava ratio of data were the major types of data collected during demonstration process.

Method of Data analysis

Quantitative data collected from the field was analyzed using simple descriptive statistics by SPSS version 20. The qualitative data collected through focus group discussion and field observation were analyzed using narrative and argument. Moreover, a simple knowledge test was also used to compare agro pastoralists' knowledge level before and after demonstration period related with the newly introduced cassava varieties.

Result and Discussion

Training of farmers, development agents and experts

Intensive knowledge and skill based training from the start of the activity up to food utilization were given for the target group. A total of 36 trainees were participated in theoretical and practical training. Among the trainees, 28 were agro pastoralists, 4 were development agents (DAs) and the rest 4 were experts. Out of the trained participants 14 (38.9%) were females while the remaining 22(61.1%) were males. The training has been given by multidisciplinary team on cassava production, productivity, management, input utilization and application method, disease and insect control mechanisms as well as its information exchange. Twenty manuals were prepared and delivered for the participant.

Table 7. Number of participants taken training on the importance and processing of Cassava

S. No	Participants	Sex		Total
		Male	Female	
1	Agro pastoralists	18	10	**28**
2	Experts (SMS)	2	2	**4**
3	Development Agents	2	2	**4**
	Grand Total	**22**	**14**	**36**

Source: Own computation, 2020

Yield performance of demonstrated varieties

The average yield (ton/ha) of improved demonstrated cassava varieties (kule and kelo) were 4.2 and 4.61, and 4 and 4.35 ton/ha during 2019 and 2020 cropping season respectively. The two years result indicated that the average yield of kelo variety was higher than that of kule.

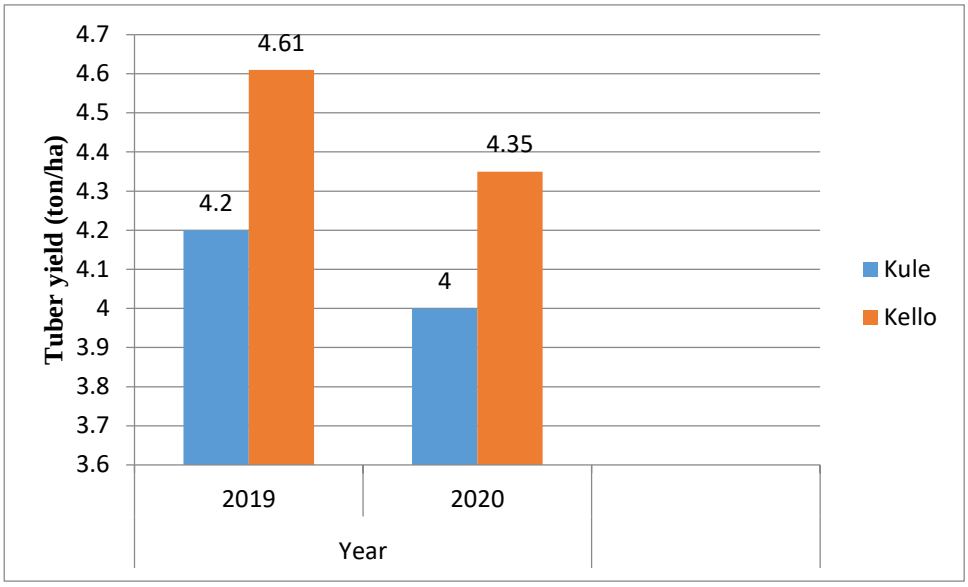

Figure 1. Average yield obtained from Cassava varieties

Source: Own computation, 2019-2020

Cassava utilization, food taste and farmers varietal preference

During the demonstration and training, food processing of cassava processed root with the mixture of flour. Kukus, kita, Bobolino were the major types of food prepared and tested during cassava food processing. The mixing ratio of cassava with wheat at 75% and 25%, 50% and 50%, respectively and finally 100% cassava only were used for food utilization. In the case of cassava and wheat mixing with 75% and 25%, Kelo was the most preferred taste and first rank in food utilization followed by kulo mixing with wheat. Similarly, in the case of cassava and wheat mixing at 50% and 50% kelo mixing with wheat was the most preferred taste and first rank in food utilization followed by Kule variety.

Among the mixing ratio, 50% cassava and 50% wheat flour mixture were the most preferred and selected by agro pastoralists' interest for both Kelo and Kule varieties.

Table 8. The Cassava and Wheat flour mixing ratio and food utilization (n-24)

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

Source: Own computation, 2020

Knowledge Level Before and After the Trial Period

Knowledge level and skills of experimental agro pastoralists' on various aspects of improved Cassava production technologies before conducting the demonstration and after implementation was measured and compared. A simple yes or no questions was designed and agro pastoralists were asked to rate their level of knowledge before and after the demonstration period. Agro pastoralists were subjected to the same questions at both occasions. The questions were asked during training period before starting the experiment and after the experiment. According to the findings, before experiment only 8.3 of the agro pastoralists had information about cassava and know about the importance of cassava while the remaining 91.7% of agro pastoralist did not have any information about cassava. However, after the intervention all the participants agro pastoralists 24(100) have responded as they know about importance, steps to be followed in food processing of cassava and know how to mix cassava with wheat flour to make different types of food.

Table 9. Agro pastoralists' knowledge level before and after the trial period (n-24)

	Before trial		After trial	
Statement	Yes (%)	No(%)	Yes(%)	No(%)
Had information about Cassava	2(8.3)	22 (91.7)	24(100)	0 (0)
Know about importance of Cassava varieties	2(8.3)	22(91.7)	24(100)	0 (0)
Know the steps to be followed in food processing of cassava	0(0)	24 (100)	24(100)	0 (0)
Know how to mix cassava with wheat flour and make different food types	0(0)	24(100)	24(100)	0 (0)

Source: Own survey result, 2019-2020

Conclusion and Recommendations

Two varieties (Kelo and Kule) were evaluated with the objective of evaluating the productivity and profitability and identifying the best performing cassava varieties with full package. It was carried out on two established FRGs during 2019 to 2020 cropping season in Yabello district Qadalle Peasant Association on irrigation bases. The trial was undertaken on agro-pastoralists land in the selected PA. For this activity, two improved cassava varieties Kelo and kule were used and planted on a plot size of 10m x 10m with 25 cutting per plot.

The quantitative data was collected through measuring of data and using check lists format while qualitative data was collected through personal observation, interview of agro pastoralists and their feedback and focus group discussion. Quantitative data collected from the field was analyzed using simple descriptive statistics by SPSS version 20. The qualitative data collected through focus group discussion and field observation were analyzed using narrative and argument. Moreover, a simple knowledge test was also used to compare agro pastoralists' knowledge level before and after demonstration period related with the newly introduced cassava varieties.

In general, the result of the study revealed that during food processing of cassava, the mixing ratio of 50% Cassava and 50% wheat was ranked 1st followed by 75% and 25% for both kelo and kule varieties. Moreover, the result of the study showed that Kelo variety was high yielder and the most preferred and selected by agro pastoralists' during food processing with wheat flour at different mixing ratio as compared to Kule. Therefore, the Kelo variety should be more popularized in the study areas by all concerned bodies such as buereau of agriculture and natural resource, research institutions, universities and NGOs.

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Participatory Evaluation of Rangeland Forage Improvement Technologies in Lowland Areas of Borana Zone, Southern Ethiopia

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Abstract

The activity was carried out at the Dirree and Elwayaa districts of Borana Zone, southern Oromia for three consecutive years. The objectives of the study were to improve rangeland productivity, utilization, and conservation systems. The districts were selected based on the priority of the pastoral community. Accordingly, a total of 5.4 hectares of bush encroached rangeland (2.7 ha each district was selected). The experiment had six treatments which include;0% thinning(Trt 1),0% thinning Plus Fire(Trt 2), 50% Thinning(Trt 3), 50% thinning plus Fire(Trt4), thinning at 100% intensity only(Trt5)and thinning at 100% intensity and application of fire(Trt6) replicated three times. The treatments were applied on 18 different plots with an area of 30mx50m each. A fire break of 10m in width was laid out in between each experimental plot. The plots were located adjacently on a homogenous area and treatments were allocated randomly to the plots. Two pastoralist research groups (PRGs) consisting of 10 members were established at each district. The training was given for the established PRGs. Both quantitative and qualitative data were collected and analyzed using SAS software, content, and narrations. The result of the study revealed that a significant effect among treatments was observed for NGSR (Non-grass species richness), BC(Basal Cover), and LC(Litter Cover) were significantly ($P < 0.05$) higher for T4 and T6 while BC was significantly ($P < 0.05$) higher in T6 than the other treatments in Elwayaa district. On the other hand, Grass biomass was significantly ($P < 0.05$) higher for T4 while NGB was significantly ($P < 0.05$) higher for T6. Moreover, a higher percentage of BC was attained for T4 and T6. Moreover, the higher percentage of BC was attained for T4 and T6 at Dirre site. The result of Focus Group Discussion also showed that the treatment1, 4, and 6 were outperformed in terms of GB, NGSR, NGB, and BC at both districts. Therefore, treatments 1, 4, and 6 should be popularized and scaled up in the study areas and similar agro-ecologies.

Key Words: Rangeland, PRGs, Thinning, Focus Group Discussion

Introduction

Rangelands are areas of the world, which because of physical limitations, such as low and erratic precipitation, rough topography, poor drainage, or cold temperatures are unsuited for cultivation and which are a source of forage for free-ranging native and domestic animals, as well as a source of wood products, water, and wildlife (Stoddert *et al*., 1975). The Borana lowlands are among the major rangelands in Ethiopia where different animal species and plant diversities and Borana pastoralists' livelihood primarily depend on. Until the early 1980s, the Borana pastoral production was considered to be one of the few remaining sustainable pastoral systems in East Africa (Cossins and Upton, 1987). Since then, the savannah ecosystem of southern Ethiopia has been experiencing greater cattle population die-offs during periodic droughts (Cossins and Upton, 1988a; Desta and Coppock, 2002) and

deterioration of the range as evidenced by the proliferation of bush encroachment and a general decline in forage production (Oba et al., 2000b).

The past development interventions planned for the improvement of rangelands and living conditions of local communities in Ethiopia failed to identify and apply the appropriate rangeland management options because a top-down approach was followed, no attempt was made to deal with pastoralists' problems using a holistic approach, and policymakers failed to understand the pastoral dynamic system (Tafesse Mesfin, 2001). Consequently, development projects implemented in pastoral rangelands of Ethiopia contributed to rangeland degradation (Coppock, 1994), which is characterized by a reduction in the quantity (biomass) and/or nutritional quality of the available vegetation (IFAD, 2003). A decrease in herbaceous productivity of the rangeland has a direct impact on livestock production, on which the livelihood of Borana pastoralists depends. The average annual primary production of the Borana rangeland is estimated at 2000 g DM ha^{-1} yr^{-1}, which might drop in drought years (Cossins and Upton, 1988b). Considerable variation in primary productivity between sites and seasons is also likely (Upton, 1986). In the Borana rangelands of southern Ethiopia, official suppression of fire in the early 1970s is perceived to have promoted the rapid expansion of bush encroachment (Oba et al., 2000). By the mid-1980s about 40% of the Borana rangelands had been affected by bush encroachment (Eshete, Bille and Corra, 1986), while recent estimates found bush encroachment at 52% of the total rangelands (Gemedo-Dalle, 2004). However, trees may have positive effects on grass growth where plants sparsely populated up to 200 woody plants/ha. The relatively high nutrient status of soil under tree canopies would be expected of the grass growing under the tree (Archer, 1990). Therefore, rather than clearing the whole invasive tree/shrub species, thinning at some thinning percentage should be focused. Currently, the adverse effects of bush encroachment on the performance of the pastoral economy are being acknowledged. Local and international non-governmental organizations and some government departments are conducting range rehabilitation, involving hand clearing of woody species along highways and near settlements, on an experimental basis. So far, little is known about the effects of bush encroachment control in terms of the responses by the encroaching woody species. It is undeniable fact that Borana pastoral and agro-pastoral settings have been encroached by bush, shrubs, and trees over time, which has resulted in a loss of potential grazing sites within the settings being the most pressing development challenge in the locality. This fact, indeed needs appropriate intervention timely, on research evidence-based and scientifically justifiable and sound technological approaches. Therefore, this project was designed to address the following objectives:

Objectives

- To improve rangeland productivity, utilization, and conservation systems in Borana pastoral areas
- To test the effectiveness of bush thinning with the combination of fire
- To understand the perceptions of the communities on the impacts of currently available bush thinning technologies

Material and methods

Description of the study area

The study was implemented in the Elwaya and Dire districts of the Borana zone. Yabello, the capital of Borana zone, is located at a distance of 565km south of Addis Ababa while Dire is located South of Yabello district. The Borana rangelands are found at the south most of the Ethiopian lowlands occupying a total land area of about 95 thousand square kilometers (McCarthy, Kamara and Kirk, 2002). They are located at 4-6^{0}N and 36-42^{0}E sloping gently from 1600masl in the North East to about 1000masl in the extreme South that borders Northern Kenya and about 1780masl in the central vicinity. The area is still predominantly in pastures comprised of flat plains forming the main parts of the range. There are occasional mountains, massive valleys, and depressions. Occupied almost entirely by pastoral populations, resource use on the Borana rangelands is largely communal, though with crop cultivation and private enclosures that appear to be increasing in recent decades. Rainfall delivery is bimodal; with the long rains accounting for 60% of the total rainfall falling between **March and May** and the short rains comprising 27% of the total rainfall falling between **September and November**. There is spatial and temporal variability in both the quantity and distribution of rainfall with an average annual rainfall varying from 353mm to about 900mm per annum (McCarthy, Kamara, and Kirk, 2002). A cool dry season occurs from June to August, while a warm dry season occurs from December to February.

Site and bush species selection

A total of 5.4 hectares area (2.7 ha of rangeland encroached by the target species was selected from each district). Based on the priority of the pastoral community, the top two encroacher tree/shrub species for the two respective districts were selected. The selection of the encroacher tree species was based on their relative dominance over the respective districts. The most encroaching trees that have covered a wide range of grazing lands were identified and prioritized together with a pastoral community (elders, Abba dheda, Abba reera, Abba olla) and other stakeholders through participation and discussion. During the project conduction, indigenous knowledge of the community -was promoted through a participatory approach. Among the many encroaching tree species, the three noxious or harmful species were selected for the program in such a way that one species was assigned to one district and the same thing was applied for the rest of the species with the respective districts. In the implementation process, technical support and supervision were given and made by the research staff, pastoralist research group (PRG) members, and concerned bodies. Monitoring and evaluation were carried out by the PRG pastoral community, a multi-disciplinary team of researchers, extension workers, and stakeholders.

The selected 5.4 hectares of bush encroached rangeland (2.7ha from each district was selected). Six treatments were replicated three times. The total plots were 18 with an area of 30mx50m each. The treatments had a combination of I) 0% Thinning II) 0% Thinning Plus Fire III) 50% Thinning IV) 50% Thinning plus Fire V) Thinning at 100% intensity only VI) Thinning at 100% intensity and application of fire. A fire break of 10m in width was laid out in between each experimental plot. The plots were located adjacently on a homogenous area and treatments were allocated randomly to the plots. The target species was marked during the cutting process and the areas were fenced using locally available materials in consultation with the community. After two years of the research conduction, hay production for smallholder pastoralists was enhanced and economical efficiencies of forage hay production

and economical benefit of livestock class benefited from the produced hay will also be estimated.

Two Pastoralists' Research Group (PRGs) were established having 10 members at each site. The training was given for the FRGs members by a multidisciplinary research team composed of range ecologists, agricultural extensionst and feed scientists on the concept of bush thinning, formation of PRGs and its role in technology adoption, how closely monitor and conduct research together with researchers and other stakeholders.

Moreover, a focus group discussion was held with the key informant, Experts, and development agent to further find out which treatment is the most promising in improving rangeland forage in the study area.

Data types and methods of collection

Quantitative data such as: basal cover, litter cover, herbaceous layer species richness, dry matter yield of grass and non-grass species were collected through different spread sheet While qualitative data were collected through Focus group Discussions and personal observation

Data Analysis

A qualitative data was analyzed using SAS software version 9.3 while qualitative data were analyzed through narration.

Result and discussions

The effect of bush controlling techniques on vegetation attributes

Table 1 presents the DM production above ground biomass yield for grass and non-grass species in kg/ha-1, species richness for grass and non-grass in number, basal cover, and litter cover in percentage across the treatments at Elwaya district. Accordingly, the dry matter production of grass biomass (GB) and non-grass biomass(NGB) as well as grass species richness (GSR) did not show any significance ($P > 0.05$). Although there was no statistically significant differences observed among the treatments- T6, T1, and T5 they were outperforming as compared to the others. On the other hand, a significant effect among treatments was observed for NGSR, BC, and LC. The NGSR was significantly ($P < 0.05$) higher for T4 and T6 while BC was significantly ($P < 0.05$) higher for T6. Moreover, a significantly higher LC was attained for T4 and T6 than the other treatments.

Table 1: Mean values for vegetation attributes across treatments in Elwayaa district

Treatments	GB (Kg/ha)	GSR (n)	NGB (Kg/ha)	NGSR (n)	BC (%)	LC (%)
1	1712±953.77	2±0.26	126±57.39	1.5±0.22^{ab}	21.6±4.22^{b}	43.27±8.48^{b}
2	747±152.56	2±0.17	108±34.57	1±0.00^{b}	24±3.31^{b}	50.46±3.29^{ab}
3	1227±269.21	2±0.21	108±40.92	1.33±0.21^{ab}	31.13±4.4^{ab}	56.18±4.24^{ab}
4	869±136.88	2±0.0	75±29.11	1.67±0.21^{a}	30.75±4.28^{ab}	61.77±7.62^{a}
5	1900±971.6	2±0.26	103±25.49	1.33±0.21^{ab}	31.14±3.9^{ab}	54.27±3.52^{ab}
6	2869±1487.15	2±0.17	123±55.54	1.67±0.21^{a}	38.65±5.32^{a}	62.67±5.16^{a}
P-value	0.36	0.77	0.93	0.04	0.04	0.04

Means with the same letter superscripts along the columns are not statistically significant at α value of 0.05 level of significance

Note: T1= 0% thinning, T2= 0% thinning + Fire, T3= 50% thinning, T4= 50% thinning + Fire, T5=100% thinning, T6= 100% thinning + Fire

GB= Grass Biomass; **GSR**= Grass Species Richness; **NGB**=Non-grass Biomass; **NGSR**=Non-grass species richness; **BC**=Basal Cover; **LC**= Litter Cover.

Table 2 presents the mean values for vegetation attributes of grass biomass, grass species richness, non-grass biomass, non-grass species richness, basal cover and litter cover before and after treatments application at Elwayae district. There were no significance differences between before and after treatment application for GSR, NGSR, BC and LC in the study area. However, GB and NGB were significantly ($P < 0.05$) higher during after treatment application than before treatment application. Hence, treatment application favored both grass biomass and non-grass biomass. However, applying the mentioned treatments to bush encroachment did not favor grass species richness, non-grass species richness, basal cover and litter cover.

Table 2: Mean values for vegetation attributes between before and after treatment applications in Elwayaa district

Period of application	GB (Kg/ha)	GSR (n)	NGB (Kg/ha)	NGSR (n)	BC (%)	LC (%)
Before	635.63±87.22^{b}	1.78±0.10	165.87±25.28^{a}	1.28±0.11	28.37±2.89	57.47±4.27
After	2472.42±603.11^{a}	2±0.11	48.17±6.31^{b}	1.56±0.12	30.72±2.41	52.07±2.34
P-value	0.005	0.17	0.0004	0.07	0.52	0.24

Means with the same letter superscripts along the columns are not statistically significant at α value of 0.05 level of significance

Note:**GB**= Grass Biomass; **GSR**= Grass Species Richness; **NGB**=Non-grass Biomass; **NGSR**=Non-grass species richness; **BC**=Basal Cover; **LC**= Litter Cover.

Table 3 presents the above ground biomass yield for grass and non-grass species in kg/ha-1, species richness for grass and non grass in number, basal cover and litter cover in percentage across the treatments at Dire district. Accordingly, GSR, NGSR and LC did not show any significant difference among treatments ($P > 0.05$). Although non- significant, T6, T1 and T5 were out performing as compared to others. On the other hand, GB, NGB and BC showed a significant difference among treatments. Grass biomass was significantly ($P < 0.05$) higher for T4 while NGB was significantly ($P < 0.05$) higher for T6. Moreover, higher percentage of BC was attained for T4 and T6.

Table 3: Mean values for vegetation attributes across treatments in Dirre district

Treatments	GB (Kg/ha)	GSR (n)	NGB (Kg/ha)	NGSR (n)	BC (%)	LC (%)
1	1071.8±79.55^{ab}	2.2±0.21	172.93±29.39^{b}	1.5±0.25	37.77±11.73ab	51.03±11.5
2	602.53±260.44^{b}	2.2±0.46	105.76±39.41^{b}	1.87±0.39	28.92±11.28^{b}	43.9±8.07
3	1173.87±401.32^{ab}	2.03±0.35	242±87.83^{b}	1.7±0.51	46±13.56^{ab}	50.83±11.92
4	1537.07±297.96^{a}	1.77±0.31	217.87±73.80^{b}	2.07±0.56	50.4±11.29^{a}	64.6±8.26
5	1130.67±342.45^{ab}	2.07±0.25	194.53±61.15^{b}	1.5±0.33	37.53±10.07^{ab}	44.32±10.17
6	1272.3±298.86^{ab}	1.93±0.23	513.73±160.79^{a}	1.33±0.17	54.63±14.41^{a}	65.03±12.41
P-value	0.04	0.76	0.05	0.46	0.03	0.26

Means with the same letter superscripts along the columns are not statistically significant at α value of 0.05 level of significance.

Note:**GB**= Grass Biomass; **GSR**= Grass Species Richness; **NGB**=Non-grass Biomass; **NGSR**=Non-grass species richness; **BC**=Basal Cover; **LC**= Litter Cover

T1= 0% thinning, T2= 0% thinning + Fire, T3= 50% thinning, T4= 50% thinning + Fire, T5=100% thinning, T6= 100% thinning + Fire

Table 4 presents the mean values for vegetation attributes of GB, GSR, NGB, NGSR, BC and LC before and after treatment application at Dirre district. A non-significant effect between before and after treatment application was attained for NGB in study area. Although there was no significant difference observed, higher NGB was observed for after treatment application However, GB, GSR, NGSR, BC and LC showed significantly ($P < 0.05$) higher for after treatment application than before treatment application.

Grass biomass was increased from 836.49±120.41 kg/ha before the treatment application to 1426.28±191.0 kg/ha after the treatment application. Moreover, GSR and NGSR were increased from 1.56±0.12 and 2.51±0.14 and 1.06±0.06 before treatment application to 2.51±0.14 and 2.27±0.23 after treatment application, respectively. These could be due to the effect of treatment application which reduced the dense stands of bush encroachment. This finding is in agreement with Bikila et al (2014) who reported that biomass, species composition; basal cover and litter cover for herbaceous species were significantly increased following the application of bush control techniques.

Basal cover was significantly increased from 20.15±2.84 % before the treatment application to 64.93±5.35 % after the treatment application (Table 4). The high basal cover after treatment application could be associated with reduced soil erosion as a result of regenerated grass and non-grass species that is species richness and reduced encroaching tree species. Litter cover was significantly increased from 36.94±4.05% before the treatment application to 69.63±5.11 % after the treatment application. This could be justified by the fact that incremental in basal coverage percentage and the newly introduced grasses and non-grasses species after the treatment application.

Table 4: Mean values for vegetation attributes between before and after treatment applications in Dirre district

Treatment application period	GB (Kg/ha)	GSR (n)	NGB (Kg/ha)	NGSR (n)	BC (%)	LC (%)
Before	836.49±120.41[b]	1.56±0.12[b]	230.89±67.01	1.06±0.06[b]	20.15±2.84[a]	36.94±4.05[b]
After	1426.28±191.03[a]	2.51±0.14[a]	251.39±43.44	2.27±0.23[a]	64.93±5.35[b]	69.63±5.11[a]
P-value	0.01	0.0001	0.78	0.0001	0.0001	0.0001

Means with the same letter superscripts along the columns are not statistically significant at α value of 0.05 level of significance

Note:**GB**= Grass Biomass; **GSR**= Grass Species Richness; **NGB**=Non-grass Biomass; **NGSR**=Non-grass species richness; **BC**=Basal Cover; **LC**= Litter Cover

In addition to the result of descriptive statistics, Focus Group Discussions was held with the key informant, Experts, and development agent to further find out which treatment is the most promising in improving rangeland forage in the study area. Accordingly, the result of the focus group discussions have also confirmed that T4(50% thinning and fire application) and T6 (100% thinning and fire application) as the best treatment to improve forage range lands at both sites.

Conclusions and Recommendation

This study was conducted in Dirre and Elwaya districts of lowlands of Borana zone for the three consecutive years (2018-2020) with the objective of improving rangeland forages. The result of the study showed that at Elwaya NGSR (Non-grass Species Richness), BC(Basal cover) and LC(Litter Cover) was significantly higher for 100% thinning and fire application. Moreover, a significantly higher percentage of LC was attained for T4 (50% thinning and fire application) and T6 (100% thinning and fire application) at Elwaya district.

The vegetation attributes for GB, GSR, NGSR, BC and LC were significantly ($P<0.05$) higher for after treatment at Dirre than before the treatment application. GB was significantly higher for T4 (50% thinning and fire application) while NGB was significantly higher for T6 (100% thinning and fire application). Furthermore, higher percentage of BC was attained for T4 (50% thinning and fire application) and T6 (100% thinning and fire application) at Elwaya district. The study have also shown that the production of GB, GSR, NGSR, LC and BC were improved due to the application of T4 (50% thinning and fire application) and T6 (100% thinning and fire application).

Moreover, a focus group discussion was held with the key informant, Experts, and development agent to further find out which treatment is the most promising in improving rangeland forage in the study area. Accordingly, a total of 2 FGD; one in each sites having 10 household members were conducted. During focus group discussion, pastoralists, experts and Development Agents have also identified T4 and T6 as the best treatment to improve forage range lands at both sites. During focus group discussion, Pastoralists experts and Development Agents have also identified T4 and T6 as the best treatment to improve forage range lands at both sites. Therefore, Both T4 (50% thinning and fire application) and T6 (100% thinning and fire application) were recommended for further demonstration to improve rangeland forage in the study area and similar agro ecologies of Borana Zone.

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Participatory Demonstration and Evaluation of Improved Haricot Bean Technologies in lowlands of Borana, Oromia National Regional State, Ethiopia

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Abstract

The study was conducted in Yabello district of Borana zone with the objectives of demonstrating and evaluating the productivity and profitability of haricot bean varieties, creating awareness, improving farmers' knowledge and skill and enhance linkage among the relevant stakeholders for the two consecutive years, 2020-2021. A total of fourteen (14) trial farmers were selected from two potential haricot bean growing peasant associations. Two FRGs having 30 farmers were established at each peasant associations .Two improved haricot bean varieties, Gofta and SER-119 and one local variety were planted each on a plot size of 10mx10m. Trial farmers were used as replication. Training on which a total of 40 participants took part was organized at Yabello Pasroral and Dryland Agriculture Research Center. Haricot bean varieties were evaluated based on their yield, storability and disease tolerance. Agronomic and yield data were collected and analyzed using descriptive statistics. Based on the yield data, 20.2 qt/ha, 13.7qt/ha and 14.1 qt/ha were obtained from Gofta, SER-119 and local (Kulo) varieties, respectively. Gofta has 43.2 % yield advantage over local check. Thus, Gofta ranked first at both sites and is recommended for pre-scaling up in the study area.

Key words: Gofta, SER-11, Demonstration

Introduction

Common bean (*Phaseolus vulgaris L.*) is one of the most important pulse crops grown in Ethiopia in terms of both area and quantity produced. The crop is cultivated in different parts, mainly Oromia, Amhara, and Southern Nations Nationalities and Peoples Region (SNNPR). Their share of the national common bean production is 51% for Oromia, 24 % for Amhara, and 21% for SNNPR (CSA, 2018). Almost all common beans are produced under rain-fed conditions by smallholder farmers on less than 0.5 hectares (Ephrem, 2016). The crop is one of the most important cash crops and sources of protein for farmers in many lowlands and mid-altitude zones. It is also widely intercropped with maize and sorghum to supplement farmers with additional income and to maintain soil fertility (IBC, 2012). Common bean farmers preferred the crop because of its fast maturing characteristics that enable households to get the cash income required to purchase food and other household needs when other crops have not yet matured (Berhanu et al., 2018).

The area under haricot bean production in Ethiopia in general and in Oromia in particular during the 2020 cropping season was 140,541.7 and 110,597.54 hectares and the production of the crop was 2,427,735.5 and 2,065,813.29 respectively. In the meantime, the average productivity of the crop was 17.5 and 18.78 qt/ha respectively (CSA, 2020). Ethiopian agriculture accounts for 85% of employment (Dercon et al., 2012). On the other hand, the population of the country is increasing alarmingly than ever before. As a result, farm size would be rapidly decreasing, increasing the need for agricultural intensification (Henday et al., 2014). Therefore, increasing the productivity of smallholders through newly improved technology has become a policy priority for development partners and the Ethiopian government.

In the Yabello district, Haricot-bean is the second major staple food crop grown by agro-pastoralists next to teff. The crop production system has been tempted by various factors like a weed, insects, diseases and lack of improved seed besides its infant experience and environmental stress (Dirriba *et al.*,2018). Based on these problems, the Pulse and oil research team of Yabello Pastoral and Dryland Agriculture Research Centre has undertaken adaptation trials on newly released varieties for the two consecutive years and recommended Gofta and SER-119 for moisture stress of Borana zone, and the study was limited to on-station only. Therefore, to fill this research gap agricultural extension research team has proposed to demonstrate and evaluate these varieties under farmers' conditions.

Research Methodology

Research Design

Two haricot bean varieties, Gofta and SER-119, and one local check (Kulo) were planted each on a plot size of $100m^2$ (10m x 10m) on farmers' fields. A seed rate of 80kg/ha and 100kg NPS/ha were used with a line spacing of 40cm and 10cm between rows and plant respectively.

Technology evaluation and demonstration methods

The evaluation and demonstration of the activity were conducted on farmers' fields to create awareness about the importance of improved haricot bean and its full package. The demonstration of the research was followed the result demonstration approach by involving FRG, development agents, and experts throughout the stage of the crop. Finally, the activity was jointly monitored and evaluated by FRG, development agents, experts, and multidisciplinary research team.

Data collection

Both quantitative and qualitative data were collected through appropriate data collection methods such as an individual interview, focus group discussion by using checklists and datasheet. The types of quantitative data collected were yield performance, the total number of farmers who participated in FRG, training and field visits, and stakeholder's participation while qualitative data were varieties selection criteria, agro pastoralists' perception towards the newly introduced technologies, and awareness created during demonstration process.

Method of data analysis

Quantitative data were analysed by simple descriptive statistics (Mean, Frequency and Percentage) using SPSS version 20 while qualitative data were analysed using narrative explanation, description, Pair-wise ranking tools as suggested by De Boef and Thijssen (2007). Moreover, a simple knowledge test was used to compare participant agro-pastoralists knowledge levels before and after the demonstration period related to improved haricot bean varieties. Yield advantages of the demonstrated varieties over the local check were calculated as suggested by Sumai *et al.* (2000) technology gap and technology index were calculated using the following formula.

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

Results and Discussions

The mean grain yield data for the two improved haricot bean and one local check varieties collected from both PAs (Peasant Associations) and trial farmers were analysed and summarized as shown in Figure 1 below. Accordingly, highest mean yield of 20.2 Qt/ha, 13.7 Qt/ha and 14.1Qt/ha was obtained from Gofta , SER-119 and local check (Kulo) varieties respectively.

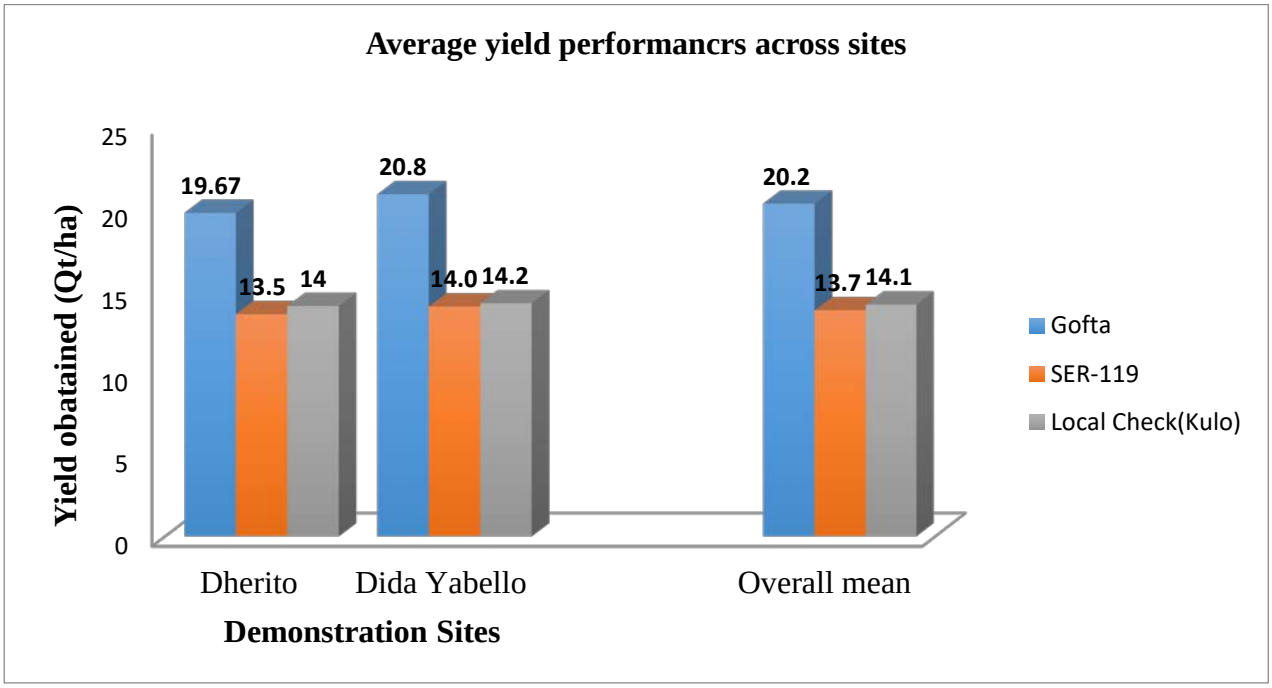

Figure 2. Yield performances of demonstrated varieties across Peasant Associations

Comparison of yield advantage of improved varieties

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

Table 10. Comparison of yield advantage of improved varieties

Demonstrated varieties	Yield obtained (Qt/ha)	Yield advantage over local variety
Gofta	20.2	43.2
SER-119	13.7	-0.03
Kulo	14.1	-

Among the demonstrated haricot bean varieties Gofta gave the highest yield (19.67 qt/ha and 20.8 qt/ha) at Dherito and Dida Yabello respectively while SER-119 and Kulo (local check) gave the lowest yield in both locations. The Gofta variety had a 43.2 % of yield advantage over local check under agro-pastoralist farm conditions.

Training provided to agro-pastoralists, Development Agents (DAs) and Experts

Intensive knowledge and skill-based training was given to the target group from the start of the activity up to harvesting. A total of 40 trainees of which 28 are agro-pastoralists, 4 are DAs, and 4 are experts were have participated in theoretical and practical training. Out of the trained participants 15(37.5%) were females while the remaining 25(62.5%) were males. The training has been given by a multidisciplinary team on haricot bean production, productivity, management, input utilization and application method, disease, insect and their controlling mechanisms as well as its information exchange. Fifteen extension manuals were prepared and delivered to the participants.

Table 11. Number and participants of target group given training on the importance of haricot bean varieties

Peasant Association (PAs)	Participants	Sex		Total
		Male	Female	
Dida Yabello	Agro pastoralists	8	4	12
	Subject Matter Specialists	2	2	4
	Development Agent (DA's)	2	2	4
	Subtotal	**12**	**8**	**20**
Dherito	Agro pastoralists	9	3	12
	Subject Matter Specialists	2	2	4
	Development Agent (DA's)	2	2	4
	Subtotal	**13**	**7**	**20**
	Grand Total	**25**	**15**	**40**

Source: Own computation, 2020

Participatory variety evaluation and selection

Farmers have an extensive and well-developed knowledge based on their environments, crops, and cropping patterns built up over many seasons and even generations. As a result, they have their criteria to select any new and improved technologies from their farming experience and repeated practices (Banziger, 2000). During participatory variety traits selection a total of 20 household heads 10 (ten) males and 4 (four) females from FRG and 4(four) males and 2(two) females from non-FRG members have participated to set their selection criteria for the demonstrated haricot bean varieties. The criteria set by agro-pastoralists were ranked using pair-wise ranking while scoring and ranking were done on consensus and resolved by the discussion as suggested by De Boef and Thijssen (2007). The evaluation was carried out during demonstration and after harvesting. Before leading the participant stakeholders (agro-pastoralists, development agents, and experts) a brief orientation was given to them on why participatory variety evaluation and selection is necessary for a research process. Thus, the evaluators were organized into small and manageable groups selecting one group leader and one secretary and encouraged to set their criteria for selecting the demonstrated varieties in order of their preference, how to evaluate each variety by considering each criteria using a rating scale, organize collected data, how to conduct group discussion and reach on a common agreement and finally report through their respective leaders.

The major criteria and attributes set by agro-pastoralists to evaluate the demonstrated haricot bean varieties were yield, disease tolerance, maturity, marketability, cook-ability, seed color, and taste. According to the pair-wise ranking result, marketability is the first important trait that agro-pastoralists perceived for selecting the demonstrated varieties followed by yield and disease tolerance. Based on these criteria, Gofta variety was ranked first followed by a local check (Kulo) in both peasant associations (PA's) for its marketability, yield, early maturity, and seed color (golden) as shown in table 3. While SER-119 ranked 3rd and preferred for home consumption.

Table 3 . Pair-wise ranking result to rank variety traits at Dherito and Dida Yabello PA's, 2019/20

Code no	Traits	Yield/ha	Disease tolerant	Maturity	Marketability	Cookabilty	Seed color	Taste
1	Yield/ha		1	1	4	1	1	1
2	Disease tolerant			3	4	2	2	2
3	Maturity				4	3	3	3
4	Marketability					4	4	4
5	Cookabilty						6	7
6	Seed color							6
7	Taste							

Table 4. Summary of matrix ranking of agro pastoralists' selection criteria

S.No	Traits	Frequency	Percentage (%)	Rank
1	Yield/ha	5	23.8	2nd
2	Disease tolerant	4	19.0	3rd
3	Maturity	3	14.3	4th
4	Marketability	6	28.6	1st
5	Cookabilty	0	0.0	7th
6	Seed color	2	9.5	5th
7	Taste	1	4.8	6th
	Total	**21**	**100.0**	

Table 5. The rank of the varieties based on agro pastoralists' selection criteria

No	Crop varities	Rank	Reasons
1	Gofta	1st	Demanded by the market, high yielder, Disease tolerant, early maturity, seed color, taste, and cook-ability
2	Kulo	2nd	Demanded by the market, Disease tolerant, early maturity, seed color, taste and cook-ability
2	SER-119	3rd	Not demanded by the market, Disease tolerant, early maturity, seed color, taste, and cook-ability

Agro pastoralists' knowledge level before and after the trial period

Knowledge level and skills of experimental agro pastoralists' on various aspects of improved Haricot bean production technologies before conducting the demonstration and after implementation was measured and compared. A simple yes or no question was designed and agro-pastoralists were asked to rate their level of knowledge before and after the demonstration period. Agro pastoralists were subjected to the same questions on both occasions. The questions were asked during the training period before starting the experiment and after the experiment. According to the findings, before the experiment only 28.6%, 35.7%, 14.3%, and 21.4% of the agro-pastoralists had information about improved haricot bean; know about the importance, appropriate spacing between plants and row and weeding and pest management practices respectively. However, after the intervention, all participants agro-pastoralist have responded as they have understood the importance, recommended space between plants and rows, weeding and pest management practices (Table 6)

Table 6. Agro pastoralists' knowledge before and after the demonstration

	Before trial		After trial	
Statement	Yes (%)	No (%)	Yes (%)	No (%)
Had information about an improved haricot bean	4(28.6)	10(71.4)	14(100)	0 (0)
Know about importance of haricot bean varieties	5(35.7)	9(64.3)	14(100)	0 (0)
Know spacing between plants and rows	2(14.3)	12(85.7)	14(100)	0 (0)
Know weeding and pest management practices	3(21.4)	11(78.5)	14(100)	0 (0)

Source: Own survey result, 2019-2020

Conclusions and Recommendations

Two varieties of haricot bean varieties Gofta and SER-119 and one local check (Kulo) were demonstrated and evaluated with the objective of evaluating the productivity and profitability and identifying the best performing haricot bean varieties with full package. It was carried out on two established FRGs during 2019 and 2020 cropping season in Dherito and Dida Yabello Peasant Association of Yabello district. In an effort of bridging knowledge and skill gaps of agro pastoralists was changed through intensive training especially on the importance of newly introduced haricot bean production and on using its full recommended packages. Knowledge and skill of development agents and agricultural experts was also enhanced through training and extension visits. Significant numbers of farmers were persuaded and information was disseminated to relevant stakeholders that might pave the way for the demand driven technology and further popularization. Based on the yield data 20.2 qt/ha, 13.7qt/ha, and 14.1 qt/ha were obtained from Gofta, SER-119 and local (Kulo) varieties, respectively. Gofta had 43.2 % yield advantage over local check. Thus, Gofta recommended for pre-scaling up in the study area and with similar agro ecologies.

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Demonstration and Evaluation of Improved Sheep Breed in Borana Zone, Southern Oromia, Ethiopia

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Abstract

On-farm demonstration and evaluation of improved technologies are very important in the transfer of technology. This study was conducted with the objectives of demonstrating and evaluating the productive performance of the 25% of Dorper crossbred and the local Blackhead Somali sheep under agro pastoralists' conditions, creating awareness, improving pastoralists'' knowledge and skill. Training was given to the selected pastoralists, Development agents, and experts on the importance and management of the improved sheep. A total of 4(four) F1 50% Dorper crossbred were provided for the two established Pastoralists' Research Groups (PRGs). Both quantitative and qualitative data were collected and analyzed using descriptive statistics and an independent sample t-test and pairwise ranking and narrative explanations. The result of the study indicated that 25% Dorper crossbred were significantly higher in birth weight, weight at 6 months, and yearling (marketable) weight at 12 months as compared to the local blackhead Somali sheep. Moreover, Dorper crossbred was found to be better in marketability, weight, meat, drought, and disease resistance compared with their counterparts. Therefore, 25% of Dorper crosses should be more popularize and scaled up by all concerned bodies to improve the productive performance of the local Blackhead Somali sheep in the study areas.

Keywords: Demonstration, Evaluation, Dorper, Blackhead Somali

Introduction

Ethiopia is among few African countries endowed with a huge sheep genetic resource. It has estimated to have a population size of 31.3 million sheep, of which 99.8 percent are indigenous type. The total population of the sheep in pastoral areas accounts approximately for 53 percent of the total Ethiopian sheep population (CSA, 2017). Sheep are adaptable to arid and semi-arid conditions and provide mutton for their keepers. In Ethiopia, small ruminants in general and sheep, in particular, are kept mainly for immediate cash or income generation, meat, saving, asset, and manure, skin, and wool production (Abebe *et al*., 2020). Sheep account for 19% and 95% of the total livestock and small ruminant live animal export, respectively (Hailemariam *et al*., 2013). The lowland sheep and goat breeds of Ethiopia are highly demanded by the neighboring and Middle East countries. Lowland breeds are more preferred as compared to highland breeds by exporters [Asegede et al., 2015]. The importance of sheep production as a source of meat in Ethiopia has been increasing from time to time. Moreover, available estimates suggest that the consumption of sheep meat will increase by 217 percent between 2015 and 2050 as a result of the human population (FAO, 2019). Despite its importance, the performance of the sheep industry in Ethiopia has been poor compared to other African countries due to inadequate feed and nutrition, widespread disease and health problems, poor management and marketing system. As a result, the current sheep production may not be meeting the increasing domestic demand and neighboring countries due to increased human population and urbanization. Thus, improving local breeds crossing with exotic breeds plays a paramount to meet the ever-increasing demand for meat without

threatening the existence of indigenous breeds. This requires appropriate research design and implementing a suitable breading strategy to improve the productivity and conservation of the indigenous breed.

Southern lowlands of Oromia region, Borana zone is a high potential for livestock production and supply of live animals to a local and international market. Sheep are also very important to the household economy in terms of providing a source of convenient amounts of cash on a more frequent basis which can partially substitute for sales of cattle. In Borana, sheep comprises 5% of total animal sale (Coppock, 1994). The dominant type of sheep kept in Borana pastoral areas is fat-rumped and fatty-tailed black-headed Somali. Because of their fatty tailed and low lean to fatty ratio black-headed Somali sheep are not demanded by local and national markets (Desiso *et al.*, 2018). Moreover, according to Yibrah (2008), most of the local sheep breeds are slaughtered and marketed at round yearling age when their body weight is 18-25 kg. However, export markets demand lambs that weigh up to 30-35 kg at yearling age. The small size and fatty nature of indigenous sheep breeds are one of the principal constraints for domestic and foreign markets.

Based on the above problems which reduce production and productivity of local sheep breeds, Yabello Pastoral and Dryland Agriculture research center has undertaken an on-station and on-farm adaptation trail of utilizing Doper as breed compliment of local breed for the last years. the result of adaption has indicated that using Dorper crossing with local blackhead Somali improved the quality and quantity of mutton production. This study was conducted only station and was limited to few numbers of pastoralists in the area. Therefore, to fill the research gap, the current activity was initiated to further promotion of this Crossbreeding system in selected districts of the Borana zone.

Research Methodology

Site and pastoralists Selection

The activity was carried out in the Dherito peasant association, Yabello district of Borana zone. The site was selected with the collaboration of district pastoral development Offices. Two Pastoral Research Groups (PRG) consisting of 30 pastoralists were established at selected PA.

Research Design

Four F1 (50% Dorper cross rams) were provided to each established PRG while each of the bought rams was used as a sire line, while local ewes were utilized as a dam line. Dental information was utilized to estimate the age of the demonstration stock ewes with 1st and 2nd parity and age < 2 years old were incorporated. All local and F1 Dorper rams that were used for mating were in the age range of 0.75 < 1.5 years to be used as a sire.

Training and field visits

The training was given for the selected pastoralists, respective DAs (Development Agents), and SMS (Subject Matter Specialists) concerning this research activity on genetic improvements like selection, production system of crossbreeding, growth, and health management. Close supervision and monitoring were made through joint action of stakeholders.

Data collection

Both quantitative and qualitative data were collected. Quantitative data collected during the demonstration were initial birth weight, weight at six months weight, yearling weight (at 12 months), and the total number of pastoralists who participated in the training, field visits, sailing price, and the number of stakeholders who participated. On the other hand, qualitative data collected were selection criteria of pastoralists, change in the level of knowledge and skill of pastoralists, and awareness created throughout the demonstration period.

Method of data collection

Quantitative data like growth, reproductive, and survival data, the total number of pastoralists who participated in the training, sailing price, and the number of stakeholders who participated were collected using checklists and datasheet tools. On the other hand, qualitative data such as selection criteria of pastoralists concerning the traits of sheep, change in the level of knowledge and skill of pastoralists, and awareness created were collected through a simple yes or no question survey and Focus Group Discussion (FRG).

Method of data analysis

Quantitative data such as birth weight, six months weight, yearling weight, number of pastoralists who participated in the training, Pastoralists Research Group (PRG) were analyzed using SPSS (Statistical Package for Social Science version 20). Pair-wise ranking method to summarize pastoralists' selection criteria (traits) concerning sheep as suggested by Haile *et al.* 2013. A simple knowledge test was used to compare pastoralists' knowledge levels before and after the demonstration period related to crossbred ram. Moreover, an independent sample t-test was used to compare the mean difference between crossbred ram and the local blackhead Somali sheep.

Results and Discussions

Training given on the importance and overall management of improved Dorper sheep

Training plays a crucial role in building pastoralists' capacity to act and adopt any new technologies. Therefore, before the start of the demonstration training was given to the selected stakeholders (pastoralists, development agents, and experts) on the growth, reproductive, and health of improved sheep. Accordingly, a total of 36 out of which 28, 4, and 4 pastoralists, Experts (SMS), and Development Agents have participated respectively.

Table 12. Training given to pastoralists, experts, and development agents on the genetic improvement of improved sheep

S. No	Participants	Sex		Total
		Male	Female	
1	Pastoralists	18	10	28
2	Experts (SMS)	2	2	4
3	Development Agents	2	2	4
Grand Total		22	14	36

Source: Own computation, 2019-2021

Pastoralists' evaluation and selection criteria

Farmers and pastoralists have extensive and well-developed knowledge and skill in selecting sheep, and ram sharing, and management traits based on phenotypic appearance and recalled pedigree, although the mating system is generally uncontrolled.

A total of 16 pastoralists' out of which 5 are women were involved in the selection traits of sheep. Pastoralists were encouraged to set their selection criteria concerning the traits of sheep. Researchers have played facilitation and technical roles. Accordingly, the criteria set by the pastoralists were disease resistance, drought tolerance marketability, meat, weight, and tail type. According to the pair-wise ranking result, marketability is the first important trait that agro-pastoralists perceived for selecting both the crossbred and blackhead Somali sheep followed by weight and meat (Table 2).

Table 13. Pair-wise ranking matrix result to sheep traits at Dherito PA, 2019/20

Code no	Traits	Disease resistance	Drought tolerance	Market-ability	Meat	Weight	Tail type	Frequency	Rank
1	Disease resistance		1	3	4	5	1	2	4th
2	Drought tolerance			3	4	5	2	1	5th
3	Marketability				3	3	3	5	1st
4	Meat					5	4	3	3rd
5	Weight						5	4	2nd
6	Tail type							0	6th

Based on the ranked traits 25 % of Dorper crossbred ranked first in terms of its marketability, weight gain, and meat. Moreover, 25 % of Dorper crossbreds are thin-tailed, better disease and drought-tolerant compared to the local sheep. In general, as perceived by pastoralists Dorper 25% cross performed better compared to the local (Blackhead Somali sheep) in terms of all the criteria (traits) set by the pastoralists (Table 3).

Table 14. Rank of sheep breed based on pastoralists' selection criteria

No	Breed	Rank	Reasons
1	Local	2nd	Fatty tail, not demanded by the local market, Low meat quality (Fatty and Whitish color) & Long yearling age
2	Dorper Crossbred 25%	1st	Thin tailed, highly demanded by the local market, high quality of meat (Red color)

On-farm performance of Dorper crosses and Blackhead Somali Sheep

The result of the descriptive statistics showed that the overall mean of initial birth weight, weight at six months, and yearling (marketable) weight at 12 months were 3.11±0.13, 27.8±0.90 and 34.9±0.46 for 25% Dorper crossbred ram while the overall mean of initial birth weight, weight at six months and yearling (marketable) weight at 12 months for Blackhead Somali were 1.40625±0.08, 24.3375±0.44 and 29.35±0.89 respectively. The

minimum and maximum initial birth weight were 2.50 and 3.50 and 0.90 and 1.70 while that of the weight of the ram at 6 months were 23.00 and 30.00, 22.70 and 26.50 for 25% Dorper crossbred and Blackhead Somali respectively. Moreover, the minimum and maximum yearling (marketable weight) of the ram at 12 months were 32.50 and 36.50, 25.50 and 32.50 for 25% Dorper crossbred and Blackhead Somali respectively (Table 4.).

An independent sample t-test was conducted to explore the mean differences between 25 % crossbred and the local (Blackhead Somali) sheep in initial birth weight, weight at 6 months, and marketable weight at 12 months of the ram. An alpha level of 0.05 was used. All groups were normally distributed. Variances were not homogenous. The result of an independent t-test indicated that there is a statistically significant mean difference between 25 % crossbred (M=3.11±0.13, SD=.37), and the Blackhead Somali (M=1.40±0.08, SD=.24), sheep in initial birth weight, t (14) = 10.99, p<0.01. Moreover, significant differences were also observed between the Dorper crossbred (M=27.8±0.90, SD=2.57) and the Blackhead Somali (M=24.33±0.44, SD=1.24) in weight of the ram at 6 months, t (14) = 3.43, p<0.01. Finally, the result has shown that there was a statistically significant mean difference between 25 % crossbred (M=34.9±0.46, SD=1.30055), and the Blackhead Somali (M=29.35±0.89, SD=2.51453), in yearling (marketable weight) at 12 months t(10.50)= 5.55, p<0.01 in the study area. In general, under pastoral or farm conditions the mean initial birth weight, weight at six months, and yearling or marketable weight were found to be significantly higher in 25% Dorper crosses (3.11±0.13, 27.8±0.90, and 34.9±0.46) as compared to the indigenous Blackhead Somali sheep (1.40±0.08, 24.33±0.44 and 29.35±0.89) respectively (Table 5).

Table 15. Productive performance of Dorper crosses and Blackhead Somali Sheep

Parameters	Breed type	N	Mean ±SE	Std. Deviation	Minimum	Maximum
Initial Birth weight of the Ram	Crossbred	8	3.11±0.13	.36815	2.50	3.50
	Blackhead Somali	8	1.40±0.08	.23970	.90	1.70
Weight of the ram at 6 month	Crossbred	8	27.8±0.90	2.56738	23.00	30.00
	Blackhead Somali	8	24.33±0.44	1.24090	22.70	26.50
Yearling (Marketable weight) of the ram at 12 months	Crossbred	8	34.9±0.46	1.30055	32.50	36.50
	Blackhead Somali	8	29.35±0.89	2.51453	25.50	32.50

Table 16. Result of independent sample t-test

		Levene's Test for Equality of Variances		t-test for Equality of Means				
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Initial Birth weight of the Ram	Equal variances assumed	2.11	0.17	10.99	14.00	0.00	1.71	0.16
Weight of the ram at 6 month	Equal variances assumed	3.02	0.10	3.43	14.00	0.00	3.46	1.01
Yearling (Marketable weight) of the ram at 12 months	Equal variances not assumed	7.57	0.02	5.55	10.50	0.00	5.55	1.00

Pastoralists' knowledge level before and after intervention

Knowledge of a particular agricultural activity determines one's perception of the technology as well as his/her immediate application of new knowledge of the same technology on currently perceived production problems. A simple yes or no question was designed for this study and pastoralists were asked to rate their level of knowledge before and after the intervention period. Agro pastoralists were subjected to the same questions on both occasions. The questions were asked during the training period before starting the demonstration and after a demonstration. According to the findings, before the demonstration of improved Dorper sheep only 8.3%, and 16.7% of the pastoralists had information about crossbreeding; know about the importance of Dorper, and know about record keeping and 16.7 % of them know the management and husbandry practices of sheep in a scientific way. However, after the intervention, all pastoralists have responded as they had information about crossbreeding, know about the importance of Dorper, have knowledge of record keeping, know the management and husbandry practices of sheep in a scientific way (Table 6). This implied the knowledge and skill of pastoralists' had improved after the intervention due to given training, awareness created, and their involvement in the research from the beginning to the end as Pastoralists' Research Groups (PRGs).

Table 17. Pastoralists' Knowledge level before and after intervention

	Before trial		After trial	
Statement	Yes (%)	No(%)	Yes(%)	No(%)
Had information about crossbreeding	1(8.3)	11(91.7)	12(100)	0 (0)
Know about importance of Dorper	1(8.3)	11(91.7)	12(100)	0 (0)
Know about record keeping	1(8.3)	11(91.7)	12(100)	0 (0)
Know the management and husbandry practices of sheep in a scientific way	2(16.7)	10(83.3)	12(100)	0 (0)

Source: Own Survey computation, 2019-2020

Conclusions and Recommendations

The present studies was conducted with the objectives of demonstrating and evaluating the performance of Dorper crosses and the indigenous blackhead Somali, creates awareness about the importance of the technology, and improve the pastoralists' knowledge and skill of production and management of the ccrossbreeding in the Yabello district. Yabello was selected based on the high potentiality for sheep production. Two PRG were established at Dherito, and 4 F1 50% Dorper crossbred were provided for the two established groups. The training was given for the selected pastoralists, respective DAs (Development Agents), and SMS (Subject Matter Specialists) concerning this research activity on genetic improvements like selection, production system of crossbreeding, growth, and health management

Both quantitative and qualitative data were collected through checklists and datasheet tools and a simple yes or no question survey and Focus Group Discussion (FRG) and were analyzed using SPSS version 20, an independent sample t-test and narration and pair wise ranking methods respectively. The result of the descriptive statistics showed that the overall mean of initial birth weight, weight at six months, and yearling (marketable) weight at 12 months were 3.11±0.13, 27.8±0.90 and 34.9±0.46 for 25% Dorper crossbred ram while the overall mean of initial birth weight, weight at six months and yearling (marketable) weight at 12 months for Blackhead Somali were 1.40625±0.08, 24.3375±0.44 and 29.35±0.89 respectively. An independent sample t-test was conducted whether the mean difference beetween the 25% Dorper crossbred and the local blackhead Somali was significantly differ or not. Accordingly, the result of the sample t-test revealed that under pastoral or farm conditions the mean initial birth weight, weight at six months, and yearling or marketable weight were found to be significantly higher in 25% Dorper crosses as compared to the indigenous Blackhead Somali sheep. Moreover, the result of simple yes or no questions conducted before and and after intervention implied that the knowledge and skill of pastoralists' had improved after the intervention due to given training, awareness created, and their involvement in the research from the beginning to the end as Pastoralists' Research Groups (PRGs).

In general, the result of the study indicated that 25% of Dorper crossbred were significantly higher in birth weight, weight at 6 months, and yearling (marketable) weight at 12 months as compared to the local blackhead Somali sheep. Moreover, Dorper crossbred was found to be better in marketability, weight, meat, drought, and disease resistance compared with their counterparts. Therefore, 25% of Dorper crosses should be more popularize and scaled up by all concerned bodies to improve the productive performance of the local Blackhead Somali sheep in the study areas.

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On Farm Demonstration of Soil and Water Conservation Structures with Banana Production in Daro Lebu and Habro Districts of West Hararghe Zone, Oromia National Regional State, Ethiopia

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Abstract

The demonstration was conducted in two districts of West Hararghe zone, Daro Lebu (Sororo kebele) and Habro (Oda Anani kebele) from 2017-2020 with the objectives of evaluating Nagriam micro catchment with mulch, semi-circular with mulch and normal pit without mulch (local practice) under farmers' condition and creating awareness among stake holders. Districts and kebeles were selected purposively based on agro-ecology and production potential. Accordingly, six farmers and two FTCs were directly participated in the research process. Farmers selection was conducted by using different criteria like interest, ability to allocate land, willingness to take risk whether the research result risk or not. Farmers used local materials for mulching purpose. For all trails, plant spacing of 2.5 m × 2.5 m, plot area of 6.25m^2 for one treatment and 18.75m^2 total areas of land was used for the three treatments. Four banana suckers per each demonstration plot and totally 12 suckers were given to experimental each farmer. Design, check list and data record sheet, frequent supervision, field observation and direct contact with farmers were used as data collection methods. Data collection sheet was prepared to collect fruit yield, number of hand per bunch, number of finger per hand and total number of fruit per bunch and the collected data was analyzed by SPSS software. From the on farm demonstration, Negriam micro catchment with mulch recorded 229.2 (000ha^{-1}) total number of fruit and 38.1 ton ha^{-1} and fruit yield respectively, semi-circular with mulch gave 216.8(000ha^{-1}) total number of fruit and 33.2 tonha^{-1} fruit yield, while normal pit without mulch gave 144.6 (000ha^{-1}) and 24.65 ton ha^{-1} total number of fruit and fruit yield respectively. Negarim micro catchment with mulch and semi-circular with mulch has 54.3% and 34.4% yield advantage over normal pit without mulch respectively. Based on its yield advantage, Negriam micro catchment with mulch structure was recommended for pre scaling up in the study area, and similar agro-ecologies.

Key words: Negriam micro catchment, semi-circular, normal pit, fruit yield, yield advantage

Introduction

Agriculture plays an important role in Ethiopia's political, economic and social development. It forms one of the largest components of the Ethiopian economy, contributing 34% of the country's gross domestic product (GDP) and 71% of employment. Crop production makes up 72% percent of the total agricultural GDP, whereas livestock accounts for 20% and other areas contribute 8.6%. Cereals (such as wheat, maize, tef, sorghum, and millet), comprise the biggest share of crop production as principal staples. 32 million tons of grains were produced by smallholder farmers in the 2009 season alone. In addition, vegetables, fruits, root crops, pulses, oilseeds, and spices are grown widely (ATA, 2017/2018).

Banana (Musa sp.) is one of the most important tropical fruits and evolved in the humid tropical regions of South East Asia with India as one of its centers of origin. Bananas including dessert and cooking types are giant perennial monocotyledonous herbs of the order Zingiberales, a sister group to the well-studied Poales, which include cereals. It does not originate from Africa it introduced to East African highland regions between the first and sixth century (Getachaw *et al*, 2020)

Bananas are among the main tropical fruit that grows largely in Asia, Latin America and Africa. Smallholders are the prime groups involved directly in growing bananas. Based on the volume of production, bananas come fourth after rice, wheat and maize. More than 100 million ton of bananas are produced every year in over ten million hectares. About 13 % of the world's banana production is exported while the remaining 87% is for local consumption. Total banana production in the world was 96 million tons on 49 million ha in 2009 (Kayat, 2016).

According to CSA (2017/2018) data, about 104,421.81 hectares of land was under fruit crops in Ethiopia. Bananas contributed about 56.79% of the fruit crop area followed by avocadoes, 17.26% of the area. More than 7,774,306.92 quintals of fruits was produced in the country. Bananas, Mangoes Avocados, Papayas, and Oranges took up 63.49%, 13.50%, 10.47%, 6.99% and 3.93% of the fruit production, respectively

Rainfall shortage constrains production in small-holder agriculture in developing countries and with on-going climate change these shortages may increase. Rainwater harvesting irrigation is an interesting technology that decreases this risk (Mekonnen, 2012). Integrating in-situ moisture conservation structures to crop production could make an important contribution to increase agricultural production and productivity where there is high moisture stress. Use of appropriate soil and water technologies such as negarim and semicircular micro catchment could be some of the alternatives in order to improve productivity of smallholder farmers (Tadele *et al*, 2016).

Most part of West Hararghe zone is also known by moisture deficit area which annually decreases production and productivity of the smallholder farmers. As a result, many rural households are majorly served by safety net program redundantly. Thus, to increase their production, using appropriate soil and water conservation structures is necessary. In the study area, banana is one of commercial crop, which more peoples use both for food and marketing purpose. Even though the crop is important in the study area, productivity of the crop is very low due to scarcity of rainfall especially in lowland parts of West Hararghe zone. However; Mechara Agricultural Research Center has conducted Effects of negarim and semi-circular structures with mulch with normal pit without mulch (local practice) on the yield of banana in moisture deficit area of Daro Labu district in 2016. The result over location of McARC showed that banana variety using Negarim micro catchment with mulch had the highest mean yield of 22.523tonha-^{1} (Tadele *et al*, 2016). Thus, Mechara Agricultural Research Center recommended negarim micro catchment with mulch for further promotion and demonstration in similar agro ecologies.

Therefore, this study was initiated with evaluating Negarim micro-catchment and semi-circular with mulch, with that of normal pit without mulch under farmers' condition using Giant Cavendish banana variety.

Objectives

- To evaluate water conservation structures (negarim micro-catchment & semi-circular with mulch) with normal pit without mulch with banana production under farmers' field condition.
- To create linkage among farmers on the technology

Materials and Method

Description of the study area

The research was conducted in two districts of west Hararghe zone, Daro Lebu (Sororo keble) and Habro (Oda Anani keble) from 2017-2020.

Mechara, which is capital town of Daro lebu district, is 434km from Addis Ababa in South East. The district is actually situated between 7º52'10''and 8º42'30'' N and 4º023'57'' and 41º9'14''E, is mostly characterized mostly by flat and undulating land features with altitude ranging from 1350 up to 2450 m.a.s.l. The ambient temperature of the district ranges from 14 to 26^{0}C with average of 16^{0}C with annual average rainfall of 963 mm/year. The pattern of rainfall is bimodal: 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 (DLWADO, 2020).

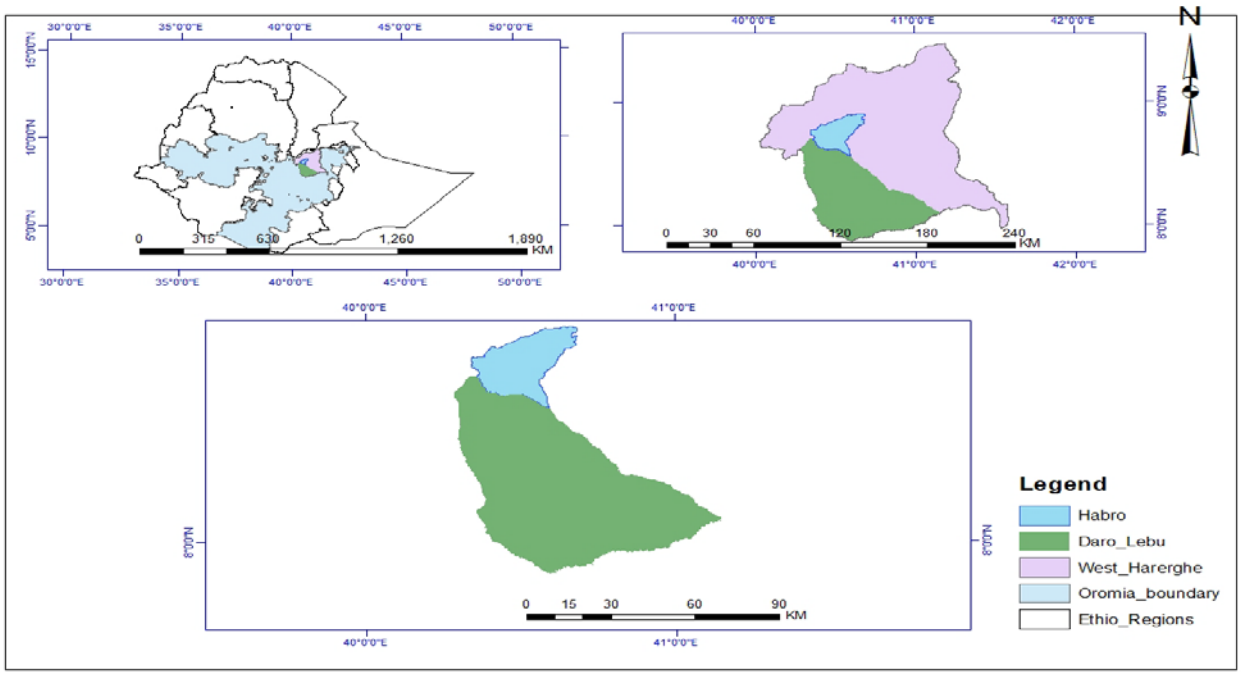

Figure 1: Map of the study area
Source: Own design from ArcGIS data (2021)

Site and Farmers' Selection

The activity was carried out for three consecutive years in two selected moisture stress districts of West Hararghe zone, Daro lebu (Sororo kebele) and Habro (Oda Anani kebele). District and kebele were selected based on agro-ecology and producing potential of banana with collaboration of Agricultural office, extension personnel and DAs. One kebele from each district and a total of three farmers and one FTC were considered from each kebele for the trail. Thus, a total of six farmers and two FTCs were participated on experiment. Farmers selection was based on criteria like gender balance, willingness to allocate land for trial, willingness to take whether the research result or risk, promise to manage the field and ability to cooperate and interest to the technology.

Research Design

The experiment was designed with three treatments; namely Negarim micro catchment with mulch, Semi-circular with mulch and Normal pit without mulch. Plot area of 6.25m^2 for one treatment and 18.75m^2 total areas of land for the three treatments, Plant spacing of 2.5m × 2.5m, 12 banana suckers across all experimental units, and locally available materials were used for mulching purpose. Continuous supervision and follow up of the activity was undertaken through joint action of the stakeholders.

Type of data and method of data collections

Method of data collections

Checklist & design was developed prior to planting. Then, personal observation, individual contact (listening to trial farmers) during site visit was used for data collection purpose. Close supervision and monitoring were undertaken through joint action of stakeholders, and Data collection sheet was prepared to collect fruit yield, number of hand per bunch, number of fruit per hand and total number of fruit per bunch.

Method of data Analysis

Both quantities data was analysed by descriptive statics and SPSS. But the result of the study was presented by tabular form.

Result and Discussion

Yield and Yield components

Table1: Yield obtained during adaptations and demonstration

Structure	Yield obtained (ton ha^{-1})	
	Adaptation	Demonstrations
Semi-circle with mulch	14.571	33.2
Normal pit without mulch	0	24.7
Negarim with mulch	22.523	38.1

Source: compiled result from Adaptations 2016; Demonstration 2021

Fruit Yield (ton/ha): According to the of biological result , Negraim micro catchment with mulch recorded is 22.523 ton ha^{-1} , But during on farm demonstration it record 38.1ton ha^{-1} which is has 15.577ton ha-^{1} yield differences. By the same way, semi-circular with mulch record 14.571 and 33.2 ton ha-^{1} during biological and on farm demonstration (Table 1 &2) : this because farmers manage their own trail by different skill and in different manner

Table 2: Fruit yield

Treatments	Fruit yield (tonha^{-1}) (N=4)			
	Min	Max	Mean	Std. Dev.
Negriam micro catchment with mulch	36.8	39.4	38.1	1.84
Semi-circular with mulch	18.7	47.6	33.2	20.4
Normal pit without mulch	21.3	28	24.7	4.7

N – Numbers of trial farmers
Source: Own computation, 2021

Number of Fruit per hand (1000ha^{-1}): Result of this study reveal that, Banana which is planted using negriam micro catchment with mulch recorded highest mean 22.7(1000 ha^{-1}) followed by Semi-circular with mulch 22.5 (1000ha^{-1}), whereas local check without mulch was 18.8 (1000 ha^{-1}) which was the lowest value

Table 3: Number of finger per hand

Treatments	Number of fruit per hand (1000/ha) (N=4)			
	Min.	Max.	Mean	Std. Dev.
Negriam micro catchment with mulch	20.8	24.6	22.7	2.7
Semi-circular with mulch	20	24.9	22.5	3.5
Normal pit without mulch	18	19.6	18.8	1.1

N – Numbers of trial farmers
Source: own computation, 2021

Total Number Fruit (1000/ha): As depicted in table 4, the highest mean of total number of fruits 229.2(1000ha^{-1}) was registered by Negarim micro catchment with mulch and the lowest was from normal pit without mulch, 144.6 (1000ha^{-1}).

Table 4**:** Total number of Fruit (1000ha^{-1})

Treatments	Total number of fruit (1000ha^{-1}) (N=4)			
	Min.	Max.	Mean	Std. Dev.
Negarim micro catchment with mulch	188	270	229.2	58.3
Semi-circular with mulch	160	273.6	216.8	80.3
Normal pit without mulch	144	145.1	144.6	0.8

N – Numbers of trial farmers
Source: own computation, 2021

Table 5: Yield advantage (%)

Treatments	TNF (000/ha)	FY (ton/ha)	NH/B (000/ha)	NF/H (000/ha)
Negarim micro catchment with mulch	58.5	54.3	29.38	20.7
Semi-circular with mulch	49.9	34	24.1	19.7

Source: our computation, 2021

Where: TNF= total number of fruit, FY=fruit yield, NH/B= number of hand per bunch, NF/H= number of fruit per hand

Negrim micro catchment with mulch and local check with mulch were evaluated with local check without mulch on farmers land. From the investigation, negarim micro catchment with mulch recorded highest total fruit 229.2(1000ha^{-1}) and fruit yield 38.1tonha^{-1} respectively. Local check with mulch also recorded next value 216.8 (000ha^{-1}), 33.2tonha^{-1} total fruit and fruit yield respectively. From the analyses result local check without mulch recorded lowest value in all parameter. Additionally Negrim micro catchment has 54.3% fruit yield advantage over the local check without mulch, which followed by local check with mulch 34 %.

Conclusions and Recommendations

Conclusion

From the study result Negrim with mulch record highest value (22.523 ton ha-^{1} and 38.1ton ha^{-1}) during release and on farm demonstration respectively. Generally, there was a high mean difference on yield obtained between the water conservation structures (Negarim micro catchment with mulch, semi-circular with mulch), and normal pit without mulch with banana production on fruit yield, number of finger per hand and total number of fruits per hectare. Accordingly, the highest mean yield of the fruit was obtained from Negarim micro catchment with mulch (38.1 tonha$^{-1)}$ followed by semi-circular with mulch (33.2 tonha$^{-1)}$, and normal pit without mulch (24.7 tonha$^{-1)}$; the highest number finger per hand and total number fruits (000ha^{-1}) was 22.7, 22.5,18.8; and 229.2, 216.8 and 144.6 for Negerim micro catchment with mulch, semi-circular with mulch and normal pit without mulch respectively with yield advantage of Negarim micro catchment with mulch 54.3% and semi-circular with mulch 34%.

Recommendation

Based on the result obtained from the three treatments conducted on banana production technologies with Negarim micro catchment water conservation structure with mulch, semi-circular with mulch and normal pit without mulch, Negarim micro catchment water conservation structure with mulch has shown promising result under all parameters and recommended for further pre scaling up. Concerned bodies like research centers, NGOs, and Agricultural offices also should give emphasis for the achievement of such a solution giving technology in a moisture stress areas

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Pre extension Demonstration of Improved Elephant Grasses under Soil Bund in Daro Lebu, Habro, and Gemachis Districts, West Hararghe Zone, Oromia Region, Ethiopia

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Abstract

*The demonstration was conducted in 2019/2020 cropping season at Daro Labu, Habro and Gemechis districts of West Haraghe zone with the objectives of evaluating improved Elephant grasses performance under farmers' condition, assess farmers' feedback for further technology development/improvement and create awareness,linkage, and networking among stakeholders in the zone. One kebele, one FTC and three farmers from each district, total of three kebeles, three FTCs and nine farmers were involved in the demonstration process. Two improved Elephant grass cultivars; ILRI # 16800 and ILRI #16840 were used for technology evaluation and selection with local check on 64m^2 soil bund area for one treatment and 192m^{2}of total area was used across location. During the experiment implementaion, fertilizer rate of 100kg/ha NPS and 50kg/ha Urea was applied and plant spacing of 1m*0.5m with planting method of 45° slant was employed. Both quantitative and qualitative data were collected through observation, group discussion on mini field day, and data recording sheet. Quantitative data was analyzed through descriptive statistics, while qualitative data like farmers' preference was analyzed using garret ranking method to rank the cultivars, and presented through narration and. The result obatined indicates, the highest fresh biomass(t/ha) was obtained from ILRI#16800 (100.3) followed by local (75.1) and ILRI#16840 (66.9). ILRI #16800 also ranked first by farmers' preference data collected on mini field day organized in most of the parameters like softness, stand vigor, biomass, and rejuvenation time and recommended for further pre scaling up in the study area, and similar agro-ecologies with animal forage deficit areas.*

Keywords*:* Elephant grass, Cultivar, Soil bund, farmers' preference, biomass, forage deficit

Introduction

Ethiopia has the largest livestock population in Africa, with 65 million cattle, 40 million sheep, 51 million goats, 8 million camels and 49 million chickens in 2020 (CSA, 2020a). Between 2000 and 2016, the average stock of livestock, measured in tropical livestock units (TLU) per 100 people, stood at 51 TLU, which is more than double the continental median of 23 TLU. The gross production value average growth rate during the same period was 4.5% also twice the continental median of 2.2% (FAO, 2019). The national herd supports, at least in part, the livelihoods of more than 11.3 million rural households, including 27– 35% of the highland livestock keepers, and a large proportion of the lowland herders, who live below the Government of Ethiopia established poverty line (Shapiro *et al*., 2017). Livestock is a major source of animal protein, power for crop cultivation, means of transportation, export commodities, manure for farmland and household energy, security in times of crop failure, and means of wealth accumulation. The sector contributed up to 40% of agricultural Gross Domestic Product (GDP), nearly 20% of total GDP, and 20% of national foreign exchange earnings in 2017 (World Bank, 2017). The major constraint that influences the productivity of livestock in the Eastern part of Ethiopia is the shortage of feed both in quantity and quality

(Tilahun *et al*., 2015), low productivity of local breeds, and lack of knowledge (Abdi *et al.*, 2013; Estefanos *et al*., 2014; Fekede *et al.*, 2016).

To solve the problems, different experiments have been conducting on forage developments in our country. Those are forage grass, legumes, crops, and others are addressed through research and development organizations. Forage grasses like Elephants, Desho, Rhodes, Panicium, Brachiaria, and Vetiver are the major improved grasses that have a great contribution to livestock production. Amongst the promising forage species promoted in Ethiopia, Elephant grass could play an important role in providing a significant amount of high-quality forage to the livestock both under the smallholder farmers and intensive livestock production systems with appropriate management practices (Alemayehu, 2004; Tessema, 2005). Elephant grass is a native of Sub-Saharan Africa introduced to Australia as forage for livestock. It is multipurpose forage for soil erosion protection, control weed infestation by mulching, soil erosion control, insect-pest control, windbreak, and fence and to demarcate boundaries among neighboring farmers (Alemayehu *et al*., 2017).

In the West Hararghe zone, low access to improved forage grasses, poor extension services on livestock forages, and feed scarcity are the major constraints in livestock production (Fekede *et al.*, 2016). Despite this, livestock fattening (oxen and goat), dairy cattle, and goat production are highly practice in the western Hararghe zone. The cut and carry system is one of the feeding systems found in the area due to the absence of grazing land and land shortage in the area. The farmers are using the industrial by-product, crop residues, local grasses, and natural pasture to feed their livestock in the area (Estefanos *et al*., 2014). The local grasses are found from schools, religious institutions, and communal government lands through purchasing by their own money.

The indigenous knowledge of farmers in the area observed that different types of natural pasture are sow/plant on soil bunds, around their home, and in the uncultivated side of their farmlands for feed their animals. Indigenous knowledge is a base for scientific research in technology evaluations. Mechara Agricultural Research Center has been evaluating different perennial grasses like Elephant grass, Desho, and Brachiaria at on-stations. Accordingly, it's recommended different Elephant grass cultivars for further demonstration and evaluation under farmers' condition. Therefore, demonstration of improved Elephant grasses under soil bund in the participatory method is necessary for further promotion and distribution of the technologies in the study area.

Objectives

- ✓ To evaluate improved Elephant grasses under farmers' condition
- ✓ To assess farmers' feedbacks for further technology development/improvement
- ✓ To create awareness, linkage and networking among stakeholders

Materials and Methods

Description of the study area

This demonstration was conducted in Daro Lebu, Habro and Gemachis districts of West Hararghe zone in the 2018/2019 production season. Daro Labu district is found at 434 km from Addis Ababa in South East and situated between 7º52'10''and 8º42'30'' N and 4º023'57'' and 41º9'14''E. The district is characterized mostly by flat and undulating land features with altitude ranging from 1350 up to 2450 m.a.s.l. Milkaye is among the kebeles of the district which is most known with animal husbandry activity. Habro district has an

altitude range from 1600-2400 m.a.s.l. and annual rainfall of 650 mm and 1000 mm while the average temperature of the district is 18°C. Bareda kebele, where the demonstration was carried out is found between Badada and Wachu kebeles of the district.

Gemechis district is located at 343 km East of Addis Ababa and situated at the coordinate between 8^{0}40’0’’and 9^{0}04’0’’N and 4^{0}50’0’’E.

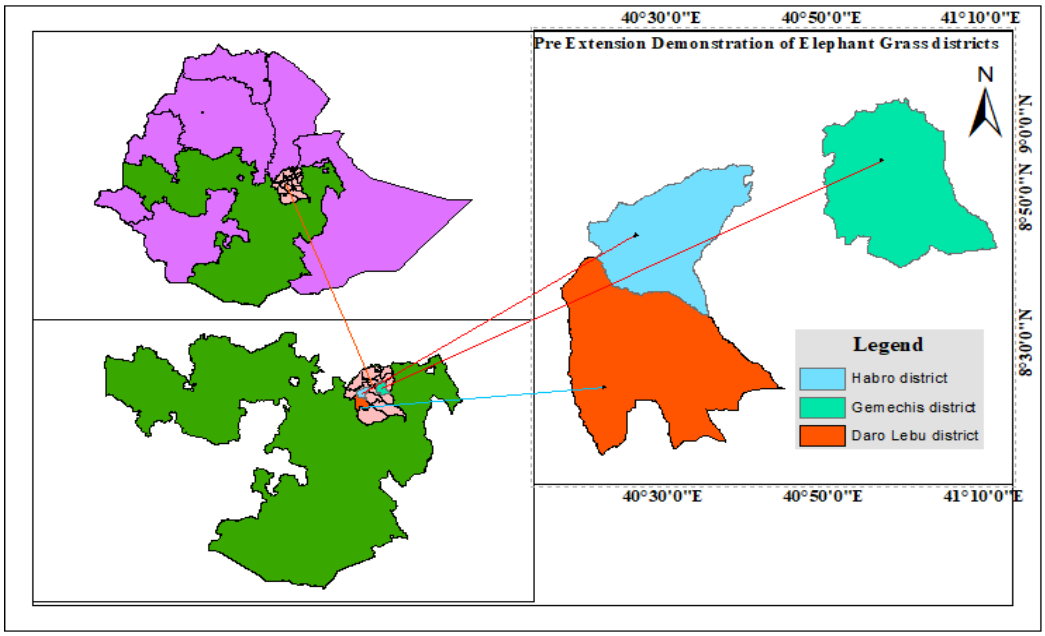

Figure 1: Map of the study area
Source: Own design from ArcGIS data, (2021)

Types of Data and Method of Data Collection

Data Types

Agronomic data collected for this activity were fresh biomass and plant height; farmers’ perceptions were also collected during mini field day based on different agronomic parameters and overall technology for the community.

Method of Data Collection

Checklist and data collection sheet were developed before planting; personal observation was used for data collection purpose. Close supervision and monitoring were undertaken through joint action of stakeholders. Finally, field day was organized for different stakeholders including farmers, development agents, agricultural experts to raise awareness and collect feedback regarding the technology.

Site and Farmers Selection

The demonstration was conducted in 2019/2020 cropping season at Daro Labu, Habro, and Gemachis districts of west Haraghe zone. One kebele, one FTC and three farmers from each district, total of three kebeles, three FTCs and nine farmers were involved in the demonstration process.

Research design

Two improved of Elephant grass cultivars; ILRI # 16800 and ILRI #16840 were demonstrated and evaluated with local check on 2m*32m; 64m^2 soil bund area for one treatment and 192m^{2}of total area was used across location. During the experiment

conduction, fertilizer rate of 100kg/ha NPS and 50kg/ha Urea was applied and plant spacing of 1m*0.5m with planting method of 45° slant was employed.

Method of data analysis

Quantitative data collected were descriptively analyzed. While, qualitative data were analyzed and presented through narration, exploration, and summarization. Garret ranking method was used to rank the three Elephant grass cultivars (two improved and one local check) based on the criteria used to select Elephant grass cultivars.

Technology Promotions and Capacity Building

Concerning awareness creation, training was organized for different stakeholders including farmers, DAs, and SMS. In addition, mini field day was organized to promote the well-performed technology and accepted by farmers.

Result and Discussions

Agronomic performance of Elephant grass

The mean values of fresh biomass of ILRI #16800, Local and ILRI #16840 of Elephant grass cultivars under this study were 100.3 t/ha, 75.1 t/ha and 66.9 t/ha respectively. The highest mean value of fresh biomass was recorded from ILRI #16800 (100.3 t/ha) cultivars and the lower mean value was from ILRI# 16840 (66.9 t/ha). This result was comparable with Tamirat *et al.* (2021) findings with maximum fresh biomass, ILRI#16800 (99.40t/ha) and the lower mean value with ILRI#16798 (64.53t/ha) at the second harvesting time. However, this result was lower than Birmaduma *et al*. (2021) whose result on similar cultivars on stations revealed ILRI #16800, ILRI #16840, and local were 163.17 t/ha, 157.3 t/ha, and 143.17 t/ha, respectively. This deference was expected due to management under on station and farmers' condition.

The mean value of plant height for the three Elephant grass cultivars; ILRI #16800, Local, and ILRI# 16840 were 75.5cm, 97.2cm, and 110.73cm respectively. The highest mean value of plant height was recorded from ILRI #16840 (110.73cm) cultivars and the lowest total was from ILRI #16800 (66cm) cultivar (Table 1). This result was comparable with Birmaduma *et al*. (2021) who reported ILRI#16840 (106cm) and lowest plant height ILRI#16787 (84 cm) at Mechara Agricultural Research on station and Kebede *et al*. (2016) who reported plant height at Areka (106.67cm), Holota (96.3cm), Adami Tulu (110.75cm).

Table 1: Agronomic performance and yield advantage

Cultivars	Biomass (t/ha)			Height (Cm)			Yield advantage(%) over local check
	Max	Min	Mean	Max	Min	Mean	
ILRI#16800	126	62.3	100.3	85	66	75.50	33.6
Local	94	47	75.1	107.6	85	97.20	
ILRI#16840	83.7	49.5	66.9	120.2	99	110.73	-10.9

Source: Own result, 2020

Field day

The field day was organized at the vegetative stage of the Elephant grass cultivars at Habro district(Bareda PA). A group of farmers, subject matter specialists, extension workers, researchers and others were involved in the program. Accordingly, 46 (37 Male, 9 Female) farmers, 3 (2 Male, 1 Female) extension workers, and 1 Male subject matter specialist, 9 others totally 59 particpants were attended the program (Table 2). Beside this, 59 leaflets on Elephant grass cultivars were delivered for the participants regarding the technology. Field visits through the facilitators, on-field technology selection, group discussion and general discussion were the major methods used in the program.

Table 2: Mini field day participants

Location	Participants								
	Farmers				Total	DAs	SMS	others	Total
	Adult M	Adult F	Youth M	Youth F					
Habro district (Bareda PA)	37	9	0	0	46	3	1	9	13

Source: Our result, 2020

Note: M-stands for male, F-stands for Female and DAs- stands for Development agents and SMS- stands for subject matter specialists

Farmers' preference

On the farmer's field, the Elephant grass cultivars' selection criteria were listed by the farmers, and ranking was conducted in a group. Farmers' preferences were ranked in the Garret ranking method. The result of Garret ranking techniques depicted in (Table 3) showed that plot coverage, Biomass, plant height, Rejuvination time, stand vigor, and softness were the major criteria used by the farmers to evaluate Elephant grass cultivars in the study area. Accordingly, ILRI #16800 cultivars ranked first in most of the criteria.

Table 3: Garret ranking result for cultivar selection

Cultivars	Ranking criteria						Rank
	PC	BM	PH	RT	SV	S	
ILRI #16800	72	75	66	69	75	72	1st
ILRI #16840	54	61	61	56	59	52	2nd
local check	43	48	51	48	52	50	3rd

Source: Own result, 2020

Note: PC= plot coverage, BM=biomass, PH= plant height, RT=Rijuvination time, SV=stand vigor, S = softness

Conclusion and Recommendation

Elephant grass plays an important role for livestock forage both under smallholder farmers and intensive livestock production systems. According to the findings, the highest fresh biomass was obtained from ILRI # 16800 (100.3 t/ha) followed by local (75.1 t/ha) and ILRI #16840 (66.9 t/ha). In addition to high fodder yielding, cultivar ILRI # 16800 has been selected by most of the parameters used to rank the three demonstrated cultivars under farmers' condition using mini field day organized for different stakeholders and has yield advantage of 33.6% over local check. This means, by using this improved elephant grass cultivar, farmers can harvest more forage yield than planting the local one. So, this cultivar is recommended for further pre scaling up in the study area as well as other areas facing with animal forage deficit.

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Pre-Extension Demonstration of Newly Released Groundnut Technologies in Daro Lebu & Boke Districts of West Hararghe Zone, Oromia National regional State, Ethiopia

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Abstract

The demonstration was carried out in Daro Lebu and Boke districts of West Hararghe Zone with the objectives of evaluating improved varieties of groundnut under farmers` field condition and to create awareness. Two kebeles were selected purposively based on groundnut production potential, one kebele from each district. Four farmers were included 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. One improved variety Milkaye with standard check were demonstrated and evaluated on 10mx10m farm area of each farmer. Both quantitative and qualitative data were collected through observation, feedback from farmers and data recording sheet. Descriptive statistics, and t -test was used to analyze collected data. While, qualitative data were analysed through description and narration. The result of the study indicated that Milkaye variety show 31.5% yield advantage over the standard check under farmer's condition. On the other hand, result of t-test shows that, there is statistically significant mean difference between the yield of standard check and improved variety (Milkaye) at less than 1% probability level. Farmers were preferred Milkaye variety due to its disease resistant, high number of pod per plant, high number of seed per pod, early maturity, drought resistance than Werer-96. Thus, Milkaye was recommended for further popularization and scaling up in study area and similar agro ecology.

Key words: *Groundnut, Milkaye**,** Yield advantage and farmers' preference*

Introduction

Groundnut **(***Arachis hypogaea L.***)**, a species in the family *leguminasea,* is an annual legume. It is known by many local names, including peanut, earthnut, monkey-nut and goobers. The groundnut originated in Latin America and was introduced to African continent from Brazil by the Portuguese in the 16th century (Adinya ***et al.,*** 2010). Groundnut is grown in nearly 100 countries. China, India, Indonesia, Nigeria, Senegal, Sudan, USA and Myanmar are the major groundnut growing countries (Taru *et al.,* 2010). The crop is mainly grown for oilseed, food, and animal feed (Pande ***et al.,*** 2003). It is the world's 13th most important food crop, 4th most important source of edible oil and 3rd most important source of vegetable protein (Taru ***et al.,*** 2010). Developing countries in Asia, Africa and South America account for over 97% of world groundnut cultivation and 95% of total production. Production is concentrated in Asia with 50% of global cultivation and 64% of global production. In Africa, groundnut production accounts for 46% of global cultivation and 28% of global production (Moumouni *et al*., 2020).

Oilseed sector plays an important role in generating foreign exchange earnings and it is mainstay of rural and national economy of Ethiopia in which groundnut is the one (USAD, 2020). Groundnut is grown under rain-fed and used for oil extraction, and for confectionary in Ethiopia. Moreover, it generates considerable cash income for several small scale producers and foreign exchange earnings through export for the country (Geleta *et al*., 2007). For people in many developing countries, groundnuts are the principal source of digestible protein (25 to 34%), cooking oil (44 to 56%), and vitamins like thiamine, riboflavin, and niacin. In many countries, groundnut cake and haulms (straw stems) are used as livestock feed. Groundnut 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. Groundnut is used to make oils and it is second largest source of vegetable oils next to soybeans (Savage and Keenan, 1994).

The lowland areas of Ethiopia have considerable potential for increased oil crop production including groundnut. The estimated production area and yield of groundnut in Ethiopia in 2019/2020 cropping season were 87,925.23 hectares and 1,565,331.62 quintals, respectively, and the largest groundnut production areas are found in Oromiya (50,812.48 ha), Benshangul-Gumuz (22,931 ha), Amhara (9,493.27 ha) and SNNPR (1,019.5 ha) regional states (CSA, 2020). However, Groundnut production is constrained and declined in Ethiopia due to poor management practices including delayed harvesting, lack of improved varieties, socioeconomic constraints, moistures or drought, diseases, mechanical damage at the time of harvesting, and limited curing and drying before storage (Berhe *et al*., 2020).

Oromia region have considerable potential for increased oil crop production including groundnut. Groundnut is mainly grown in Oromia region mainly in East and West Harerghe, Wollega, Kelem Wollega and Ilubabor. West Hararghe has a suitable environment for the production of low land pulse and oil crops especially for the production of ground nut with area coverage of 3,873 83 hectar in 2019/20 cropping season (CSA, 2020). Particularly areas such as Daro Labu, Babile and Gursum are the major producers of groundnuts for local and commercial consumption. Ground nut is mainly produced by small scale farmers and used as cash crops income generation for local farmers. Beside income for farmers, groundnut provides an inexpensive source of high quality dietary protein and edible oil. The production of ground nut is relatively easy and it has been found to be reliable under circumstances where other pulse crops would have failed due to drought. Production of groundnut is influenced by many factors such as climatic factors (rainfall, temperature, humidity, wind, solar radiation, edaphic), soil factors (very low organic carbon and very low available phosphorus) and biological factors (pests and diseases) and agronomic factors (fertilizer, spacing and weed management).

Based on practical problem of shortage of improved variety and low productivity of local varieties in the area, Mechara Agricultural Research Center have been conducting selection of genotypes in different breeding nurseries for last years and then advanced to variety trial to see its varietal performance across locations and years in Groundnut producing low lands areas of West Hararghe and released improved Groundnut variety namely Milkaye in 2019 cropping season for lowland of west Hararghe and similar agro ecologies. The newly released varieties give 22 Qt/ ha and show 14% yield advantage over standard check Werer-962 variety during the evaluation period. In addition the variety showed moderately resistant to bacteria leaf blight and leaf spot diseases in the tested environments, early maturing and relatively good oil & protein content as compared to standard check. Therefore, this activity

was initiated with objectives for to demonstrate and evaluate improved groundnut technologies in the study area.

Objectives

- To evaluate the performance of improved variety of groundnut under farmers condition
- To create linkage among stakeholders
- To collect farmers feedback on groundnut variety production and management 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°52'10" and 8°42'30" N and 4°023'57" and 41°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 to 2450 m.a.s.l. Ambient temperature of the district ranges from 14 to 26°C, with average of 16°C and 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).

Boke is one of the districts of West Hararghe zone well known in moisture stress. It bordered on the south by the Shebelle River which separates it from Bale zone, Daro Lebu on the South-west, Habro on the North-west, Kuni on the North-east, and Galetti River on the east which separates it from the East Hararghe Zone. Boke Tiko is administrative town of the district. It located at latitude of 10°56'26.5"N and a longitude of 14°16'49.07"W (Encyclopedia, 2013). Coffee is an important cash crop produced in the district. Among the coverage of the district the crop covers over 50 square kilometers.

Farmer's selection and demonstration field establishment

The study was conducted in Daro Lebu and Bake districts of west Hararghe zone in 2019/2020 cropping season. Site and farmers selection was conducted with participation of respective district of Agricultural and natural resource Office based on groundnut production potential. Similarly, trial farmers were selected collaboratively with respective Developmental Agent by considering different selection criteria's like farmers interest to the technology, model farmers and managing the field as required. Thus, a total of four (4) farmers were selected from both districts (three farmers from Boke district of Chabi kebele & one farmer from Daro Lebu district of milkaye kebele).

Table 1: Summary of selected districts, kebeles, farmers and varieties used for demonstration

Location/district	Kebele	No. of trial farmers	Varieties used for the trial
Daro Lebu	Milkaye	1	Milkaye & Warer-962 (standard check
Boke	Chabi	3	
Total		**4**	

Source: Demonstration result, 2019/20

One improved variety of groundnut namely Milkaye and standard check (Werer 962) were evaluated under farmer's` field condition. The experiment was demonstrated on 100 m^2 demonstration plots for each variety on each trial farmers and seed rate of 90 kg/ha. A spacing of 60cm X 10cm between row & plant spacing was used, respectively during the demonstration. Before conducting the trial, farmers were trained about improved groundnut production practices like seed rate, planting dates, crop management aspect and recommended agronomic practices. In addition, mini field day was organized at vegetative stage to create awareness and collect farmers' feedbacks on evaluated varieties.

Data Types and Method of Data Collection

Both qualitative and quantitative data were collected for the study. Qualitative data like farmer preference on demonstrated varieties was collected through personal interview of farmers during mini field day organized. On the other hand quantitative data like gained yield from demonstrated variety from each was collected directly from the field by researchers.

Method of Data Analysis

Descriptive statistics were used to analyze the crop performance concerning yield and yield components of the experiment harvested from demonstration plot. While qualitative data were analyzed through garret ranking technique and narration.

Results and Discussions

Crop performance and yield advantage of improved variety on the farmer's field

The mean yield of Milkaye and Werer 962 varieties was 8.9 and 6.1 Qt/ha with standard deviation of 3.9 and 3.2, respectively. The percentage increase in the yield of Milkaye variety over standard check was observed during demonstration time. Accordingly, Milkaye variety show 31.5% yield advantage over the standard check under farmer's condition. Even though, Milkaye variety's more yield than standard check (Werer- 962), it didn't show its potential yield during its release, 22 Qt/ha. This reduction of yield was caused by moisture stress at different stages of the crop at sowing, vegetative and flowering time which resulted in decrement in pod per plant, seed per pod, pod length and seed yield as well as high rainfall after maturity. This problem was agree with the report of Dahanayake *et al*., (2016) on 'Effects of water stress on yield and some yield components of three selected oil crops; Groundnut, sunflower and sesame'; Water stress had a highly significant impact on seed yield and biological yield. Water stress in groundnut production during flowering period may have resulted in death of pegs before pod initiation. After re-watering, the plants resumed flowering reaching physiological maturity with small pods without mature seeds. Plants stressed during maturity stage had a higher number of seeds per plant compared to other stressed treatments. The plants stressed during the vegetative stage also reduced pod number and seed yield. The reduction in seed yield agrees with previous findings on legumes under water stress such as black beans (Nielson et al, 1998); faba beans and Bambara groundnuts (Mwale *et al*, 2007, European Union FP-5 INCO-DC, 2002) and cereals like oats (Sandha *et al*, 1977) and maize (Kamara *et al*, 2003).

Table 2: Yield summary of the variety on farmers' fields in Qt/ha (N=4)

Variety Name	Max.	Min.	Mean	Std deviation	t-value	Sign
Milkaye	12.8	3.5	8.9	3.9	5.9***	0.001
Warer -962	9.9	2.2	6.1	3.2		

Source: Our computation, 2020/21

*** indicate significance at less than 1% probability level

Table 2 showed that the mean yield of standard check was less than that of Milkaye variety which indicated that using improved variety enhance the yield gain of farmers from their land. As shown in Table 2 the t-test value shows that, there is statistically significant mean difference between the yield of standard check and improved variety (Milkaye) at less than 1% probability level. This implies that, using improved variety increases the probability farmers to harvest more yield from their land than using local variety.

Farmers' Preference on Groundnut Technologies

Farmers' preferences data on improved groundnut technologies were collected at maturity stage of the crop through organizing field day. The data was collected from farmer's field and Farmer Training Center (FTC) of Chabi kebele in Boke district. A total of Forty Eight (48) participants were participated on mini field day for technology evaluation and selection at farmer's field.

Table 3: Mini Field day Participants

No.	Type of participants	No. of participants		Total participants
		Male	Female	
1	Farmers	22	21	43
2	Developmental Agent (DA)	1	1	2
3	Expert	3	0	3
Grand Total		**26**	**22**	**48**

The result of Garret ranking techniques on Table 4 indicate that seed size, disease resistant, number pod per plant, number of seed per pod, early maturity and drought resistance were used as major criteria rank and evaluating groundnut varieties on farmers field. Farmers were preferred Milkaye variety due to its disease resistance, high number of pod per plant, high number of seed per pod, early maturity, Drought resistance than Werer-962 (Table 4). Therefore, based on farmers', preference Milkaye variety was ranked as 1st for further dissemination in the study area.

Table 4: Garret Ranking Result

Variety	Garret score & ranked Criteria								Rank
	SS	DR	NP	NS	EG	Ph	EM	DrR	
Milkaye	69	68	72	71	71	64	73	70	1st
Werer-962	69	50	48	48	45	42	49	50	2rd

Note: SS= Seed size, DR= disease resistance, NP= Number of pod per plant; NS= Number of seed per pod, EG= Erected gross type, PH=Plant height, EM=Early maturity, DrR= Drought resistance

Conclusion & Recommendation

Oil seed sector plays an important role in generating foreign exchange earnings and it is mainstay of rural and national economy of Ethiopia in which groundnut is one. Hence, this study was conducted to evaluate yield performance of improved variety of groundnut under farmer's condition. The result of paired t test revealed that there is yield difference between improved and local varieties in terms of grain yield and showed grain yield advantage over the standard check by 31.5% with similar management.

On the other hand, ranking analysis also indicated that Milkaye variety was preferred due to its disease resistance, high number of pod per plant, high number of seed per pod, Early maturity, Drought resistance than Werer- 96 variety under farmer's condition. Therefore, this variety was recommended for production at west Hararghe Zone and similar agro ecological conditions to improve groundnut production and productivity.

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Pre-Extension Demonstration and Evaluation of Sesame Technologies in Daro Lebu, Mieso and Hawi Gudina Districts of West Hararghe Zone, Oromia National Regional State, Ethiopia

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Abstract

The experiment was carried out in Daro Lebu, Hawi Gudina and Mieso districts of West Hararghe Zone with the objectives of evaluating improved sesame varieties under farmers` field condition and to create awareness and improve skill of production and management of improved sesame varieties. One kebele and one FTC from each district; four farmers and one FTC from each kebele, total of twelve farmers and three FTCs were selected purposively based on sesame production potential, interest to the technology, managing the experiment, having appropriate land for the experiment and taking the risk in condition of failure happens. BaHa-zeyit and BaHa-necho improved sesame varieties were demonstrated and evaluated with standard check (Adi). The experiment was demonstrated on 300m^2 plot area across locations. Both quantitative and qualitative data were collected through observation, farmers' feedback and data record sheet. Descriptive statistics was used to analyse the collected quantitative data. While qualitative data were analysed in narration and summarization. Garret ranking method was used to rank farmers' preference data on sesame variety selection criteria. The result of the study indicated that the yield advance was obtained from BaHa-zeyit (3.05Qt/ha) followed by BaHa-necho (2.7Qt/ha) and the least was 1.45Qt/ha from Adi. In addition, BaHa-zeyit variety ranked first with those parameters used to rank the three varieties on mini field day like drought tolerance, disease tolerance, pest tolerance, number of branches per plant, number of capsules per plant, capsule length, and seed per capsule, early maturity; and has yield advantage of 110% over Adi. Thus, BaHa-zeyit is recommended for further popularization and scaling up in study area, and similar agro-ecologies.

***Key words**: Sesame, BaHa-zeyit, BaHa-necho, Adi, Demonstration*

Introduction

Sesame (Sesamum indicm L.) is an annual crop and one of the important oil crops of the world and belongs to the order Tubiflorae and family Pedaliaceae cultivated for seed (Raikwar & Srivastva, 2013). The oilseed sector in Ethiopia is one of the fastest growing sectors in the country. It is the second largest source of foreign exchange earnings after coffee (FAO, 2012) and sesame is the main oilseed crop in terms of production value. In 2010, Ethiopia was considered the second main exporter of sesame seeds in the world, behind India (FAOSTAT, 2012). The cultivation of sesame has grown since 2000, owing to its high value on the export market and good adaptability in the country.

The many varieties of Ethiopian sesame seeds make it suitable for a wide range of applications, either as seeds or oil products. Another feature of sesame is its flexibility to different soil types and harsh environments, which makes it well suited for production in most of the country. Furthermore, "sesame rotates well with a number of other crops including cotton, corn, peanut and sorghum, and is also a good soil builder. That said, many farmers do not diversify and focus solely on sesame" (Coates et al., 2011). CSA, (2019/20) reported, out of 820,792.09 hectare covered by oil seeds, sesame particularly covers about

375,119.95 ha (45.7%); and contributed the yield of 0.78% (2,626,541.89 quintals) to the national product with average productivity of 7Qt/ha; similarly, in Oromia the total area coverage during 2019/20 crop season was 36,492.24hectares and the yield obtained was 247,134.28 quintals with the average productivity of 6.77Qt/ha and West Hararghe is also a good potential area for this crop.

Although there was an increase in average yields, production is rain-fed, characterized by intensive labor and low levels of inputs (Coates *et al*., 2011). According to Gelalcha (2009), it was reported that "the existing production system suffers from traditional farming practices, unimproved seed and lack of fertilizer use. The reason for low sesame productivity owes to a combination of various factors. The main constraints, highlighted by Gelalcha (2009), are low use of improved seeds, fertilizers and cultivars, biotic stress and lack of knowledge on adequate post-harvest crop management farming practices. The supply system for improved inputs is not well developed, and extension services to improve farming techniques are not sufficient. As a consequence, producers are increasingly betting on other crops, such as maize and sorghum, considered to be ''less risky and more profitable'' (Gelalcha, 2009).

In semiarid regions across the world, the production potential of sesame is often limited by drought stress (Boureima *et al*., 2012). In addition, insects at seedling stage and prevalence of diseases, traditional farming practices, unimproved seed and lack of fertilizer use are among the major factors lessening production and productivity of the crop in West Hararghe zone. Therefore, improving production and productivity of sesame in West Hararghe is the most decisive through improved extension service, availing new technology, disease resistant and drought tolerant as well as early maturing varieties to cope with moisture stress problem thereby change the livelihood of farming communities.

Hence, Mechara Agricultural Research Center has conducted the adaptation trail of improved BaHa-necho & BaHa-zeyit sesame varieties at Daro Labu, Hawi Guddina and Mieso districts in 2017/18 crop season which were released by Haramaya University in 2016. The result of the adaptation trial revealed that BaHa-necho (5.98Qt/ha) & BaHa-zeyit (5.7Qt/ha) gave yield advance than Adi (4.02Qt/ha) with yield advantage of 48.8% and 41.8%, respectively. Therefore, there was a need to further evaluate BaHa-necho & BaHa-zeyit varieties under farmers' condition in the study area.

Objectives

- To evaluate the performance of improved variety of sesame under farmers' condition
- To create linkage among stakeholders
- To collect farmers feedback on sesame production and management in the study area

Materials and Methods

Description of the study area

The study was conducted in Daro Lebu, Mieso and Hawi Gudina districts of West Hararghe Zone of Oromia national regional state, Ethiopia.

Daro Lebu is district, which is its town is Mechara is found at about 434km South East of Addis Ababa. The district is situated between 7°52'10''and 8°42'30'' N and 4°023'57'' and 41°9'14''E. The ambient temperature of the district ranges from 14 to 26^{0}C with average of 16^{0}C with average annual rainfall of 963 mm/year. Mieso woreda is located at (latitude 9°23' N, longitude 40° 75'E, annual total rain fall ranges from 271 to 1111mm, mean annual maximum temperature 26.8 to 30.6°C and mean minimum annual temperature is 13.7 to 15°C(Hirut and Kindie, 2015). The altitude of Mieso ranges from 1107 to 3106 meters above sea level.

Hawi Gudina is situated between 7°52`15`` and 9°25`43``N and 40°34`13`` and 41°9'14" E. The topography of the district is mainly flat lowland with altitudes ranging from 976 to 2077 m a.s.l.

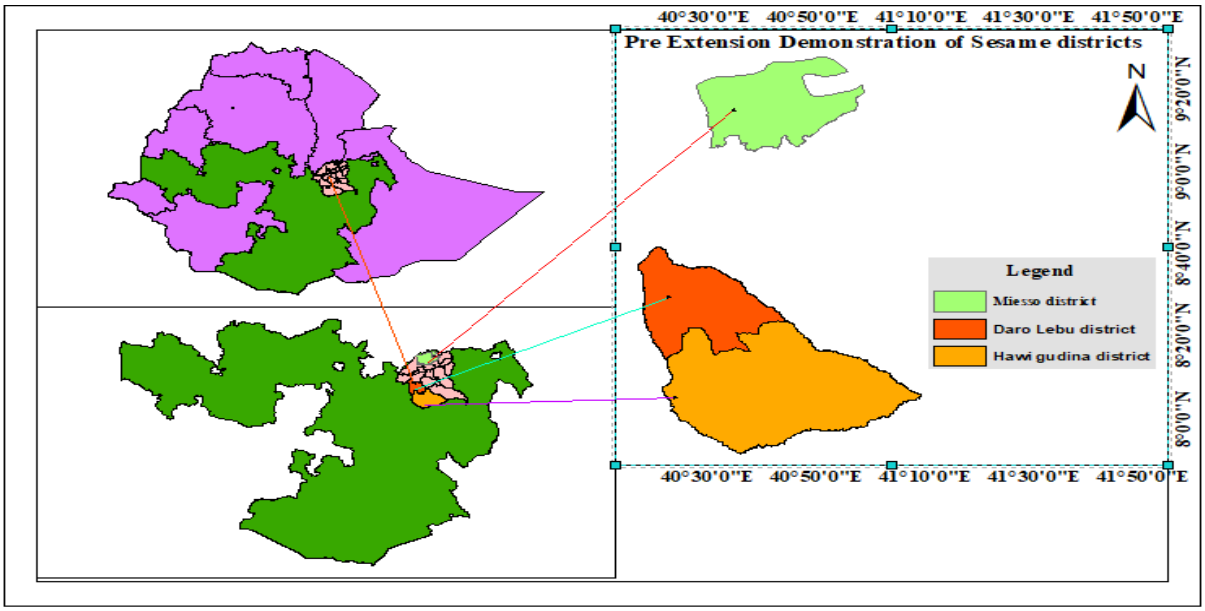

Figure 1: Map of the study area
Source: Own design from ArcGIS data, (2021)

Types of Data and Method of Data Collection

Data Types

Agronomic data like: date of sowing, farmers' preference and yield per area were collected.

Method of data collection

Data collection sheet is developed prior to planting. Then, personal observation, measurement and focus group discussion were used as data collection methods.

Site and Farmers Selection

The activity was conducted for one year in Daro Lebu, Miesso, and Hawi Gudina districts of West Hararghe zone. Accordingly, Sakina kebele from Daro Lebu district, Ibsa kebele from Hawi Gudina district, and Golbo kebele from Mieso district were purposively selected based on their sesame production potential. Meanwhile, four farmers and One FTC from each kebele and total of 12 farmers and 3 FTCs were selected in collaboration with woreda's agricultural experts and respective extension workers based on their willingness to the technology, managing the experiment and have appropriate land for the experiment.

Research Design

Two improved sesame varieties; BaHa-necho and BaHa-zeyit were demonstrated and evaluated with standard check (Adi) on 10m*10m simple plot area. During the demonstration, 100kg/ha of NPS fertilizer rate at sowing time, 5kg/ha of seed rate, plant spacing of 40cm*10cm was used and agronomic practices like weeding and thinning were also applied for each demonstration plot.

Method of data analysis

Quantitative data collected were analysed using descriptive statistics. While, qualitative data were analysed and presented through narration and summarization. Garret ranking method was used to rank the three sesame varieties in farmers' preference criteria to select the most preferred sesame variety.

Technology Promotion and Capacity Building

Concerning awareness creation, training was organized for different stakeholders' including farmers, DAs and SMS. In addition, mini field day was organized for different stakeholders including farmers, SMS and DAs to promote the well performed technology and accepted by farmers

Result and Discussions

Yield Performance of the Varieties

The yield data were collected from eight farmers among the trial farmers in Mieso, Hawi Gudina and Daro Lebu districts. The result obtained from the three sesame varieties accounted 3.05 Qt/ha for BaHa- zeyit, 2.7 Qt/ha for BaHa- necho and 1.45 Qt/ha for Adi. The highest yield was recorded from BaHa-zeyit and the lowest from Adi as well as BaHa-zeyit variety has 110% yield advantage over Adi (Table 2).

Table 1: Mean yield of sesame varieties across districts

Varieties	**Mean yield (Qt/ha)**		
	Daro Lebu	Hawi Gudina	Mieso
BaHa-zeyit	3.11	3.84	1.5
BaHa-necho	3.2	2.74	1.885
Adi (Standard Check)	1.42	1.9	0.8

Source: Our result, 2020

Table 2: The yield of improved sesame varieties and its yield advantage

Varieties	Yield (Qt/ha) N=8				Mean difference over Adi (Qt/ha)	Yield advantage (%)
	Min	Max	Mean	Std. Dev.)		
BaHa-zeyit	1.66	4.94	3.05	1.25	1.6	110
BaHa-necho	1.62	4.20	2.7	0.99	1.25	86.2
Adi	.35	2.59	1.45	.79	-	-

Source: Our result, 2020

Table 3: Seed yield at different stages

Varieties	**Yield (Qt/ha)**		
	Release (2015)	Adaptation (2017/18)	Demonstration (2020/21)
BaHa-zeyit	13.03	5.7	3.05
BaHa-necho	12	5.98	2.7
Adi	9.7	4.02	1.45

Source: Our result, 2020

The yield obtained during the demonstration was less than during release and adaptation due to moisture stress at different stages of the crop which might decrease capsule per plant and seed yield in line with the findings of Dahanayake *et al*. (2016) on 'Effects of water stress on yield and some yield components of three selected oil crops; Groundnut, sunflower and sesame'; Water stress had a highly significant impact on seed yield and biological yield. The highest seed yield was obtained by T1 Groundnut (14.1g/plant), Sunflower (9.79 g /plant) and Sesame (9.5 g/plant) whereas least seed yield belonged in T3 Groundnut (1.9g/plant), Sunflower 5.75g/plant) and Sesame (3.4g/plant). It seems that Groundnut, Sunflower and Sesame are very sensitive for water stress conditions resulting decreases of yield. Effect of water stress on number of pods per plant was highly significant. The highest number of pods per plant was obtained in T1 Groundnut (12/plant), Sesame (17.9/plant) and the least number of pods per plant was obtained in T3 Groundnut (5.2 /plant) and Sesame (11.2/plant).

Field day and awareness creation

Mini field day was organized at maturity stage of the sesame at Hawi Gudina district. A group of farmers, subject matter specialists, communication experts, researchers and other experts were involved on the program. There are 36 (33 Male, 3 Female) farmers, 3 extension agents and 6 subject matter specialists were participated on the program (Table 4). Field visit through facilitator, on-field technology selection, group discussion and general discussions were the major methods used in the program. The Bedru *et al*. (2009) indicated that defining purpose, planning, implementation and evaluation of the program is important in conducting field day on the farmers' field. In the program, farmers have selected the best performed sesame variety based on different criteria for further production. Beside this, 80 leaflets on sesame production were delivered for the participants of the field day program organized to create awareness on the improved sesame technologies.

Table 4: Mini field day participants at Hawi Gudina district, Ibsa kebele

Location	Participants of mini field day								
	Farmers					DAs	SMS	Other	Total
	Adult M	Adult F	Youth M	Youth F	Total				
Ibsa PA	33	3	0	0	36	3	1	12	16
Total	33	3	0	0	36	3	1	2	16

Note: M-stands for male, F-stands for Female and T-stands for total, DAs- stands for Development agents and SMS-stands for subject matter specialists.

Farmers' preference

Farmers' preference data on improved sesame technologies was collected at maturity stage of the crop using organized mini field day. The data was collected at farmer's field at Hawi Gudina district, Ibsa *kebele*. Both women and men were participated on mini field day for technology evaluation and selection at farmer's field.

On the farmer's field, the sesame variety selection criterions were listed by the farmers and ranking was conducted in a group. Farmers' preferences were ranked in garret ranking method. The result of Garret ranking techniques depicted on Table 5 showed that drought tolerance, disease tolerance, pest tolerance, number of branch per plant, number of capsule per plant, capsule length, seed per capsule and early maturity were the major criteria used by the farmers to evaluate sesame varieties in the study area; accordingly, BaHa-zeyit variety ranked first in the majority of criteria's.

Table 5: The result of Garret ranking techniques of sesame varieties selection criteria

Varieties	**Garret score and ranked criteria**									Rank
	DrT	DsT	PT	HE	NB	CL	NCP	SPC	EM	
BaHa-zeyit	63	66	63	62	60	56	65	67	71	1st.
Adi	49	46	55	54	56	55	55	59	59	3rd.
BaHa-necho	62	65	61	60	59	53	62	66	57	2nd.

Source: our result, 2020

Note: DrT= drought tolerance, DsT= Disease tolerance; PT= pest tolerance, HE= height, NB= number of branch per plant, NCP= CL= capsule length, number of capsule per plant, SPC= seed per capsule, EM= early maturity

Profitability analysis of the varieties

Table 6: Cost-Benefit Analysis of the Demonstrated Sesame Varieties

No	Variables	Varieties		
		BaHa-zeyit	BaHa-necho	Adi
1	Yield obtained (qtha-1)	3.05	2.7	1.45
2	Sale price (ETB/qt)	5000	5000	5000
3	Gross Returns (P*Q)	15250	13500	7250
4	Labor (land preparation to loading to store)	3800	3750	3650
	Seed purchase	250	250	250
	Fertilizer (NPS)	1400	1400	1400
	Store (sack purchase)	56	42	14
	Total Variable Costs TVC (ETB/ha)	5506	5442	5314
5	Fixed cost	2000	2000	2000
6	Total cost (TC)	7506	7442	7314
7	Net Return (GR-TC)	7744	6058	-64
8	**Benefit cost ratio (NR/TC)**	**1.03**	**0.81**	**0.01**

Source: Our computation, 2020

As illustrated in the above table (Table 6) the cost benefit ratio analysis, the net return gained from BaHa-zeyit and BaHa-necho Adi was 7744 birr and 7442 birr, respectively. While, producing Adi variety the producer loss 64 birr on hectare. BaHa-zeyit variety had higher cost benefit ratio (1.03) than BaHa-necho (0.81) and Adi (0.01). This means, BaHa-zeyit variety is more profitable than BaHa-necho and Adi variety with the same cost expenditure for the three varieties per unit area. Therefore, the producers can maximize their profit through producing BaHa-zeyit sesame

Conclusions and Recommendations

BaHa-zeyit and BaHa-necho varieties of improved sesame were evaluated with Adi on twelve experimental farmers land. From the evaluated treatments BaHa-zeyit variety has shown Yield advance (3.05Qt/ha) than Adi (1.45Qt/ha) and BaHa-necho (2.7Qt/ha). Even though the varieties didn't record its potential yield due to moisture stress during different stages which might decrease capsule per plant and seed yield of the crop, BaHa-zeyit variety has more yield advantage, 110% over Adi and benefit-cost ratio of 1.03 in the study area. Farmers have also selected BaHa-Zeyit variety in terms of drought tolerance, disease tolerance, pest tolerance, number of branch per plant, number of capsule per plant, capsule length, seed per capsule, and early maturity on the organized mini field day. Beside observation and the experiment result, the demand of the crop in the market due to its whitish color, it has motivated the farmers to accept the technology, expand and disseminate the seed further on their own land in the future and it is recommended for further pre scaling up.

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Pre-Scaling up of Animal Drawn Wheat Row Planter in Selected Districts of Arsi, West Arsi and Bale Zones

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Abstract

Pre- scaling up of animal drawn wheat row planter was carried out in three purposively selected districts namely Tiyo from Arsi, Dodola from West Arsi and Sinana from Bale zones with objectives of creating wider demand pull by reaching large number of users, enhancing production and productivity of wheat using this technology improving farmers' knowledge and skill of application of the improved technology and increasing local capacity for future scaling up of the technology. From these districts six peasant associations were purposively selected based on their accessibility from list of peasant associations. Then, a total of six groups one at each peasant associations which have an average of fifteen members of farmers composed of male, female and youth were organized to undertake scaling up of technology. A total of 84 participants of which 64.3% was male and 35.7% female from four districts participated on both theoretical and practical training. The training was mainly focused on how to operate technology and relative advantage of technology. Training was also provided to capable micro enterprises that could fill gap of shortage of technology and linkage was also done with different stake holders. Mini-field-day was organized to share experiences and knowledge and all the farmers who attended the demonstration understood advantages of this technology. Therefore; Animal drawn wheat row planter technology recommended for further promotion, popularization and wider multiplication and dissemination of the technology.

Key word: Wheat row planter, Scaling up, Stakeholders, Training and Linkage

Introduction

In Ethiopia wheat is the most important food crop and accordingly the crop is grown on 1.63 million hectares annually. The annual production was estimated to 3.43 million tons which is 17% of total cereal crops production (CSA, 2014). According to available data (CSA, 2014), the average national productivity is 2.01 tons per hectare which is one of the least productivity in the world compared to world average wheat productivity per hectare which is 4 tons (FAO 2009).

In recent years, demand was growing for row planting implements and methods as farmers' awareness for row planting is developing from their own evolving traditional practices and extension advocacy. According to Tolosa *et al*, (2014) Many attempts for wheat and teff row planting are emerging as farmers in many places are trying out with undesigned items like 'masti' (designed for baking injera) and various bottles and other containers. With such traditional and unverified methods of row planting, dramatic increase in yield and reduction of the quantity of seed required has been reported by farmers, DAs and experts. The research study done by Tolosa *et al*, (2014) in high land and low lands of Arsi zone also reported that there is significant yield difference between row planted and broadcasted wheat farm (13.9%) in high lands but with low significant difference in lowland areas.

Asella Agricultural Engineering Research Center developed wheat row planter which can solve this problem and conducted participatory evaluation of different planters from different sources. From the result obtained from participatory evaluation of different planters; OARI-Asela AERC wheat row planter comes first because of its minimum labor requirement, appropriate seed rate which is almost equivalent to recommend seed rate and time it takes to cover one hectare. The participant farmers during the evaluation and demonstration process also ranked at first OARI-Asela AERC wheat row planter. Depending on the result obtained during technology evaluation pre-extension demonstration of wheat row planter was done in two zones namely Arsi and west Arsi. Results from previous pre-extension demonstration which were eight hour to plant one hectare with pair of oxen and two persons whereas four pair of oxen and twelve persons to cover the same amount of land. The seed rate of this technology was 120kg/he whereas 200kg/he by traditional way of planting and 70 quintals yield for wheat row planter and 60 quintals for traditional one.

Therefore, this research intended to scale up/out animal drawn wheat row planter to selected districts of Arsi, west and Bale zones.

Objectives of the study

- To create wider demand pull by reaching large number of users
- To enhance production and productivity of wheat using this technology.
- To improve farmers' knowledge and skill of application of the improved technology
- To increase local capacity for future scaling up of the technology

Methodology

Site and farmer selection

To conduct pre-scaling up of animal drawn wheat row planter first three districts namely Xiyo from Arsi, Dodola from west Arsi and Sinana from Bale zones were purposively selected because of their representativeness and appropriateness. Then experimental site and representative farmers were selected based on location, soil type, suitability for more farmers to visit the plot with DA and district expert for to undertake the experiment. To do this farmers` training center (FTC) was used as experimental site to undertake pre-scaling up of animal drawn wheat row planter.

Technology evaluation and demonstration method/techniques

Pre-scaling up of animal drawn wheat row planter was held in the three selected districts of three zones in the presence of farmers and different stakeholders. To do this farmers research (FREG) approach was followed. This group in composes fifteen members which have different category of farmers like male, female and youth. For these groups Asella Agricultural Engineering Research Center produces wheat row planters for each group and distributed it to groups. Since, this research is pre-scaling up the exiting mechanism was training of capable micro-enterprises as well as training, demonstrating performance of the technology, field day, leaflets and mass media coverage on the production of the technology and linking them with different stakeholders.

Data type and method of data collection

This study employed both qualitative and quantitative data from primary data source. Primary data such as uniformity of seed dropped, time to cover one hectare, labor reduced, agronomic and yield data, total number of farmers participated in training, field visits and field days by gender, Numbers of farmers become aware of the relative advantage of the technology by gender, Role of farmers and other stakeholders in technology scaling up was collected using data like field observation, household/participant interview, focus group discussion.

Method of data analysis

The study employed simple statistical analytical tools like percentage and mean value for data analysis.

Stakeholder analysis

In enhancing animal drawn wheat row planter technology dissemination, improving wheat production and productivity, the research center was closely working and made frequent consultation with its respective stakeholders. Pre-scaling up activity should be done by different actors in partnership and collaborative approach. So, stakeholder analysis is highly important for institutional arrangement 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 much they are closer to the project? What are their roles, duties and responsibilities in implementing the activity? And finally the roles, duties and responsibilities of each actor were clearly stated in implementing the activity. Accordingly, 4 (four) responsible and collaborative participant stakeholders/actors were identified. Namely, Agricultural Engineering Research Center, office of Agriculture and Natural resources of each zone, micro-enterprises; Tiyo and Tijo, and Sinana Districts office of Agriculture and Natural resources. Besides, stakeholders' forum was organized for consultation meeting; stakeholder platforms were established at zone and District levels; Memorandum of Understanding (MoU) was signed.

Communication methods used

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

- Telephone (fixed and/or mobile)
- Study tour or field visit and supervision
- Workshop (for status evaluation)
- Field day
- Demonstration: method and result demonstrations
- Group meeting and discussion session

Table 1
Stakeholder roles and responsibilities in implementing the activity

Stakeholders	Roles and responsibilities
Asella Agricultural Engineering research center	❖ Coordination and facilitation, ❖ Provision of animal drawn wheat row planter technology ❖ Provision of inputs ❖ Provision of training ❖ Technical backstopping ❖ Organize field days and Supervision and joint monitoring and evaluation
Micro-enterprises	❖ production of animal drawn wheat row planter ❖ Availing technology to users by reasonable price
District and Zone level Agricultural and natural resources offices	❖ Assist in site and participant farmers' selection ❖ Follow up day to day activities ❖ Assist in providing training ❖ Facilitate technology distribution ❖ Jointly organize and participate on field days
Farmers	❖ Allocate land and perform required practices ❖ Actively participate in the training ❖ Share skills and experiences to neighbor farmers

Results and Discussions

Training

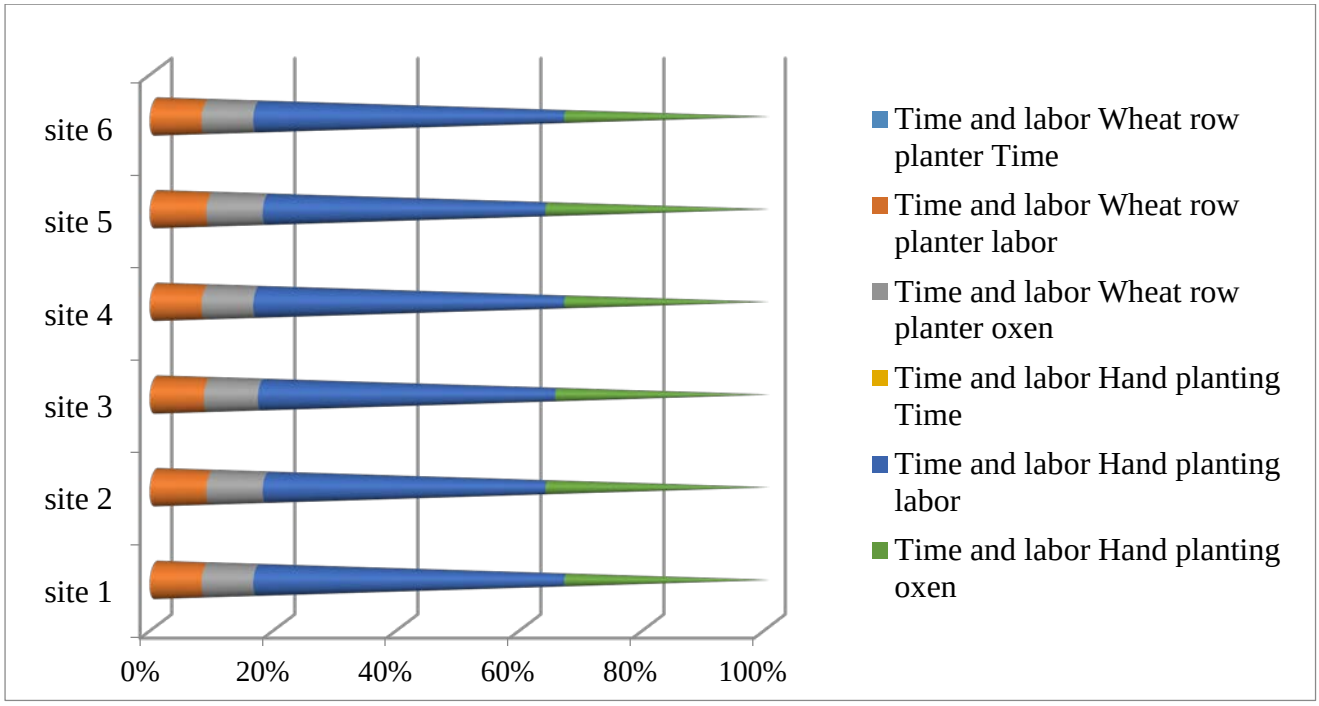
A total of 69 participants of which about 37.7% female and about 62.3% males have attended the training successfully. The training mainly focuses on promotion of technology and awareness creation among farmers and participant stakeholders. After training, all FRGs were provided a wheat row planter technology with modified spike tooth harrow.

Table 1: Training given for farmers, development agents and districts experts

Districts	Participants	Male	Female	Total
Dodola	Farmers	18	12	30
	Experts	2	-	2
	DAs	1	-	1
Tiyo	Farmers	9	6	15
	Experts	2	-	2
	DAs	-	1	1
Sinan	Farmers	9	6	15
	Experts	2	-	2
	DAs	-	1	1
Total		43	26	69

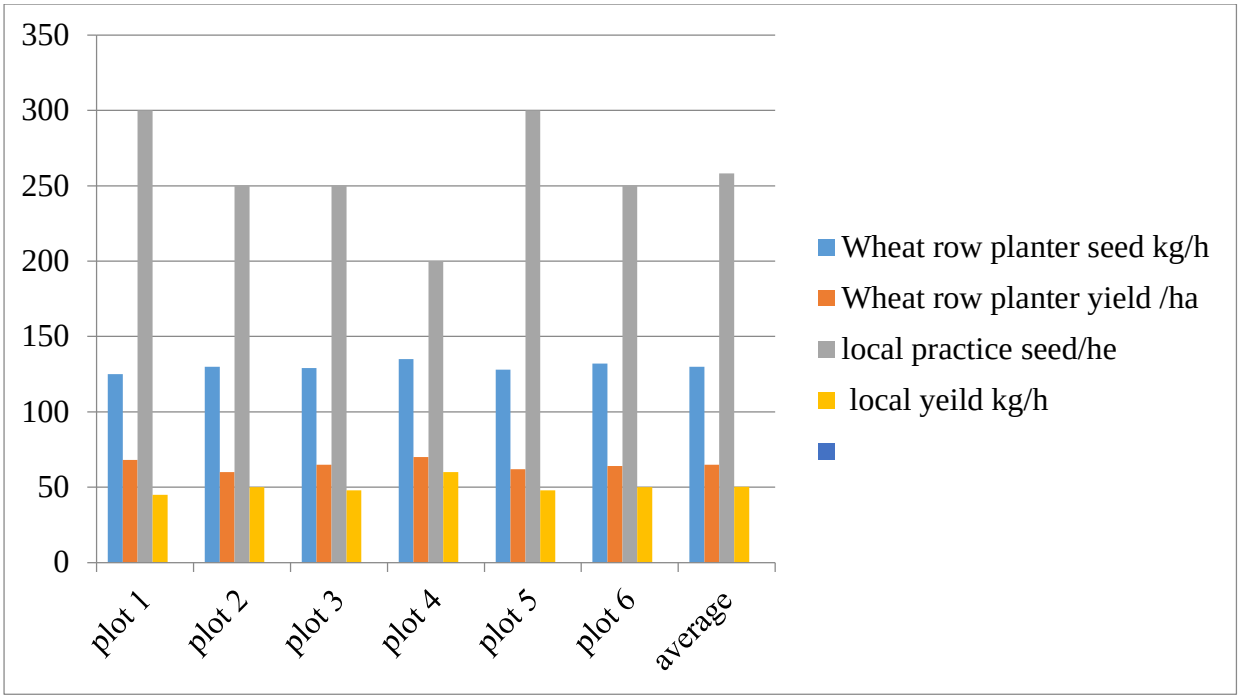
Time and labor taken

The result in the following graph shows that time taken to complete planting of one hectare of land by one pair of oxen ranges from 7-8 working hours. Whereas data in the following graph shows that it takes the farmers to plant one hectare of land with four pair of oxen in nine working hours (9). As a result planting wheat by row planter minimizes time wastage. In addition, planting wheat by row planter also reduce labor force to complete one hectare of land by pair of oxen from twelve person to two person. This has an advantage in terms of cost and other merits. This also graphically illustrated as follow.



Seed and yield comparison

As it was revealed on the following graph the average seed to plant one hectare of land was one hundred thirty four kilogram (130kg). Where as to plant the same amount land using un-designed local planning material need about two hundred fifty eight kilogram (258kg) of seed. Planting wheat by wheat row planter had relative yield advantage over local one by fourteen quintals (14quintals) on average. It also graphically illustrated as follow.



Conclusion and Recommendations

Conclusion

This research was conducted in three purposively selected districts of Arsi, Bale and west Arsi zones namely Tiyo, Sinana and Dodola because of their appropriateness for the technology being scaled up. To undertake scaling up of this technology two peasant association from each district were selected and six FRG of which 37.7% female and about 62.3% of them were male were established. Time taken to complete planting one hectare of land by one pair of oxen ranges from 7-8 working hour. Whereas it takes the farmers to plant one hectare of land with four pair of oxen in nine working hours. As a result planting wheat by row planter minimizes time wastage. Farmers use this time to operate other farm activities. In addition, planting wheat by row planter also reduce labor force to complete one hectare of land by pair of oxen from twelve person to two person. From this finding there is reduction time and labor by wheat producer farmers. The result this finding also reveals that the average seed to plant one hectare of land was one hundred thirty four kilogram (13okg). Where as to plant the same amount land using un-designed local planning material need about two hundred fifty eight kilogram (258kg) of seed. Planting wheat by wheat row planter had relative yield advantage over local one by fourteen quintals (14quintals) on average.

Recommendations

Animal drawn wheat row planter technology recommended for further promotion, popularization and wider multiplication and dissemination of the technology.

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Pre-Extension Demonstration of Faba Bean Thresher Through Freg In Selected AGP-II Districts of Arsi Zone

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Abstract

Pre-extension demonstration of faba beab thresher through FREG in selected AGP-II Districts of arsi zone was carried out in two purposively selected districts namely Tiyo and Lemu Bilbilo from Arsi zone with the objectives of enhancing farmers awareness on the importance and use of the machine, evaluating the performance of the machine under farmers condition, collect farmer's feedback on technology, evaluating the economic analysis/ cost-benefit gain of the machine. Two kebeles were purposively selected based on their accessibility and two framers research extension groups composed of members representing male, female and youth were organized to undertake the demonstration. Training was given to a total of 84 participants of which 64.3% was male and 35.7% female from four districts participated on both theoretical and practical training. The training was mainly focused on how to operate technology and relative advantage of technology. The demonstration was conducted on two hosting farmers from FRGs. Among the farmer interviewed 50% had responded that it was simple to operate the faba bean thresher, 33.3% of farmers responded that it was very simple and 16.7% of respondent farmers were responded that it was medium to operate faba bean thresher technolog. Maintenance of the technology was also considered as one criterion to see the simplicity of technology. Regarding to the simplicity of maintenance of technology; 40% of farmers responded that maintenance of technology was medium, 31.3% and 11.7% answered as it was simple and very simple to maintain technology. Whereas only 15% the respondent responded that it was difficult to maintain it. Regarding affordability of the technology; about 46.7% of respondent farmer responded that the cost of technology was medium that it can be affordable by the average farmers and 23.3% of farmers responded that the price of technology was low to purchase. About thirty percent 30% of respondent said that the price of technology was high to afford. From the result of this finding net income of farmers increased from six thousand three hundred fifty (6, 350) birr. Thus, faba bean thresher technology was recommended for further scaling. the average threshing capacity of the machine was three point eight quintals per hour (3.8quintals/hr). Whereas threshing by tradition practice was one point two quintals per hour (1.2quintals/hr). As revealed in the following graph threshing faba Bean using thresher reduce labor from four person to two person. Apart from this no breakage recorded by traditional one whereas 8% breakage recoded while threshing by faba Bean thresher. Therefore technology was recommended for farther improvement.

Key words: *Demonstration, Faba bean thresher, Faba bean, Net benefit and Farmers perception*

Introduction

Faba bean (*Vicia faba* L.) is one of the most important cool season grain legumes in Ethiopia in terms of hectarage, total production, foreign exchange earnings and soil amelioration (Amare, 1990). Faba bean contributes to smallholder livelihoods in multiple ways. It can play a significant role in improving smallholders' food security, as an affordable source of protein and other essential nutrients.

Faba bean can have an income benefit for smallholders as it yields a higher gross margin than cereals (IFPRI, 2010). Its crop residue is also widely used as animal feed In addition to improving food and nutritional well-being, faba bean can improve soil fertility through its ability of fixing atmospheric nitrogen to the soil. According to Somasegaran and Hoben (1994), faba bean is the efficient N fixer (240 to 325 kg ha^{-1} yr^{-1}) when inoculated with *Rhizobium leguminosarum* bv. *viciae*.

Research on cropping systems in Ethiopia indicated that the improvements in soil fertility from planting wheat after faba bean in rotation can improve grain yield of wheat by more than one ton per hectare and can reduce fertilizer usage for cereals up to 60% (Amanuel and Daba, 2006). Different research works made in recent years revealed that inoculation of faba bean with *R. leguminosarum* can *increase* yield by 10 to 50% (Abere et al., 2009).

Despite tremendous advantage of this crop, faba bean producer farmers are facing challenge of threshing it in traditional way which is backward, time consuming and tedious farm activity. Bako Agricultural Engineering research center adapted a faba bean thresher with good and promising capacity. According to Bako Agricultural Engineering research center (unpublished report of 2017) the threshing capacity of 306.31Kg/hr was obtained percentage of mechanical damage and threshing efficiency at this operation is 0.02 and 95.2%, respectively.

Therefore, this study is initiated with the objectives of demonstrating Faba bean thresher to farmers of selected AGP-II districts Arsi zone.

Objective

- To enhance farmers awareness on the importance and use of the machine
- To evaluate the performance of the machine under farmers condition
- To collect farmer's feedback on Faba bean thresher technology
- To evaluate the economic analysis/ cost-benefit gain of the machine

Material and methods

Materials

The materials that were used for the implementation of this study were faba bean thresher, 10HP motors, digital balance and stopwatch.

Method

Site selection, Technology evaluation and demonstration methods/techniques

Demonstration of faba bean thresher was held in two districts purposively selected based on their crop potential. Based on this Lemu Bilbilo and Munessa districts of Arsi zone were selected. Two kebeles from each district and in each Kebele one FRG which has different category of farmers like male, female and youth established. The technology was tested and compared with traditional way of threshing faba bean at selected kebele station. Both result and method demonstration method and techniques was followed. The mechanisms used to enhance farmer to farmer learning and information exchange was field visit/tour and field day. The experiment was done on two treatments which were new practices with its local practices.

Data type and Method of data collection

This study was employed both qualitative and quantitative data from primary data sources. Primary data such as time reduced because of using this machine, labor reduced, economic return/profitability, total number of farmers participated in training, field visits and field days by gender, numbers of farmers become aware of the relative advantage of the technology by gender, role of farmers and other stakeholders in technology demonstration, farmers' opinion was collected using different appropriate data collection method/technique such as field observation, household/participant interview, focus group discussion.

Method of data analysis

Data was analyzed using descriptive statics like percentages, mean values and frequencies. Economic data on Faba Bean Thresher was analyzed using partial budget analysis.

Result and Discusion

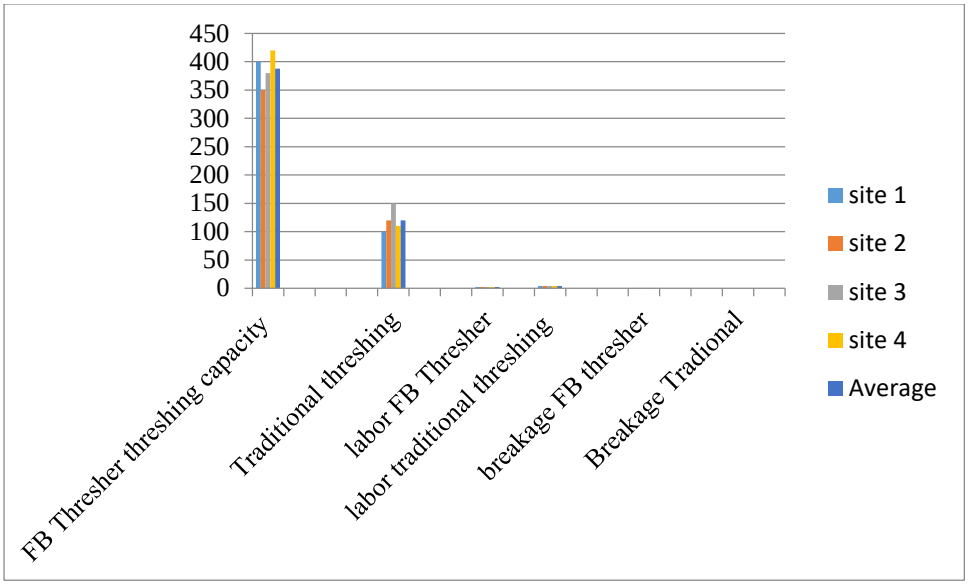
A total of 84 participants of which 64.3% was male and 35.7% female from four districts participated on both theoretical and practical training. The training was mainly focused on how to operate technology and relative advantage of technology as indicated in the (Table 1) below.

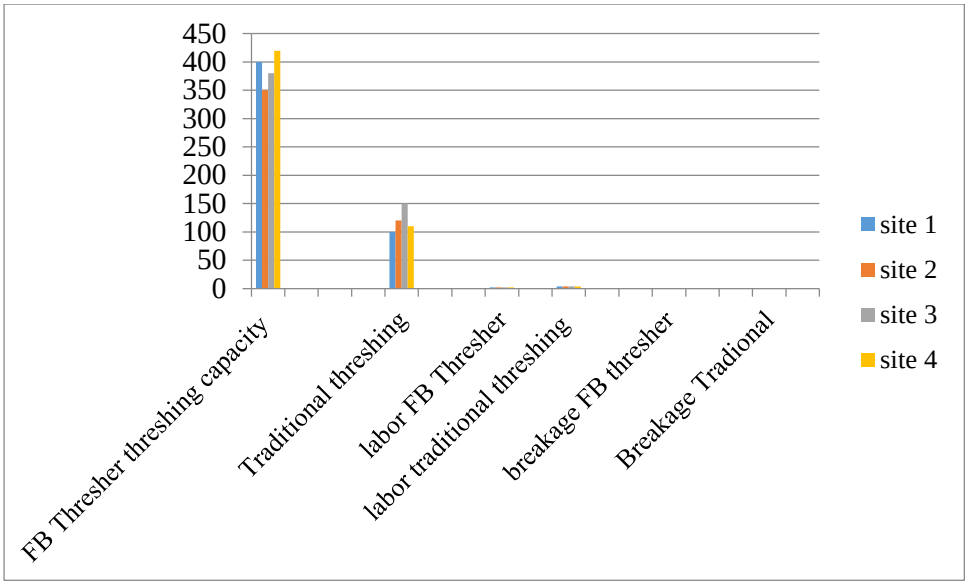
Table 1. Training for farmers and to stakeholders on faba bean thresher.

Disticts	Description of participants	Male	Female	Total
Lemu-Bilbilo	Farmers	18	12	30
	Agricultural Experts	4	2	6
	Development agents	4	2	6
	Supervisor	2	-	2
Tiyo	Farmers	18	12	30
	Agricultural Experts	4	-	4
	Development agents	4	2	6
	Supervisor	-	-	-
Grand total		54	30	84

Performance of the technology

As it was revealed on the following graph the average threshing capacity of the machine was three point eight quintals per hour (3.8quintals/hr). Whereas threshing by tradition practice was one point two quintals per hour (1.2quintals/hr). As revealed in the following graph threshing faba Bean using thresher reduce labor from four person to two person. Apart from this no breakage recorded by traditional one whereas 8% breakage recoded while threshing by faba Bean thresher.





Profitability analysis of the machine

The profitability analysis of the machine was done by comparing two crop threshing mechanisms which were traditional animal trampling and stationary engine driven machine threshing. Faba bean thresher technology reduced the cost of human labor and animal labor which were calculated as four thousand 4,000 birr to three thousand two hundred fifty birr 3,250 respectivly. Whereas total cost incurred for human labor force both for machine operation and re-cleaning of crop were nine hundred (900) birr. From the result shown in the following table net income of farmers increased to six thousand seven hundred fifty (6, 750) birr. The other quality of the machine that adored by farmer`s was straw chopping capacity of the machine for their livestock feed which was serious problem in the study area.

Table 2:- profitability analysis of machine

	Traditional practices	**Faba bean thresher**
Average yield in quintal per hectare	22.5	24
Gross return	90,000	96,000
Labor for transportation	1,200	850
Labor for threshing	1,800	-
Labor for winnowing	600	-
Animal labor	400	-
Labor for operation	-	600
Labor for re-cleaning	-	300
Machine cost	-	1,500
Total cost that vary	4,000	3,250
Net income	**86,000**	**92,750**

Farmer perception

Among the farmer interviewed 50% had responded that it was simple to operate the faba bean thresher, 33.3% of farmers responded that it was very simple and 16.7% of respondent farmers were responded that it was medium to operate faba bean thresher technology Table 2. Maintenance of the technology was also considered as one criterion to see the simplicity of technology. Regarding to the simplicity of maintenance of technology; 40% of farmers responded that maintenance of technology was medium, 31.3% and 11.7% answered as it was simple and very simple to maintain technology respectively. Whereas only 15% the respondent responded that it was difficult to maintain it. Regarding affordability of the technology; about 46.7% of respondent farmer responded that the cost of technology was medium that it can be affordable by the average farmers and 23.3% of farmers responded that the price of technology was low to purchase. About thirty percent 30% of respondent said that the price of technology was high to afford as depicted in the table 2 below.

Table 3. Farmer's response towards the technology

N^{o}	Criteria	Attributes	N^{o} of respondent	Percentage (%)
1	Ease of operation	Very simple	20	33.3
		Simple	30	50
		Medium	10	16.7
		Difficult	0	0
		Very difficult	0	0
2	Maintenance	Very simple	7	11.7
		Simple	20	31.3
		Medium	24	40
		Difficult	9	15
		Very difficult	0	0
3	Price to afford technology	Very low	0	0
		Low	17	28.3
		Medium	20	33.3
		High	23	38.3
		Very High	0	0
4	Portability of technology	Very simple	12	20
		Simple	18	30
		Medium	20	33.3
		Difficult	10	16.7
		Very difficult	0	0

Framers` feedback and reaction

In the process of demonstrating faba bean thresher mini-field day was organized. In the course of field day different stakeholders and researcher were participated and reacted on what they observed during operation. Criteria's were threshing capacity, time and labor reduced, easiness of operation, portability and affordability of technology and feedback were collected and analyzed. Beside all these attributes there were seed breakage of 8% during the operation of fababean threshing using thresher. As a result, all participant farmers and stakeholders liked and accepted faba bean thresher technology with slight modification which was seed breakage due to different size of seed and high speed of machine.

Conclussion and Reccomendation

Demonstration of faba bean thresher was under taken in the purposively selected districts of Arsi zone. Demonstration of the technology intended to enhance farmers awareness on the importance and use of the machine, evaluate the performance of the machine under farmers condition, collecting farmer's feedback faba bean thresher technology and evaluate the economic analysis/ cost-benefit gain of the machine to minimize the problems that were faced by faba bean producer farmers threshing it in traditional way which was backward, time consuming and tedious farm activity. The technology was tested and compared with traditional way of threshing faba bean at selected kebele station. Both result and method demonstration method and techniques was followed. The mechanisms used to enhance farmer to farmer learning and information exchange was field visit/tour and field day. From result of this finding the average threshing capacity of the machine was three point eight quintals per hour (3.8quintals/hr). Whereas threshing by tradition practice was one point two quintals per hour (1.2quintals/hr). As revealed in the following graph threshing faba Bean using thresher reduce labor from four person to two person. Apart from this no breakage recorded by traditional one whereas 8% breakage recoded while threshing by faba Bean thresher. Result of this finding indicate that among farmer interviewed 50% had responded that it was simple to operate the faba bean thresher, 33.3% of farmers responded that it was very simple and 16.7% of respondent farmers were responded that it was medium to operate faba bean thresher technology. Maintenance of the technology was also considered as one criterion to see the simplicity of technology. Regarding to the simplicity of maintenance of technology; 40% of farmers responded that maintenance of technology was medium, 31.3% and 11.7% answered as it was simple and very to maintain technology. Whereas only 15% the respondent responded that it was difficult to maintain it. Regarding affordability of the technology; about 46.7% of respondent farmer responded that the cost of technology was medium that it can be affordable by the average farmers and 23.3% of farmers responded that the price of technology was low to purchase. About thirty percent 30% of respondent said that the price of technology was high to afford. Profitability analysis of the machine was done by comparing two crop threshing mechanisms which were traditional animal trampling and stationary engine driven machine threshing. From the result shown in the following table net income of farmers increased from six thousand three hundred fifty (6, 350) birr. As a result, all participant farmers and stakeholders liked and accepted faba bean thresher technology with slight modification which was seed breakage of 8% due to different size of seed and high speed of machine.

Therefore, Researchers have to solve the problem related newly developed faba bean thresher technology which was high percent of breakage.

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Pre-extension Demonstration of Livestock Feed Mixer in selected AGP-Districts of Arsi and west Arsi zones

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Abstract

This demonstration activity was conducted with the objectives of enhancing farmers awareness on the importance and use of the livestock feed mixer machine, evaluating the performance of the livestock feed mixer machine under farmers condition and to collect farmer's feedback on machine at Lemu Bilbilo and Adaba districts of Arsi and west Arsi zones. The demonstration site and representative farmers were selected based on location and suitability to involve more farmers to visit the demonstration sites. Field day was organized to enhance farmer to farmer learning, information exchange and experience sharing among Farmers and other stakeholders on technology. On the organized training a total of 38 participants of which 68.4% were male and 31.6% female from four districts participated on both theoretical and practical training. The training was mainly focused on how to operate technology and relative advantage of technology. Among the farmer interviewed 43.3% had responded that it was simple to operate the livestock feed mixer technology, 36.7% of farmers responded that it was very simple and 20% of respondent farmers were responded that it was medium to operate livestock feed mixer technology. Maintenance of the technology was also considered as one criterion to see the simplicity of technology. Regarding to the simplicity of maintenance of technology; 26.7% of farmers responded that maintenance of technology was medium, 13.3% and 43.3% answered as it was very simple and simple to maintain technology respectively. Whereas only 16.7% of the respondent responded that it was difficult to maintain it. Regarding to affordability of the technology; about 30% of respondent farmer responded that the cost of technology was low that it can be affordable by the average farmers and 23.3% of farmers responded that the price of technology was low to purchase. Whereas about 26.7% and 20% of respondent said that the price of technology was high and very to afford technology. Portability of technology also considered as one criterion for selection of technology by interviewed farmers. Among interviewed farmers 40%, 36.7% and 23.3% of respondent farmers responded that portability of the technology was simple, very simple.

Therefore, livestock feed mixer technology is recommended for further scaling up and wider utilization.

Key words: Demonstration, Livestock feed mixer, Training and Farmers Perceptions

Introduction

Livestock is an integral part of the agriculture and the contribution of live animals and their products to the agricultural economy accounts for 40%, excluding the values of draught power, manure and transport of people and products (Winrock International, 1992). Livestock serve as sources of food, traction, manure, raw materials, investment, cash income, security, foreign exchange earnings and social and cultural identity. Ethiopia holds the largest livestock population in Africa estimated at about 43.1 million heads of cattle, 23.6 million sheep, 18.6 million goats, 4.5 million donkeys, 1.7 million horses, 0.33 million mules, 34.2 million chicken and 4.9 million beehives (CSA, 1996). Similarly, contributions of livestock

to cash income of the smallholders account for up to 87% and, subsistence of some pastoral communities is entirely based on livestock and livestock products. Despite these roles, the productivity of livestock in general is low and compared to its huge resource its contribution to the national economy is below expected. Zegeye (2003) indicated that feed shortage, poor genetic potential for productive traits, poor health care and management practices are the major contributors to the low productivity.

Essentially, feed mixing can be done either manually or mechanically. The manual method of mixing feed entails the use of shovel to intersperse the feed's constituents into one another on open concrete floors. This method is generally characterized by low output, less efficient, labor intensive and may prove unsafe, hence, hazardous to the health of the intended animals, birds or fishes for which the feed is prepared. A wide variety of mixers are available for use in mixing components, the selection of which depends mainly on the phase or phases the components exists such as solid, liquid or gaseous phases. Different research centers and institutional organizations develop and evaluate animal feed chopper, miller and mixer but most of them are used in commercial stage. This brings difficulty for small scale farmers to own and use these technologies.

To tackle this problem Asella Agricultural Engineering Research Center developed livestock feed mixer that has the mixing capacity of 400kg/hr. Therefore; this study initiated with the objective of demonstrating livestock feed mixer in selected districts of Arsi and west Arsi zones.

Objectives of the study

- To enhance farmers awareness on the importance and use of the livestock feed mixer machine
- To evaluate the performance of the livestock feed mixer machine under farmers condition
- To collect farmer's feedback on machine
- To evaluate the economic analysis/ cost-benefit gain of the livestock feed mixer machine

Material and methods

Materials

The materials that was used for the implementation of this study are livestock feed mixer, 10HP motors and other necessary materials.

Method

Site selection, Technology evaluation and demonstration methods/techniques

Demonstration of livestock feed mixer was held in two districts from Arsi and west Arsi purposively selected based on their livestock potential. Based on this Lemu Bilbilo and Adaba districts zone were selected. The study also was conducted in one PA from each district and in each PAs one FRG was established that has different category of farmers like male, female and youth. The technology was tested and compared with traditional way of livestock feed mixing at selected PA station. Both result and method demonstration method and techniques was followed. The mechanisms used to enhance farmer to farmer learning and information exchange was field visit/tour and field day. The experiment was done on one treatment with its local practices.

Data type and Method of data collection

This study was used both qualitative and quantitative data from primary data sources. Primary data such as time reduced because of using this machine, labor reduced, economic return/profitability, total number of farmers participated in training, field visits and field days by gender, numbers of farmers become aware of the relative advantage of the technology by gender, role of farmers and other stakeholders in technology demonstration, farmers' opinion was collected using different appropriate data collection method/technique such as field observation, household/participant interview, focus group discussion.

Method of data analysis

Data was analyzed using descriptive statics like percentages, mean values and frequencies. Economic data on livestock feed mixer was analyzed using partial budget analysis.

Result and Discusion

A total of 38 participants of which 68.4% was male and 31.6% female from four districts participated on both theoretical and practical training. The training was mainly focused on how to operate technology and relative advantage of technology as indicated in the Table 1 below.

Table 1. Training for farmers and to stakeholders on livestock feed mixer

Disticts	Description of participants	Male	Female	Total
Lemu Bilbilo	Farmers	9	6	15
	Agricultural Experts	2	-	2
	Development agents	1	-	1
	Supervisor	1	-	1
Adaba	Farmers	9	6	15
	Agricultural Experts	2	-	2
	Development agents	2	-	2
	Supervisor	-	-	-
Grand total		26	12	38

Farmer perception

Among the farmer interviewed 43.3% had responded that it was simple to operate the livestock feed mixer technology, 36.7% of farmers responded that it was very simple and 20% of respondent farmers were responded that it was medium to operate livestock feed mixer technology. Maintenance of the technology was also considered as one criterion to see the simplicity of technology. Regarding to the simplicity of maintenance of technology; 26.7% of farmers responded that maintenance of technology was medium, 13.3% and 43.3% answered as it was very simple and simple to maintain technology respectively. Whereas only 16.7% of the respondent responded that it was difficult to maintain it. Regarding to affordability of the technology; about 30% of respondent farmer responded that the cost of technology was low that it can be affordable by the average farmers and 23.3% of farmers responded that the price of technology was low to purchase. Whereas about 26.7% and 20% of respondent said that the price of technology was high and very to afford technology. Portability of technology also considered as one criterion for selection of technology by interviewed farmers. Among interviewed farmers 40%, 36.7% and 23.3% of respondent farmers responded that portability of the technology was simple, very simple as depicted in the table 2 below.

Table 2 .Farmer's response towards the technology

N^{o}	Criteria	Attributes	N^{o} of respondent	Percentage (%)
1	Ease of operation	Very simple	11	36.7
		Simple	13	43.3
		Medium	6	20
		Difficult	0	0
		Very difficult	0	0
2	Maintenance	Very simple	4	13.3
		Simple	13	43.3
		Medium	8	26.7
		Difficult	5	16.7
		Very difficult	0	0
3	Price to afford technology	Very low	0	0
		Low	9	30
		Medium	7	23.3
		High	8	26.7
		Very High	6	20
4	Portability of technology	Very simple	11	36.7
		Simple	12	40
		Medium	7	23.3
		Difficult	0	0
		Very difficult	0	0

Framers` feedback and reaction

In the process of demonstrating livestock feed mixer mini-field day was organized. In the course of field day different stakeholders and researcher were participated and reacted on what they observed during operation. Criteria's were availability of feed and cost of feed in relation to their feed shortage and feedback were collected and analyzed. Because of above stated quality livestock feed mixer has many advantages. As a result, all participant farmers and stakeholders liked and accepted livestock feed mixer technology.

Conclussion and Reccomendation

Demonstration of livestock feed mixer was under taken in two purposively selected districts Arsi and west Arsi Zones. From each one potential kebele was selected and in each kebele one FRG was established. The objectives of the study were enhancing farmers awareness on the importance and use of the livestock feed mixer machine, evaluating the performance of the livestock feed mixer machine under farmers condition and collecting farmer's feedback on machine. Among the farmer interviewed 43.3% had responded that it was simple to operate the livestock feed mixer technology, 36.7% of farmers responded that it was very simple and 20% of respondent farmers were responded that it was medium to operate livestock feed mixer technology. Maintenance of the technology was also considered as one criterion to see the simplicity of technology. Regarding to the simplicity of maintenance of technology; 26.7% of farmers responded that maintenance of technology was medium, 13.3% and 43.3% answered as it was very simple and simple to maintain technology respectively. Whereas only 16.7% of the respondent responded that it was difficult to maintain it. Regarding to affordability of the technology; about 30% of respondent farmer responded that the cost of technology was low that it can be affordable by the average farmers and 23.3% of farmers responded that the price of technology was low to purchase. Whereas about 26.7%

and 20% of respondent said that the price of technology was high and very to afford technology. Portability of technology also considered as one criterion for selection of technology by interviewed farmers. Among interviewed farmers 40%, 36.7% and 23.3% of respondent farmers responded that portability of the technology was simple, very simple as depicted in the below. As a result, all participant farmers and stakeholders liked and accepted livestock feed mixer technology.

Therefore, livestock feed mixer technology is recommended for further scaling up and wider utilization.

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Pre-Extension Demonstration of Soil Test Based Recommended P-Fertilizer Rate for Maize in Jimma and Ilu Ababor Zones, Oromia Regional State, Ethiopia

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Abstract

Pre-extension demonstration of soil test based recommended p-fertilizer rate for maize was conducted in Mana and Darimu districts of Jimma and Ilu Ababor Zones, respectively, with the objectives of demonstrating and creating awareness on soil test based crop response p-fertilizer recommendation rate for maize under farmers' conditions in the 2020 cropping season. Two treatments; blanket recommendation/farmers' practice and soil test based crop response p- fertilizer recommendation rate were used with improved maize (BH 661) variety. The demonstration was under taken on two FTCs and 18 hosting farmers' fields by considering both FTCs and farmers' fields as replication. The trial was conducted on a single plot of 12 m x25 m area for each treatment with the spacing of 80cm and 50cm between rows and seeds respectively using recommended seed rate of 25kg/ha and recommended N-fertilizer rates of 138kg/ha and 92 kg/ha for Darimu and Mana districts, respectively. One FRG consisting of 15 members was established per each kebele. *A total of 114 participants were participated on field visit held during physiological maturity of the crop. The average yield gained from soil test based fertilizer recommendation rate was more economical than that of farmers' practice. Likewise, the economic analysis result shows that the highest average net income (51,848.75 ETB) was obtained from the soil test based fertilizer recommended rate. Hence, the pre-scaling up of soil test based p-fertilizer recommendation rate for maize should be carried out in the coming main cropping season in the study areas.*

Key Words: Demonstration, Soil Test Based, Farmers' Practice, p-fertilizer, maize

Introduction

Maize (*Zea mays L.*) is one of the most important food crops worldwide (Christian *et al.*, 2012). It is the principal component of human diet and feed constituent for domestic animals. In Ethiopia, maize is one of the most important cereal crops grown`. Among all cereals, maize ranks second to teff (*Eragrostis teff*) in area coverage but first in productivity and total production (CSA, 2018/19). The national area coverage and average yield of maize is 18.60% (about 2,367,797.39 hectares) and 30.08% (94,927,708.34 quintals), respectively. The area coverage and average yield of maize in Oromia regional state is 137,868.06 hectares and 58,887,064.26 Quintals, respectively (CSA, 2020/21).

However, there are a number of factors that causing the low production and productivity of maize. Among these factors, inappropriate cropping systems, mono-cropping, nutrient mining, unbalanced nutrient application, removal of crop residues from the fields and inadequate re-supplies of nutrients have contributed to decline in crop yields (McDonald *et al.*, 2005). One of the major problems constraining the development of an economically successful agriculture is nutrient deficiency (Fageria & Baligar, 2005). Nutrient mining due to sub optimal fertilizer use in one hand and unbalanced fertilizer uses on other have favored the emergence of multi nutrient deficiency.

The role of fertilizers is to increase yield and ensure healthy produce by supplying the right balance of nutrients to the soil**. Fertilizers accounted for more than 50% of the increase in yield (Yazıcı & Korkmaz, 2020).** Fertilizer recommendations should take into account the existing nutrient availability in the soil and should be developed specifically for different crops in different agro-ecologies (Bermudez & Mallarino, 2007). The use of chemical fertilizer through soil test based crop response to overcome nutrient deficiencies is a practice that is receiving a wide acceptance in the country. Besides, site specific soil test based recommended usage of fertilizer provides macro and micro nutrients that is needed by the crop to provide the maximum yield and which is economically feasible for the producers. Keeping in view of the above facts, the study was conducted to overcome the over-or under-application of fertilizers associated with the use of blanket recommendations, which results in reduced nutrient use efficiency or losses in yield, unnecessary input costs, and reduced profitability in the study areas.

The objectives of this study

- To evaluate yield performance and profitability of p-fertilizer recommendation under farmers' condition,
- To enhance knowledge and skills on importance of site specific crop response based p-fertilizer recommendation and
- To collect feedback on the yield of soil test crop response based p-fertilizers recommendation rate for maize under farmers' condition.

Research Methodology

Description of the study areas

Mana District is located at 373.83 km from capital city of Ethiopia, Addis Ababa and 20 km west of Jimma town. The administrative center of this district is Yebu. It is geographically located between 7°44´59.99´´ N latitude and 36°44´59.99´´ E longitude and the altitude of the district ranges from 1470 to 2610 m. a.s.l. The mean minimum and maximum temperatures are 13.0^{0}C and 24.8^{0}C, respectively with the average annual rainfall of 1523 mm. The land in this district shows that 89.1% is arable or cultivable (86.1% is under annual crops), 2.7% pasture, 2.8% forest, and the remaining 5.4% is considered swampy, degraded or otherwise unusable. Mixed cropping system is mainly practiced in the District. Maize, tef, sorghum, barley, wheat, coffee, chat and horse bean are the most widely cultivated crops in the district. Chat and coffee are important cash crops.

Darimu District is one of districts of Ilu Ababor Zone in Oromia regional state and the district is subdivided in to 45 rural and 2 urban kebeles. The district administrative center is Dopa, located 64 km away from Zonal town Ilu Ababor (Metu) and 664 km to the South west from Addis Ababa. It is located at latitude of 8° 36'0" N and longitude of 36°11'0'' E and altitude of the area ranges from 792-1800 meter above sea level. The climatic condition of the Darimu district fluctuates with long summer rainfall (June to September), short rainy seasons (March to April) and winter dry seasons (December to February) and the mean annual rainfall ranges from 1172-1740 mm. Agriculture is the main stay of livelihood of people with mixed farming system among which maize, teff, sorghum, barley and beans are the dominant crops in the study area.

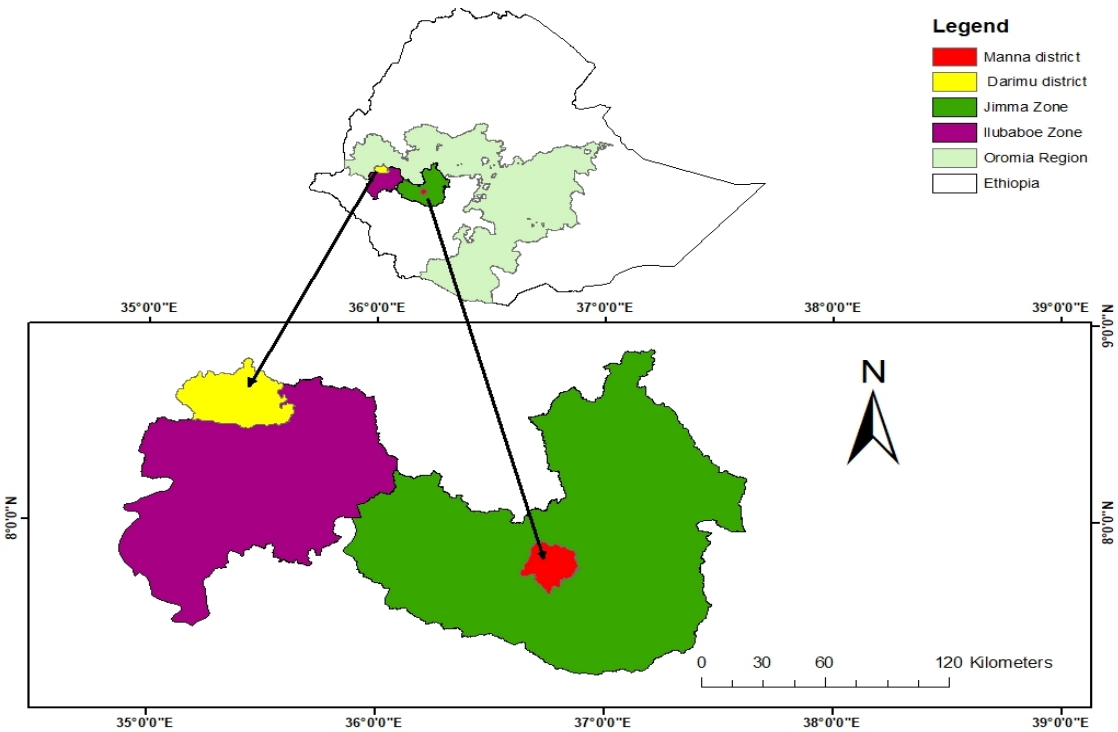

Figure 1: map of Mana and Darimu districts

Site and farmers' selection

Pre-extension demonstration of soil test based recommended p-fertilizer rate for maize (BH 661) was conducted in two districts of Jimma and Ilu Ababor Zones, Mana and Darimu, respectively. Purposive sampling method was applied to select two representative districts and three kebeles from each district on the basis of maize production potential, accessibility, completed calibration and verification study in the districts. Two well-represented farmers training centers (one FTC per district) were used to simplify the demonstration process and enhance the participation of follower farmers and other stakeholders during technology extension events.

The farmers were purposively selected based on their eagerness toward acceptance of new technologies, land provision for activity implementation and willingness to share experiences for other farmers in collaboration with community leaders, DAs, and SMS. The selected farmers were grouped in the form of farmer research groups (FRGs). One FRG with the member of 15 farmers per Kebele in consideration of gender issues and a total of ninety (90) farmers were formed. In each FRG, three hosting farmers were selected with the rest being participant farmers. Accordingly, the demonstration trial was conducted on two FTCs and 18 hosting farmers' field by considering both FTCs and farmers field as replication.

Field design and materials

Two treatments: blanket recommendation (farmers' practice) and soil test based crop response p- fertilizer recommendation rate for maize were set side by side on adjacent plots of 12 m * 25 m each and 24 m * 25 m of whole plot size. Recommended agronomic practices, spacing of 80 cm and 50 cm between rows and plants, respectively using recommended seed rate of 25 kg/ha were used.

Before conducting the trial, composite soil samples were collected following the zigzag soil sampling pattern using auger from a depth of 0-20 cm. The importance of composite sampling in a zigzag pattern is relatively inexpensive, easily tracked and reproducible result might be obtained (Hardy *et al*., 2008). Soil parameters such as available P and pH of the experimental soil were analyzed with standard laboratory procedures. Depending on initial phosphorus status in the soil, rate of fertilizer to be applied was calculated by the formula (kg P/ha) = (Pc-Po)*Pf, where: Pc = critical P-value which was 10 ppm and 5.5 ppm, Pf = P requirement factor which was 7.49 and 13.89 in Darimu and Mana districts, respectively and Po = Initial P values for the site. 138kg/ha and 92 kg/ha of recommended N fertilizer (urea) rate for Darimu and Mana districts, respectively was applied in split application of 1/3 at planting time and 2/3 at one month after planting with the necessary agronomic and management practices. The experimental fields were prepared by using oxen plow in accordance with conventional farming practices followed by the farming community in the area. Thus, experimental field operations (preparation) were carried out by hosting farmers; whereas activities such as planting, first and second weeding, harvesting, and threshing were handled by FRG members with close supervision of the researchers.

Technology demonstration approaches

FRGs members (those who are engaged in farming activities, farmers with Maize variety background and interested to work in groups) and follower farmers (farmers who are organized under each FRG to enhance farmer-farmer technology dissemination and co-learning) were encouraged to participate on different extension events such as trainings, and field visits/tours organized at the representative site. Training was provided for farmers', agricultural experts and DA's with the aim of creating awareness on the soil test based fertilizer application technology. Field visit was organized during the crop maturity stage for the farmers, experts and the concerned stakeholders to convince sound variability between the treatments in the areas.

Method of Data Collection

Both quantitative and qualitative data were collected through personal field observation, individual interview, Focus Group Discussion by using checklist and data sheet tools. Types of collected quantitative data were number of farmers participated in FRG, yield performance, economic analysis and number of stakeholders participated on the training. While qualitative data were farmers' opinions towards the new technology.

Methods of Analysis

Simple descriptive statistics were used to analysis quantitative data; whereas qualitative data analyzed using narrative explanation. The economic related data was analyzed using gross margin analysis.

Results and Discussions

Yield performance of demonstrated technologies

The result obtained from the trial conducted at Mana and Darimu Districts indicates that fertilizer application based on site specific soil test produced higher maize grain yield and performed the best(sound yield variability between the treatments and within the sites) over blanket recommendation. Soil testing is the most reliable tool for making good economic and environmental decisions about applying fertilizers; hence it is helpful for efficient and effective use of urea and P fertilizers. The use of site specific fertilizer application enhanced the overall mean maize grain yield from 52.45 qt ha^{-1} (blanket recommendation) to 75.8 qt ha^{-1} (soil test crop response based p-fertilizer recommendation) with 44.5% yield advantage.

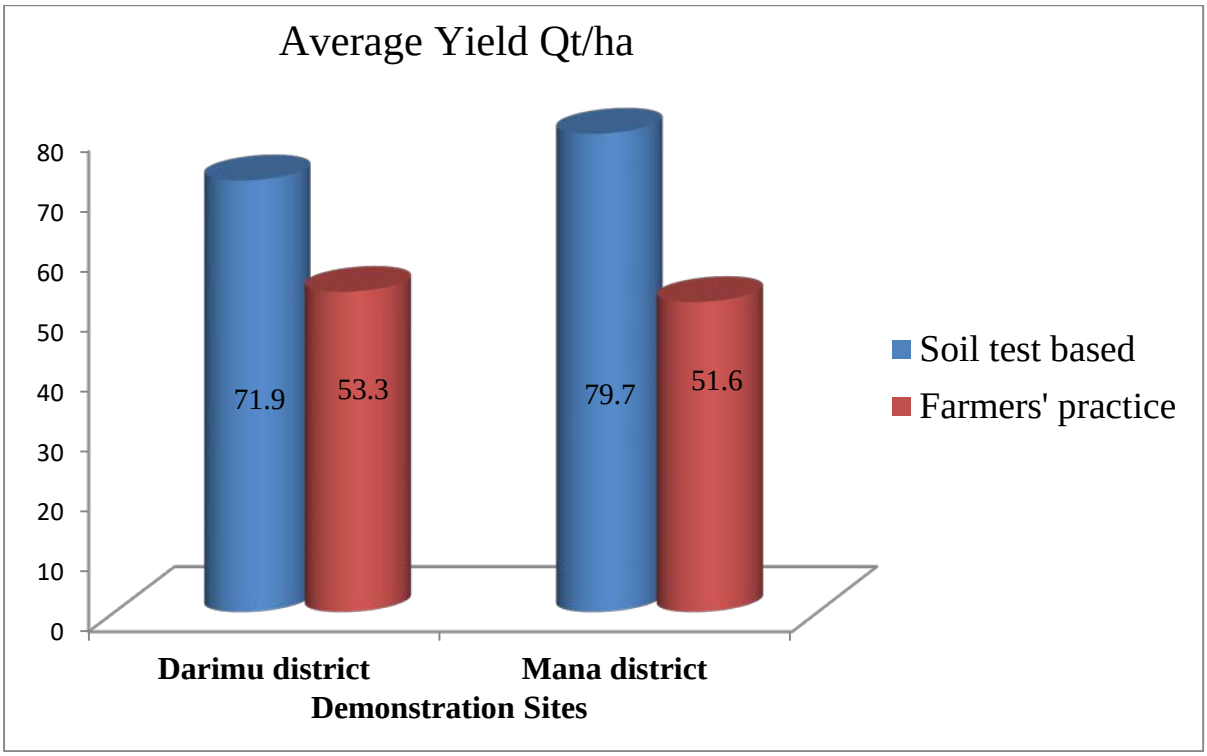

Figure 1: Mean yield data of the Maize technologies in the Districts

Yield advantage were calculated using the formula

$$\text{Yield advantage \%} = \frac{\text{Yield of STCRBFR (qt ha}^{-1}\text{) - Yield of FP (qt ha}^{-1}\text{)}}{\text{Yield of FP (qt ha}^{-1}\text{)}} \times 100$$

Where, STCRBFR = Soil test crop response based fertilizer recommendation

FP = Farmers' practice

Table 3**:** Yield advantage of the STCRBFR over the farmers' practice

Treatment	**Mean yield (qt ha^{-1})**	**Yield advantage (%) over the Farmers' practice**
Farmers' practice	52.45	-
Soil test crop response based fertilizer recommendation	75.8	44.5

The above table 3 indicates that the hosting farmers had obtained more than 40% yield advantage from soil test crop response based fertilizer recommendation over the blanket recommendation.

Economic Analysis

Gross margin analysis was employed to identify economic feasibility of the fertilizer recommendation rate among farmers' practice and Soil test crop response based -fertilizer recommendation. All variable costs with the assumption that the rest of costs incurred are the same for all treatments and benefits were calculated on hectare basis in Ethiopian birr by using the prevailing market prices for variable inputs at planting and for outputs at the time the crop was harvested. Likewise, the price of variable inputs: NPS, Urea and labour were 1622 ETB qt^{-1}, 1581.51 ETB qt^{-1} and 75 ETB per day whereas maize grain output was 800 ETB qt^{-1} at farm gate. The economic analysis result shows that the highest net income (51,848.75 ETB) was obtained from soil test based fertilizer recommended rate in Mana and Darimu Districts.

Table 4: Economic analysis for Maize technologies

Locations: Mana and Darimu Districts		
Parameters	Treatment	
	FP	STCRBFR
Yield (Y) obtained (t ha-1)	5.23	7.58
Unit Price (ETB qt-1)	800.00	800.00
Total variable costs (ETB ha-1)	4028.51	8791.25
Gross Return (Price x Y)	41,840	60,640
Net Return (GR-TVC)	37,811.5	51,848.75

Note: STCRBFR = soil test crop response based P-fertilizer recommendation, ETB = Ethiopian Birr

Source: Own computing data, 2020

Training and Field visit

The training was given to farmers, DAs and district experts by multidisciplinary team of researchers on the concepts of FRG establishment, role and responsibility of FRG members in the executing the trial, importance and method of soil sampling and significance of soil test based crop response p-fertilizer recommendation. A total of 70 farmers' (61 Male and 9 Female), 18 DAs (15 Male and 3 Female) and 11 Experts (9 Male and 2 Female) were participating in training program. In addition to the training, participatory field visit was arranged in Mana and Darimu districts of Jimma and Ilu Ababor Zones for a total of 114

participants. Field visit was prepared for creating an opportunity for farmers to learn from each other, share experiences especially on how to practice the trial as all FRG members practice on their farm.

Table 1: Gender composition number of stakeholders' participated field visit

Districts	Participants	Male	Female	Total
Darimu	Farmers	30	7	37
	DAs	8	1	9
	Other stakeholders	11	1	12
Mana	Farmers	27	8	35
	DAs	7	2	9
	Other stakeholders	10	2	12
Total		**93**	**21**	**114**

Source: Own Data, 2020

The recommended Phosphorus and Nitrogen fertilizers in the study areas

As reported by Dagne *et al.*, (2013) at calibration study for maize in Mana district, 5.5 ppm of P-critical value and 13.89 of P-requirement factor was determined for phosphorus fertilizer recommendation and 92 kg ha^{-1} of N-fertilizer recommended for the study area. Similarly, 138 kg ha^{-1} of N-fertilizer (Urea), 10 ppm of Phosphorus critical level, and 7.49 of P-requirement factor for maize production were recommended in Darimu District (Dagne *et al.*, 2018). Consequently, the calibration recommendation was used for implementation of soil test crop response based Phosphorus fertilizer recommendation treatment whereas farmers' practice/blanket recommendation treatment was implemented using fertilizer recommended by the Ministry of Agriculture and Rural Development that is 100kg ha^{-1} of NPS and urea.

Table 2: Mana and Darimu Districts recommended P and N fertilizer rate

Sites	P_o (initial p values) (ppm)	P_c (P critical level) (ppm)	Pf (Requirement factor)	Rate of P-fertilizer applied Kg/plot(300 m^2)		Rate of N-fertilizer (urea)applied Kg/plot(300 m^2)	
				Fp	STCRBFR	Fp	STCRBFR
Mana district recommended P and N fertilizer rate per farmers' entire field of experiment							
site 1	1.29	5.5	13.89	3	10.6	3	6
site 2	1.785	5.5	13.89	3	9.3	3	6
site 3	1.775	5.5	13.89	3	9.4	3	6
site 4	1.702	5.5	13.89	3	9.5	3	6
site 5	1.481	5.5	13.89	3	10.1	3	6
site 6	0.976	5.5	13.89	3	11.4	3	6
site 7	1.199	5.5	13.89	3	10.8	3	6
site 8	2.75	5.5	13.89	3	6.9	3	6
site 9	1.152	5.5	13.89	3	10.9	3	6
site 10	1.738	5.5	13.89	3	9.4	3	6
Average	**1.5848**	**5.5**	**13.89**	**3**	**9.83**	**3**	**6**
Darimu district recommended P and N fertilizer rate per farmers' entire field of experiment							
Site 11	1.5	10	7.49	3	9.5	3	9
Site 12	1.9	10	7.49	3	9.2	3	9
Site 13	1.8	10	7.49	3	9.0	3	9
Site 14	0.9	10	7.49	3	10.2	3	9
Site 15	0.8	10	7.49	3	10.3	3	9
Site 16	0.7	10	7.49	3	10.4	3	9
Site 17	1.4	10	7.49	3	9.7	3	9
Site 18	2.0	10	7.49	3	8.9	3	9
Site 19	0.9	10	7.49	3	10.2	3	9
Site 20	1.1	10	7.49	3	10.0	3	9
Average	**1.3**	**10**	**7.89**	**3**	**9.74**	**3**	**9**

Note: Fp = farmers' practice; STCRBFR=soil test crop response based fertilizer recommendation.
Source: Own Computing Data, 2020

As indicated from the results presented in Table 2 there were varying available Phosphorus level within the demonstration sites. The lowest the available P of the demonstration sites (0.7 and 0.976 ppm), the highest it desired the recommended P-fertilizer rate (10.4 and 11.4 kg/plot) and the highest the available p of the demonstration sites (2.0 and 2.75 ppm) the lowest it desired the recommended P-fertilizer rate (8.9 and 6.9 kg/plot) based on determined P_c and Pf across Darimu and Mana Districts, respectively.

Farmers' Feedback

On the exchange visit demonstration site, the participants exchanged their views, opinions and shared their experience. During this time an assessment was made to know how the farmers perceived the technology. Result of the assessment revealed that soil test crop response based fertilizer recommendation was appreciated by farmers in terms of its efficient use of fertilizers and advanced yield advantage over blanket recommendation. Participants also request technical support to be benefitted from technologies with soil laboratory accessibility with affordable charge.

Conclusion and Recommendations

The variability in yield performance between and within the demonstrated sites might have originated from differences in the status of soil fertility and site specific varying weather conditions. For this reason, site specific soil test crop response determines the soil's nutrient status before a crop is planted which encourages plant growth by providing the best fertilizer recommendations and results predictable yield variability within sites over blanket fertilizer recommendation which is lacks of consideration for soil and crop variability.

The overall average yields gained from soil test based fertilizer recommendation rate were more economical than that of farmers' practice. Farmers were perceived soil test based fertilizer recommendation rate positively because it improves crop yield and identifies nutrient deficiency in soil. So, Soil laboratory should be more functional with affordable charge so that farmers will get access to test their soil. Hence, the pre-scaling up of soil test based fertilizer recommendation rate for Maize should be carried out in the coming main cropping season in the study areas.

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Pre-Extension Demonstration of Soil Test Based Recommended P-Fertilizer Rate for Bread Wheat at Gechi and Chora Districts of Buno Bedele Zone, Oromia Regional State, Ethiopia

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Abstract

*Pre-extension demonstration of soil test based recommended fertilizer rate for bread wheat was conducted in Gechi and Chora districts of Buno Bedele Zone in 2020 cropping season. The main objectives of the study were to evaluate yield performance and profitability of soil test crop response based phosphorus fertilizer recommendation and to create awareness on site specific crop response fertilizer recommendation rate of bread wheat under farmers' condition. Two treatments: blanket recommendation/farmers' practice and soil test based crop response P-fertilizer recommendation rate were used with improved bread wheat (Liban) variety. The demonstration was conducted on two FTCs and 18 hosting farmers' fields by considering both FTCs and farmers' fields as replication. The trial was conducted on a single plot of 12 m x 20 m area for each treatment with the spacing of 20cm between rows using recommended seed rate of 125 kg/ha and recommended N-fertilizer rates of 92 kg/ha and 138 kg/ha for Gechi and Chora Districts respectively. Field visit was organized for a total of 118 participants during physiological maturity of the crop. The highest mean grain yield was obtained from soil test based fertilizer recommendation rate with more than 60 % yield advantage over blanket fertilizer recommendation. Similarly, the economic analysis result shows that the highest average net income (*34,262.7 *ETB) was obtained from the soil test based fertilizer recommended rate. Hence, the pre-scaling up of soil test based P-fertilizer recommendation rate for bread wheat should be carried out in the coming main cropping season in the study areas.*

Key Words: *Pre-extension demonstration, Bread wheat, Soil test, Blanket recommendation, FRG, FTC, fertilizer*

Introduction

Bread wheat is one of the major crops predominantly grown by small-scale farmers under rain fed condition in the highlands of Ethiopia (Bishawa and Alemu, 2017). In terms of caloric intake, wheat is the second most important food crop in the country next to maize (FAO, 2014). However, In Ethiopia, agriculture is still characterized by low productivity, a high level of nutrient mining, low use of external inputs, traditional farm management practices and limited capacity to respond to environmental shocks (Assefa *et al*., 2013; Amante *et al*., 2014; Agegnehu *et al*., 2016). As reported by Shiferaw (2014), Ethiopian soils lack most of the macro and micronutrients that are required to sustain optimal growth and development of crops. Phosphorus is one of primary concern in the appraisal of the soil resources of Ethiopia since most of the soils in the highland areas of the country are reported to be deficient in phosphorus (Agegnehu *et al.*, 2015; Brady & Weil, 2008). Thus, crop growth in such area needs application of N and P containing fertilizer. However, the rates applied differ with diverse factors such as soil types, agro-ecology, farmers' perception to fertilizer and resource endowment. In contrast to this, variability to fertilizer application, blanket fertilizer recommendations have been adapted through extension program in the

Ethiopia. The blanket recommendations are regardless of considering the physical and chemical properties of the soil as well as does not taken to account climatic condition and available nutrient present in the soil (Taye Bekele *et al.*, 2000).

As indicated by (Kenea *et al.*, 2001) 100 kg ha^{-1} of DAP and 100 kg ha^{-1} of urea were set by the Ministry of Agriculture and Rural Development and these blanket recommendation lead to excess or low application of chemical fertilizers, that aggravates stunted growth of plants due to toxicity or deficiency of the essential elements (Abreha and Yesuf, 2008). Consequently, fertilizer recommendations should take into account the available nutrient already present in the soil. However, for many years no studies have been conducted on site specific fertilizer recommendation rate.

To come up with solution, soil test based crop response phosphorus recommendation and verification trial was conducted in Gechi and Chora Districts and determination of optimum N-fertilizer, P-Critical level and P-requirement factor were completed and promising result was obtained. Therefore, the trial was conducted to undertake participatory demonstration of soil test crop response based phosphorus fertilizers recommendation rate for bread wheat under farmers' condition.

The objectives of study:

- To evaluate yield performance and profitability of p-fertilizer recommendation under farmers' condition,
- To create awareness on the importance of site specific crop response based p-fertilizer recommendation and
- To collect feedback on the yield of soil test crop response based p-fertilizers recommendation rate for maize under farmers' condition.

Methodology

Description of the study areas

Chora is one of the Districts in the Buno Bedele Zone of Oromia Region of Ethiopia. Chora is bordered on the south by the Jimma Zone, on the west by Yayo, on the north by Dega, and on the east by Bedele and its major town is Kumbabe. The district is located at 519 km and 36 km from the capital city of Ethiopia, Addis Ababa and Buno Bedele zonal capital town, Bedele, respectively. It is located at an average elevation of 2000 m.a.s.l and located at $08^0$13'33.7" to $08^0$33'55.0" N latitude and $035^0$59'59.7" to $036^0$15'15.8" E longitude. It is characterized by warm climate with a mean annual maximum temperature of 25.5°C and a mean annual minimum temperature of 12.5°C. The annual rainfall ranges from 1000-1500mm. The economy of the area is based on mixed cropping system and livestock raring agricultural production system among which dominant crops are maize, teff, sorghum and wheat.

Gechi District is located in Buno Bedele Zone of Oromia Region, south western Ethiopia. It is located at longitude and latitude of 8º27'N36º21'E and 8.450ºN36.350ºE, respectively at about 462 km road distance southwest of Addis Ababa. The area has an altitude between 1500-2100m above sea level and humid agro ecology. The average annual rainfall ranging from 1000 to 1200 mm and the minimum and maximum daily temperature of 13ºC and 18°C. There are diversified economic activities in this District. Crop cultivation and animal rearing are the most known activities that the societies practice. The major crops grown are: maize, tef, sorghum, barley, wheat, pulses and coffee.

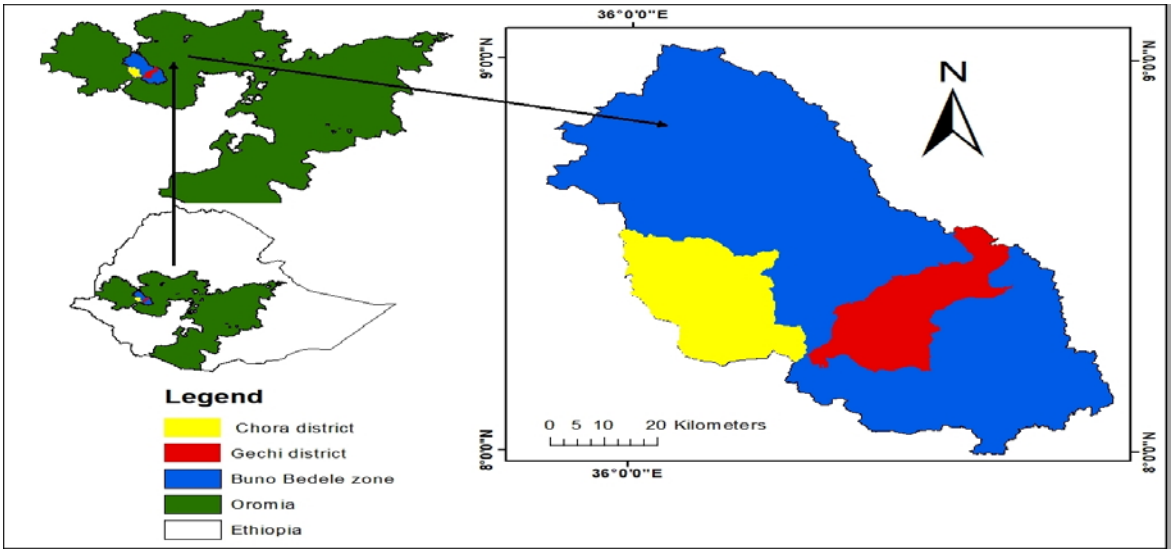

Figure 1: Map of Chora and Gechi Districts

Site and farmers' selection

Purposive sampling method was employed to select Chora and Gechi Districts from the Buno Bedele Zone based on wheat production potential, completed calibration and verification studies. From each District, three representative kebeles were selected purposively by considering road accessibility and production potentialities and two well-represented farmers' training centers (one FTC per District) were used to simplify the demonstration process and enhance the participation of follower farmers and other stakeholders during technology extension events.

Availability of suitable and sufficient land to accommodate the trials, willingness to contribute the land, vicinity to roads to facilitate the chance of being visited by many farmers, initiatives to implement the activity in high-quality, good in field management and willingness to explain the technologies to others were the criteria used to select the hosting farmers. One FRG having 10-12 members including hosting farmers were established in each kebele in collaboration with community leaders, DAs, SMS, and FRG members. Accordingly, the experiment was carried out on two FTCs and 18 farmer's fields (three hosting farmers per kebele), which are used as replication.

Field design and materials

The trial was conducted on soil test crop response based recommended Phosphorus fertilizer rate for bread wheat (Liban) and blanket recommendation on 12 m x 20 m experimental plot size for each treatment with the spacing and seed rate of 20 cm between rows and 125 kg ha^{-1}, respectively.

Surface composite soil samples were collected from the experimental fields at a depth of 0-20 cm by using an auger to analyze available P and pH with standard laboratory procedures before planting time. The rate of fertilizer applied was calculated by the formula (kg P ha) = (Pc-Po)*Pf, where: Pc = Critical P-value, Po = Initial P- values for the site and Pf = P requirement factor based on initial phosphorus status in the soil. The recommended N fertilizer rate that was 92 and 138 kg ha^{-1} in Gechi and Chora Districts respectively were applied in split application of 1/3 at planting time and 2/3 at one month after planting with the necessary agronomic and management practices. The experimental fields were prepared by using oxen plow following conventional farming practices followed by the farming community in the area. Thus, experimental field preparation was carried out by hosting

farmers whereas activities such as planting, first and second weeding, harvesting and threshing were handled by FRG members with close supervision of the researchers.

Technology demonstration approaches

The extension events such as training and field visits/tours were organized at the representative site to enhance farmer to farmer learning and experience sharing. FRGs members and concerned stakeholders were motivated to participate on these different extension events. Field visit was arranged for farmers, DAs, and experts to create awareness on the soil test based fertilizer application technology.

Data collected and

The grain yield data and the total number of farmers participated on field visit and training were recorded. The cost incurred and profits gained data were collected.

Methods of data analysis

Simple descriptive statistics were also used to analyze quantitative data; while qualitative data were analyzed using narrative explanation. The economic related data were analyzed using gross margin analysis.

Results and Discussions

Yield performance of Wheat technologies

Application of site specific p-fertilizer recommendation and optimum N-fertilizer causes higher yield performance over blanket fertilizer recommendation/farmers' practice. Fertilizer application based on soil test also correct the imbalances in nutrients according to crop requirements, increases produce and efficient use of fertilizer for improving wheat production. Farmers were observed different experimental sites and appreciated the performance of Wheat technologies. Participants reflect their feedback as soil test crop response based fertilizer recommendation generates higher return and yield over blanket recommendation/farmers' practice based on variability between treatments of demonstration sites. Soil testing is the most reliable tool for making good economic and environmental decisions about applying fertilizers; hence it is helpful for efficient and effective use of urea and P-fertilizers. The result obtained from the trial conducted at Chora and Gechi districts indicates that fertilizer application based on site specific soil test was higher bread wheat grain yield over blanket recommendation. The use of site specific fertilizer application enhanced the mean bread wheat grain yield from 13.5 and 21.6 qt ha^{-1} (blanket recommendation) to 24.9 and 32.3 qt ha^{-1} (soil test crop response based p-fertilizer recommendation) in Chora and Gechi districts respectively.

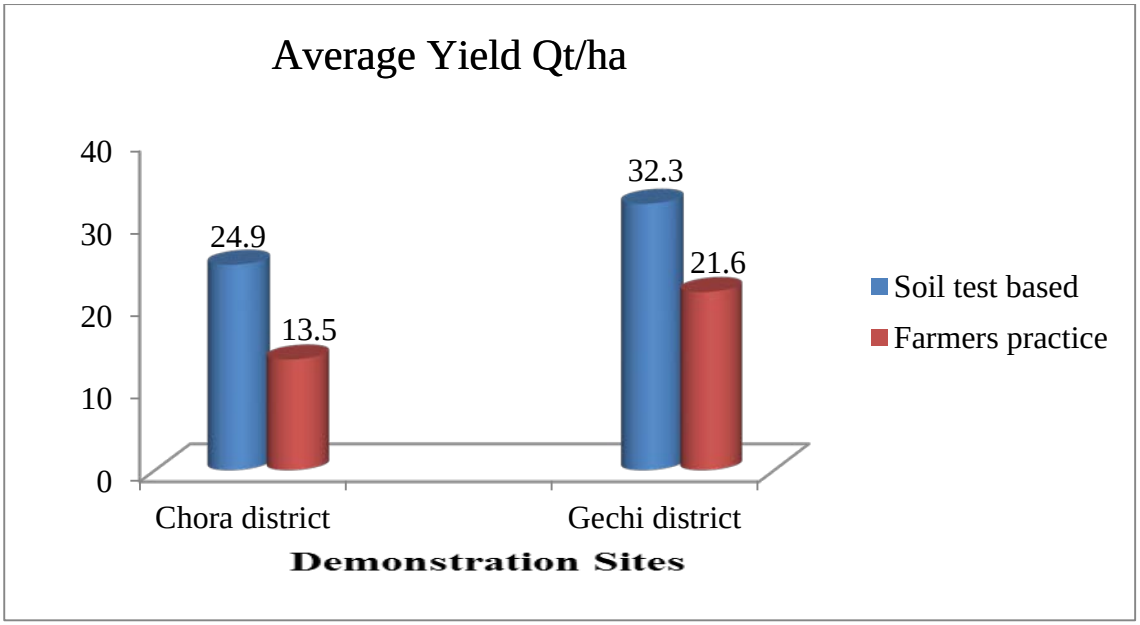

Figure 1: Mean yield data of the demonstrated technologies in the districts

Yield advantage of the districts were calculated using by formula
Where**,** STCRBFR = Soil test crop response based p- fertilizer recommendation

$$\text{Yield advantage \%} = \frac{\text{Yield of STCRBFR (qt ha-1) - Yield of FP (qt ha-1)}}{\text{Yield of FP (qt ha-1)}} \times 100$$

FP = Farmers' practice

Table 3: Yield advantage of STCRBFR over farmers 'practice

Treatment	Mean yield (qt ha^{-1})	Yield advantage (%) over Farmers' practice
Farmers' practice	17.55	-
soil test crop response based fertilizer recommendation	28.6	63

As the result of the above table 3 indicates STCRBFR is more strategic toward increment of farmers production and hosting farmers had obtained more than 60% of yield advantage from soil test crop response based p- fertilizer recommendation over the blanket recommendation (farmers' practice).

Economic Analysis

Economic analysis was done using gross margin analysis at prevailing market value of the grain and inputs during the cropping period. Only total costs that varied were used to compute costs. All costs and benefits were calculated on hectare basis in Ethiopian birr (ETB ha^{-1}). Accordingly, inputs that vary like NPS, N-fertilizer and labor price were 1622 ETB qt^{-1}, 1581.51 ETB qt^{-1} and 75/day whereas, bread wheat grain output was 1500 ETB qt^{-1} at farm gate price. The economic analysis result shows that the highest net income (34,262.7 ETB) was obtained from soil test based fertilizer recommended rate in Gechi and Chora districts.

Table 3: Economic analysis for bread wheat technologies

Locations: Gechi and Chora districts		
Parameters	Treatments	
	FP	STCRBFR
Yield (Y) obtained (t ha^{-1})	1.76	2.84
Unit Price (ETB qt^{-1})	1500.00	1500.00
Total variable costs (ETB ha^{-1})	4028.51	8337.3
Gross Return	26,400	42,600
Net Return (GR-TVC)	22,371.49	34,262.7

Source: Own computing Data, 2020

Note: STCRBFR = soil test crop response based P-fertilizer recommendation, ETB = Ethiopian Birr

Training and Field visit

Training was given to the participants on the concepts of FRG establishment, role and responsibility of FRG members in executing the trial, importance and method of soil sampling and significance of soil test based crop response P-fertilizer recommendation. A total of 68 farmers' (57 Male and 11 Female), 18 DAs (14 Male and 4 Female) and 9 Experts (7 Male and 2 Female) were participating on training. In addition to the training, participatory field visit was arranged in Gechi and Chora districts of Buno Bedele Zone for a total of 118 participants with the aims of sharing experiences especially on how to practice the trial and as all FRG members practice on their own farm.

Table 1: Gender composition stakeholders participated on field visit

Districts	Participants	Male	Female	Total
Gechi	Farmers	27	9	36
	DAs	7	2	9
	Other stakeholders	13	1	14
Chora	Farmers	29	7	36
	DAs	5	4	9
	Other stakeholders	12	2	14
Total		**93**	**25**	**118**

Source: Own Data, 2020

The recommended Phosphorus and Nitrogen fertilizers in the study areas

As Dagne *et al.*, (2017) reported during the calibration study, 3.8 ppm of P-critical level and 30.28 of P-requirement factor was determined and 138 kg ha-1 of nitrogen fertilizer was recommended for the study area. Likewise, the calibration study on bread wheat at Gechi district indicated that a P-critical level of 2.5 ppm and P-requirement factor of 46.06 was determined, and 92 kg ha-1of nitrogen fertilizer was recommended (Dagne *et al.*, 2019). Soil test crop response based Phosphorus fertilizer recommendation treatment was implemented using calibration recommendation whereas farmers' practice was implemented using blanket fertilizer recommendation set by the Ministry of Agriculture and Rural Development that is 100kg ha^{-1} of NPS and urea.

Table 2: Gechi and Chora Districts recommended P and N fertilizer rate

Sites	P_o (initial pvalues)(ppm)	P_c (P critical level) (ppm)	Pf (Requirement factor)	Rate of P-fertilizer applied Kg/plot(240)		Rate of N-fertilizer (urea)applied Kg/plot(240)	
				Fp	STCRBFR	Fp	STCRBFR
Gechi district recommended P and N fertilizer rate per farmers' entire field of experiment							
site 1	1.04	2.5	46.06	2.4	9.77	2.4	4.8
site 2	1.24	2.5	46.06	2.4	8.34	2.4	4.8
site 3	1.96	2.5	46.06	2.4	3.6	2.4	4.8
site 4	1.44	2.5	46.06	2.4	7.019	2.4	4.8
site 5	1.9	2.5	46.06	2.4	3.98	2.4	4.8
site 6	2.04	2.5	46.06	2.4	3.03	2.4	4.8
site 7	1.68	2.5	46.06	2.4	5.5	2.4	4.8
site 8	1.04	2.5	46.06	2.4	9.77	2.4	4.8
site 9	1.4	2.5	46.06	2.4	7.3	2.4	4.8
site 10	1.46	2.5	46.06	2.4	6.9	2.4	4.8
Average	**1.52**	**2.5**	**46.06**	**2.4**	**6.52**	**2.4**	**4.8**
Chora district recommended P and N fertilizer rate per farmers' entire field of experiment							
Site 11	1.16	3.8	30.28	2.4	11.62	2.4	7.2
Site 12	2.64	3.8	30.28	2.4	5.12	2.4	7.2
Site 13	1.38	3.8	30.28	2.4	10.62	2.4	7.2
Site 14	0.96	3.8	30.28	2.4	12.42	2.4	7.2
Site 15	1.3	3.8	30.28	2.4	10.90	2.4	7.2
Site 16	1.34	3.8	30.28	2.4	10.81	2.4	7.2
Site 17	1.16	3.8	30.28	2.4	11.57	2.4	7.2
Site 18	1.1	3.8	30.28	2.4	11.85	2.4	7.2
Site 19	1.44	3.8	30.28	2.4	10.34	2.4	7.2
Site 20	2.35	3.8	30.28	2.4	6.35	2.4	7.2
Average	**1.483**	**3.8**	**30.28**	**2.4**	**10.16**	**2.4**	**7.2**

Note: FP = Farmers' practice; STCRBFR=soil test crop response based fertilizer recommendation.

Source: Own Computing Data, 2020

The result presented in Table 2 indicates there was a varying available phosphorus level within the demonstration sites. The highest the available p of the demonstration sites (2.64 and 2.04 ppm) the lowest it desired the recommended p-fertilizer rate (5.12 and 3.03 kg/plot) and the lowest available p of the demonstration sites (0.96 and 1.04 ppm) the highest it desired the recommended p-fertilizer rate (12.42 and 9.77 kg/plot) based on determined P_c and Pf across Chora and Gechi districts respectively.

Farmers' Feedback

On the exchange visit demonstration site, the participants exchanged their views, opinions and shared their experience. During this time an assessment was made to know how the farmers perceived the technology. Result of the assessment revealed that soil test crop response based fertilizer recommendation was appreciated by farmers in terms of its efficient use of fertilizers and advanced yield advantage over blanket recommendation. Farmers'

requests for soil laboratories accessibility with affordable charge and they also ask technical support to be benefitted from technologies.

Conclusion and Recommendation

As a result of conducted pre-extension demonstration on bread wheat in study areas indicates, the highest mean bread wheat grain yield was obtained from soil test based fertilizer recommendation rate with more than 60% yield advantages over blanket fertilizer recommendation. Similarly, net of return gained from soil test based p-fertilizer recommendation was more profitable than that of blanket recommendation. Due to these results, the farmers reflect their opinion as fertilizer application based on soil tests is an efficient and effective use of fertilizers over blanket recommendations. So, Bedele Agricultural Research Center (BeARC) soil laboratory should be more functional with free/in low charge so that farmers will get access to test their soil. BeARC, Zonal and districts Bureau of Agriculture should work and harmonize on the transfer of the technology to end users/farmers'. Therefore, the pre-scaling up of soil test based p-fertilizer recommendation rate for bread wheat should be conducted for further dissemination of technology in the study areas.

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